博士論文

The Effects of Writing Tutorials on Student Revisions in a Japanese Writing Center

（日本のライティング・センターにおけるチュートリアルが学生の書き直しに与える影響）

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1. Introduction

In recent years, in the field of writing instruction in Japan, writing centers have drawn attention as a support service for students' writing. Writing centers provide one-on-one tutorial sessions with tutors on students' writing such as term papers, articles, and theses beyond the regular curriculum. Tutors at a writing center are mainly undergraduate or graduate students with specialized training in teaching and tutoring academic writing. Tutorial interaction is regarded as the core of writing centers (Harris, 1995; North, 1984). The interaction provides not only individualized instruction (Harris, 1995) but also "a chance to talk to someone about writing whether it is the ideas already on paper or new ideas bringing new possibilities" (Ritter, 2002, p.4). Harris (1995) argues that writing centers do not and should not repeat the overcrowded classroom experience with an overburdened instructor. In her words, the writing center is "a haven for students where individual needs are met" (p.27).

The mission of writing centers is "to produce better writers, not better writing" (North, 1984, p.438). Therefore, writing centers help students to formulate their own plans for effective revisions through tutorial interactions instead of fixing students' papers. That is, a writing center is regarded as a place to foster students' autonomy as writers. Autonomy has been defined by many researchers to date. One of the most representative definitions of autonomy in language learning is provided by Holec, who defines autonomy as "the ability to take charge of one's own learning" (1981, p.3). Holec elaborates this definition as follows:

> To take charge of one's own learning is to have, and to hold, the responsibility for all the decisions concerning all aspects of this learning, i.e.:

－determining the objectives;

－defining the concepts and progressions;

－selecting methods and techniques to be used;

－monitoring the procedure of acquisition properly speaking (rhythm, time, place, etc.);

－evaluating what has been acquired.

The autonomous learner is himself capable of making all these decisions concerning the learning with which he is or wishes to be involved.

(Holec, 1981, p.3)

Benson (2001) defines autonomy as "the capacity to take control of one's own learning" (p.47) and lists three levels of control: learning behavior, psychology of learning and learning situations. Little (1990) describes autonomy as follows:

> "Essentially, autonomy is a capacity － for detachment, critical reflection, decision-making, and independent action. It presupposes, but also entails, that the learner will develop a particular kind of psychological relation to the process and content of his learning. The capacity for autonomy will be displayed both in the way the learner learns and in the way he or she transfers what has been learned to wider contexts." (Little, 1990, p.4).

Little (2002) mentioned that autonomous learners can be interpreted as those who "explicitly accept responsibility for their own learning and exercise that responsibility in a continuous effort to understand what, why and how they are learning, and with what degree

of success" (p.186). Little also argues that "learner autonomy depends crucially on reflection and self-assessment" and "learners gradually become autonomous by developing and exercising the reflective skills of planning, monitoring and evaluating their learning" (p.186). Although the definition of autonomy in language learning differs according to the researcher, the following central features are included (Littlewood, 1999).

> (1) Learners should take responsibility for their own language learning. The reason for this is that all learning, in all cases, is something that can only be done by the learner themselves, and that even when school education is over, the learner is required to develop the ability to continue studying.
> (2) Taking responsibility means taking personal ownership of part or all of the many processes that have hitherto traditionally been performed by a teacher, including deciding the purpose of learning, selecting the methods of learning, and evaluating achievement.
>
> (Littlewood, 1999, p.71)

In the context of second language (L2) writing, there is some literature relating to autonomy (see, for example, Ferris, 2011; F. Hyland, 2000; Hyland & Hyland, 2006). F. Hyland (2000), for example, referred to the term "autonomy" in her study which examined the cases of two students' use of feedback and interactions with their teachers. In her study, autonomy can be used in the sense that students can make their own decisions on feedback use, take full responsibility for their own writing and make revisions on their own using their own strategies.

Based on the definitions above, in the present study, autonomous writers are defined

as those who take responsibility for their writing. Students are considered to be autonomous when they can make an effective revision plan including decision-making on the use of tutor feedback and on revision strategies to be used, monitor the process of their writing, and evaluate their own writing. Students who have learned self-editing strategies (see Cogie, Strain, & Lorinsks, 1999) may also be considered to be a kind of autonomous writers. Ultimately, autonomous writers become able to make self-initiated revisions to improve their writing even without any feedback.

Writing centers started in the 1930s in the United States and expanded from the 1950s and the 1970s (Carino, 2002). To date, a considerable number of studies on writing centers have been conducted in the U.S. (e.g. Blau & Hall, 2002; Carino, 2002; Carter-Tod, 1995; Harris & Silva, 1993; Myers, 2003; Powers, 1993; Ritter, 2002; Thonus, 1995, 1998a, 1998b, 1999a, 1999b, 2001, 2002, 2004; Weigle & Nelson, 2004; Williams, 2002, 2004, 2005). In Japan, on the other hand, the first writing centers were established in 2004, and since then, the number of writing centers has been steadily growing across the country. With the increase in the number of writing centers in Japanese universities, research on writing centers in Japan has been growing year by year. However, much of the research discusses the role and administration of writing centers (Hays, 2010; Itoh, 2008; Johnston & Swenson, 2005; Johnston, Cornwell, & Yoshida, 2008; Johnston, Cornwell, & Yoshida, 2010; Johnston, Yoshida, & Cornwell, 2010; Yoshida, Johnston, & Cornwell, 2010; Yasuda, 2006), while others report the writing center practice at an individual university (e.g., Masamune, 2009, 2012; Matsuta, 2011; Morikoshi, 2008). In the near future, as the number of writing centers in Japan continues to increase, studies on tutorial practice in Japanese writing centers will become necessary in order to provide effective tutorials with EFL writers. Although there are a few empirical studies on writing center tutorials in Japanese

context (Nakatake, 2012; Sadoshima, 2009; Sadoshima, Shimura, & Ohta, 2009), to the best of my knowledge, no previous studies in Japan have attempted to link writing center tutorials with the revisions made later by students to their texts. In the U.S. or other countries as well, the majority of previous studies on writing center tutorials have focused on the interactional features of writing tutorials and there have been very few studies on the effects of writing center tutorials on students' subsequent revisions. In addition, as I, as a tutor, had been involved in tutoring practices at a writing center in Japan for several years under the mission of "producing better writers, not better writing", I have become interested in how writing center tutorials can affect students' revision processes and their writing and how writing center tutorials can contribute to fostering autonomous writers, which led to another motivation of the present study.

As Gally (2010) claims, although the concept of writing centers in Japan has been influenced by U.S. writing centers for non-native speakers of English, not all aspects of American writing centers can be applied to writing centers in Japan, where English is a foreign (not just a second) language. The linguistic, social, and cultural context is significantly different from the cases of U.S. writing centers. Therefore, the findings of the present study are expected to be valuable in that they provide new insights on L2 writing center research as well as writing center research in Japan. In addition, understanding how students respond to what was discussed in a tutoring session in revising their drafts is important and useful for tutors in order to pursue effective tutoring with Japanese EFL students. Therefore, this study aims to investigate the effects of writing center tutorials on students' subsequent revisions. The present study is significant in that it attempts to challenge the unexplored area of writing center studies, which is the effects of writing center tutorials on students' revisions, and it also examines the effects of writing centers

from three perspectives: tutorial conversation during the sessions, students' revisions after the sessions, and their responses to tutor feedback in their revision processes.

In this thesis, there are three major objectives. As mentioned above, there has been little research connecting writing center tutorials and students' subsequent revisions after the sessions. Therefore, one of the primary objects is to accumulate more study results on writing center research by investigating the effects of writing center tutorials on students' revisions. Another objective is to describe what occurs in Japanese EFL writing center tutorials. I hope the present study will serve as a stepping stone to the further development of future writing center research and both L1 and L2 writing instruction in Japan. The final objective is to share the findings from the present study with those who are interested in writing centers, either administrators or writing center researchers, those who plan to establish a writing center or who have already established one, for the future development of writing centers in Japan. I hope that this case study will inspire new initiatives at other writing centers as well. I expect the present study to make an important contribution to the discussion of the role of writing centers in university education not only in Japan but also in EFL countries.

This thesis consists of six chapters. Chapter 2 covers the history and philosophy of writing centers and the introduction of writing centers and their localized practices in Japan. Chapter 3 presents previous studies on student response to feedback, L2 writing center empirical research on writing center tutorials, and scaffolding. In Chapter 4, the methods of the research including research questions, data collection, and data analysis are described. Chapter 5 reports on the results of this study with detailed discussions through triangulated data analyses: firstly tutor feedback offered in writing center tutorials is presented, followed by students' revisions after tutoring sessions in terms of types and use of feedback, then

finally the reasons for their use of tutor feedback in their revision processes. This chapter also discusses what other factors can affect students' revisions. The main findings are discussed in Chapter 6. The last chapter addresses the limitations of the study and future research possibilities, and finally discusses the theoretical significance and implications of the current study and its pedagogical implications.

2. Overview of writing centers

Before reviewing previous literature related to this study, the history and philosophies of writing centers are firstly reviewed. Following this, the introduction of writing centers and their localized practices in Japan are overviewed.

2.1. History and philosophy of writing centers

Writing centers originated in the U.S. in the 1930s. One of the first writing centers in the U.S. was the University of Iowa writing center in 1934 (e.g., Carter-Tod, 1995). At that time, writing centers were called “writing labs”. In the 1960s and 1970s, due to open admissions resulting from affirmative action, colleges and universities were open to various kinds of students including children of immigrants and academically underprepared students (Waller, 2002). In order to cope with this issue, many universities started to provide remediation for the lack of basic academic skills, and writing centers came to play an important role in offering remedial education for L1 English students who were academically underprepared for college, in other words, who did not have writing skills adequate for college-level coursework, which led to the expansion of writing centers in the 1970s. Although the original purpose of writing centers was to help with L1 writing skills, the situation of writing centers changed in the early 1990s due to an increase in the number of international students and immigrants (Sadoshima, Shimura, & Ota, 2009; Sanehira, 2012). Since then, L2 English writers with various linguistic and cultural backgrounds have begun to use writing centers for their English writing (Cartor-Tod, 1995, Williams & Severino, 2004). Today, most major universities in the U.S. have their own writing center, and the establishment of writing centers has taken root not only in the U.S. but also in Australia and Asian countries (Ota & Sadoshima, 2012).

According to Carter-Tod (1995), in the U.S., there are three main types of writing centers: 1) ones directly under the university English department; 2) ones with no affiliations with any department in the university, and 3) ones connected with other learning centers in the university. Gally (2010) describes a typical writing center and tutoring style in the U.S. as follows:

> A typical writing center in the United States is an organizational unit within an educational institution that provides tutoring and other education-related services related to writing. The tutoring is typically done peer-to-peer, meaning that students who have been trained as tutors meet one-on-one with other students ― sometimes called "clients" ―to discuss the clients' writing projects, although tutoring may be conducted by faculty or by nonstudent tutors as well.
>
> (Gally, 2010, p.62)

As mentioned in Gally (2010) above, one of the key features of writing centers is peer tutoring. Although there is another group of tutors called professional tutors, who are usually not students but those with advanced education or degree in writing theory and instruction (Carter-Tod, 1995), in general, U.S. writing centers use both undergraduates and graduate students as tutors. According to Fujioka (2011), "although there are differences in tutor populations at different writing centers, peer tutors seem to be more common than instructional tutors" (pp.208-209). There are a variety of models for writing centers (Kinkead & Harris, 1993), but most writing centers operate peer-tutoring based on Bruffee's (1984) idea that "tutoring is essentially interaction between peers who share similar backgrounds, experience, and status, one that creates a different and powerful context for

learning" (as cited in Williams, 2005, p.37). Fujioka (2011) argues that the two instructional principles of writing centers are process-oriented and student-centered approaches, which are represented in North's (1984) commonly shared mission of writing centers as follows:

> in a writing center the object is to make sure that writers, and not necessarily their texts, are what get changed by instruction. In axiom form it goes like this: Our job is to produce better writers, not better writing. (North, 1984, p.438)

Fujioka (2011) mentions that "collaborative learning between peers, along with two instructional perspectives of process-orientation and emphasis on student learning has created a distinctive instructional approach at writing centers" (p.208).

There are three main philosophies of writing centers (Sadoshima, 2009; Sadoshima, Shimura, and Ota, 2009; Sadoshima & Ota, 2013). Firstly, the ultimate goal of writing centers is nurturing independent writers. Tutors are guided to help writers find their own solutions to writing problems. Tutors show writers how to improve students' texts when students write alone instead of editing papers. The writer is in control of the discussion. Tutors offer hints or a choice of correction methods but leave final decisions to the writer. Second, writing centers are based on a view of writing as a process. In the 1980s, writing centers widely developed along with the idea of the process approach, which suggests that writing instruction focus on the process of writing rather than its product. Students are encouraged to visit the writing center and seek advice at any stage: brainstorming, drafting, and revising. Students can visit the center even before they start to write. Students can make unlimited visits per paper. Students can switch the language of their sessions throughout the writing stages. The last philosophy is Writing Across the Curriculum (WAC), which

supports writing across all disciplines, not just English composition. According to Sadoshima (2009), there are issues common to all writing regardless of the field of research, thus writing is an independent terrain. Therefore, tutors are not required to be experts in a student's field of research. Tutors offer advice from an objective reader's perspective.

2.2 Writing centers in Japan

Although writing centers have a long history in the U.S., it is only recently that writing centers have been introduced to Japanese universities. In Japan, the first writing centers were established in 2004. Since then, writing centers in Japan spread gradually, and as of 2016, the number of Japanese universities and colleges which have started writing centers has increased to more than 20 in Japan (Itatsu, 2016). The number of writing centers in Japan is expected to grow in the future. Background to the foundation of writing centers in Japan is the fact that in recent years in Japan, some universities where some of the courses are taught in English and students are required to do writing assignments in English started taking note of a writing center as one of the support institutions for students' writing beyond the regular curriculum. In addition, Yoshida et al. (2010) explain that many Japanese students have problems on English academic writing at the university levels because there is a big gap between the required academic writing skills at the university level and writing skills students have learned in junior and senior high schools, which led to the introduction of writing centers in Japanese universities. In fact, several studies refer to the lack of Japanese students' academic writing experiences both in Japanese and English. Kobayashi and Rinnert (2002) revealed the lack of emphasis on L1 Japanese writing-related activities in high school. Kobayashi and Rinnert also reported that the Japanese high school students in their study had few opportunities to develop the academic skills required for

writing papers and many Japanese students have problems writing academic papers in the initial stage of undergraduate or graduate course. Nakanishi (2006) found that nearly 80% of all the participants in her study had no experience of writing more than 50 words at a time in English in their junior and high schools. Yasuda (2006) notes that Japanese university students report problems with presenting their ideas logically and evaluating other's opinions critically because they have limited opportunities to develop these skills. These situations created the need and demand for writing centers to offer remedial instruction outside of regular classes. Masamune (2009) argues the need for writing centers beyond the regular curriculum from the different perspective. She points out that it is difficult for teachers to provide each student with suitable instruction to fit their situation or to encourage them to develop their thinking in their writing process even though they can provide feedback to their students because of a large number of students in a class and a limited time of class (pp. 109-110).

As in the U.S. and elsewhere, there is a variety of writing centers in Japanese universities. Osaka Jogakuin College, for example, offers writing tutorials conducted only in English by tutors who are all native-English-speaking full-time or part-time instructors at the college. They help students with course-related English writing, including essays, summaries, and research papers (Johnston, Cornwell, & Yoshida, 2010). The writing center at Osaka Jogakuin College is a part of the Self-Access & Study Support Center (Johnston, Cornwell, & Yoshida, 2008). The University of Tokyo writing center, which is called the Komaba Writers' Studio (KWS), supports particular first-year English courses; Active Learning of English for Science Students (ALESS), Active Learning of English for Students

of the Arts (ALESA), and Fluency-Oriented Workshop (FLOW[1]). At the Komaba Writers' Studio, the graduate student tutors provide students with tutorial sessions in Japanese or English by students' choice and tutor availability.

Although the writing centers introduced so far provide assistance for Japanese students' L2 English writing, there are writing centers to help Japanese students or international students with their L1 or L2 Japanese writing. For example, Kanazawa Kogyo University offers individualized assistance for various kinds of Japanese writing, including students' essays and papers for course assignments and purpose statements and Curriculum Vitas (CVs) for job applications (Yoshida et al., 2010). Similarly, Tsuda College and Kansai University offer consultation for Japanese writing (Yoshida et al., 2010). Kanazawa University and Reitaku University offer writing tutorials to international students on their L2 Japanese writing (Masamune, 2009, 2012 ; Matsuta, 2011).

Waseda University is quite unique in that the writing center assists students with both English and Japanese writing. Students can choose to receive a tutorial session in either English or Japanese or both. At Waseda University, trained Japanese graduate students and international students serve as tutors. The type of support this writing center offers is extensive, from course assignments such as term papers, articles, or theses to application letters for studying abroad. The writing center at Waseda University was originally established for students in the School of International Liberal Studies. It is now open to the students from all the departments with both English and Japanese writing.

Writing centers in Japanese universities are different form U.S. writing centers in the following three points: the populations of tutors, the language of tutorials and the type of

[1] FLOW (Fluency-Oriented Workshop) is a single-term compulsory English program for first-year students to help them improve their English speaking ability, which started in 2015. The class is taught in English by ALESS and ALESA faculty.

support writing centers offer. Tutors in U.S. writing centers are peer tutors, who are undergraduate or graduate students and in most cases, they are L1 English speakers. As mentioned above, U.S. writing centers offer tutorial sessions in English for students' L1 English or ESL writing. In Japan, on the other hand, the major body of tutors are graduate students and the rest are full-time, part-time instructors, or professionals. In addition, tutors in Japanese writing centers are native speakers of Japanese, English, and other languages. Regarding the language of tutoring, there are tutoring English writing conducted in English, tutoring English writing conducted in Japanese. What matters is that most of the writing centers in Japan offer tutorial sessions in English or Japanese for EFL writing within an institution where the primary language of communication is Japanese. Some writing centers help students with L1 Japanese or L2 Japanese writing in Japanese. The Waseda University writing center and The University of Tokyo Writing Center both offer writing tutorials where students have a choice to receive tutors' assistance in either English or Japanese.

As in the U.S. and elsewhere, every writing center is different, and there is no one model among writing centers in Japan (Johnston et al., 2008). As Johnston et al. (2010) explain, "the centers are organized to fit the unique needs of their schools and students, and this has led to diversity among the centers" (p.700). Although there is a great deal of diversity in the types of writing center, writing centers in Japanese universities share the common educational principle, which is "the view of writing centers as a place to help students become independent writers and also develop their ideas through writing" (Fujioka, 2011, p.215).

3. Background of the study

In this chapter, previous studies on the relationship between writing tutorials and student revision are reviewed in Section 3.1 and then previous research on student response to feedback is surveyed in Section 3.2. In Section 3.3, empirical research on writing center tutorials is summarized. In Section 3.4, scaffolding, which is the central concept for the present study to analyze tutorial interactions, is discussed.

3.1 Previous studies on the relationship between writing tutorials and revision

Although numerous studies on writing tutorials between tutors and writers at writing centers have been conducted（e.g. Ritter, 2002; Thonus, 1995, 1998a, 1998b, 1999a, 1999b, 2001, 2002, 2004; Williams, 2002, 2004, 2005), there has been very little research on the effects of writing centers on the student revision. Thonus (2002) points out that "rarely is writing center assessment connected with assessments of quality or change(s) in students' writing" (p.112). The analysis of tutorial interaction is insufficient to understand the whole context of the effects of writing conferences on student revision. For more rich description of students' revisions, the analysis of how students revise their texts after the conference, and how students use feedback they received during the conference in their revision processes is indispensable.

Although very little research has been conducted on the relationship between writing center tutorials and students' subsequent revisions, there has been a few studies that investigated the effects of writing conference on student revision. Goldstein and Conrad (1990) observed how the negotiation of meaning affected the student's subsequent revision in ESL writing conferences. Goldstein and Conrad found that L2 writers had a higher percentage of successful revision when negotiation had taken place in the conferences while

when the students did not negotiate meaning, they either revised unsuccessfully or they did not attempt revision at all. They suggest that the negotiation of meaning does play a role in subsequent revision because "negotiation requires students to be more actively involved in the discussion either by asking questions or answering them, which may lead to better retention" (p.457) and consequently lead to successful revision.

Patthey-Chavez and Ferris (1997) also claim that oral conference did influence students' subsequent revisions. They examined whether the status of the student (weaker or stronger) can affect the conferencing process or students' revisions. Patthey-Chavez and Ferris found that the stronger students more actively participated in the conferences and were able to make more substantial revisions, while the weaker students, who were not actively involved in the conferences, were more likely to simply take the teacher's suggestions and incorporate them directly into their subsequent revisions. They also report that the stronger students received less direct, more mitigated feedback by their teacher than the weaker students.

Haneda (2000) investigated the nature of writing conference between teacher and student in relation to students' subsequent revisions in her Japanese as foreign language classroom, focusing on the difference of students' L2 proficiency level. Haneda found that all the students highly incorporated conference discussion into their drafts and the average number of revisions resulting from conference discussion was the same between the two different proficiency (advanced and intermediate) groups. In addition, it was revealed that advanced students made revisions both on content and language use, while intermediate students were more concerned with language use.

However, these three studies were conducted on writing conference between teacher and student, not between tutor and student at a writing center. Williams (2004) investigated

the effect of writing center tutorials on ESL student revision. Williams analyzed the changes in drafts written after the tutorial session with a T-Units (Hunt, 1965) coding system. A T-unit is "one main clause plus whatever subordinate clauses happen to be attached or embedded within it" (Hunt, 1965, p.735). In Williams' study, the types of revisions were divided into four categories: *Unchanged*, T-units that remained unchanged from the first to second draft, that is, the same text in the same sequence; *New*, T-units that were completely new in second draft; *Small-scale* or *Slight change*, T-units that were grammatically changed; and *Substantial*, T-units that were semantically changed. Williams also attempted to link writing center tutorials with students' subsequent revisions, combined with tutor behavior (explicit/implicit suggestions) and tutee behavior (written notation of suggestions/plan, resistance to tutor's suggestions and acknowledgement of suggestions) during the session. It was found that the focus of tutorial discussion is usually consistent with the focus of revision, and surface-level issues discussed in the session are more likely to be revised than substantial problems. In Williams' study, it was also revealed that negotiations and scaffolding by the tutor is linked with substantial revisions. In addition, the results of Williams' study showed that students' revisions are more likely to be made when tutors' suggestions are direct, when students are actively involved in the tutorial interaction, and when students write down their revision plans during the session.

All these studies mentioned above mainly focus on tutorial interactions themselves and lack the perspective of students' responses to tutorial feedback in revising their drafts. The next section will review previous research on student response to feedback.

3.2 Students' responses to feedback

In the field of L2 writing instruction, there have been a large number of studies on

student response to teacher feedback when revising their drafts. In particular, a comparative study between teacher and peer feedback use has been commonly employed. Connor and Asenavage (1994) examined the impact of teacher and peer feedback on eight ESL students from different countries in the U.S. They found that only 5% of revisions were directly derived from peer feedback, in contrast with 35% resulting from teacher feedback and 60% from self-feedback. Paulus (1999) investigated the response of 12 undergraduate ESL learners to teacher and peer feedback. She found that the students incorporated 87% of the total amount of teacher feedback, against 51% for peer feedback. Tsui and Ng (2000), in the studies on six EFL students' responses to teacher and peer feedback, reported that the secondary ESL students in their study incorporated more teacher than peer feedback into their revisions. Zhao (2010) examined the response of 18 Chinese EFL university students to teacher and peer feedback. She found that the students used more teacher than peer feedback in revising their drafts. The results of her study also indicated that students' understanding of teacher feedback can affect students' response to teacher feedback. In contrast to the results mentioned above, Mendonca and Johnson (1994) found that students used their peers' feedback in more than half their revisions. Nelson and Murphy (1993) showed that students made significant change based on their peers' suggestions in half of the cases. Although much of the previous studies showed that teacher feedback was more likely to be incorporated and led to greater improvements in the writing, some studies suggest that peer feedback also plays a significant role in the students' revisions (e.g., Tsui and Ng, 2000; Yang et al, 2006).

In studies on student response to feedback, several studies focused on students' preference for type of feedback. Zhang (1995) asked 81 EFL students which type of feedback they believed was most effective. The results showed that 94% of all the participants preferred teacher to peer or self-feedback. Nelson and Carson (1998) conducted

interviews with four L2 students and showed that students preferred teacher feedback to peer feedback and consequently they incorporated teacher feedback more frequently than peer feedback in their revisions. Tsui and Ng (2000) explain the reasons for less incorporation of peer feedback that "Firstly, L2 students may not trust their peers' responses to their writing because they are not native speakers of English. Secondly, L2 students from cultures that see the teacher as the only source of authority may consider their peers not knowledgeable enough to make sensible comments and ultimately not incorporate the comments into their writing" (p.149). Hyland (2000) mentions that "peer feedback is seen as a way of giving more control to students since it allows them to make active decisions about whether or not to use their peers' comments as opposed to a passive reliance on teachers' feedback" (p.35).

Previous studies on student response to feedback reviewed above have been mainly discussed in terms of the amount of feedback used in students' drafts. However, to gain a better understanding of student response to feedback in the revision process, how students respond to feedback in revising their drafts should be also taken into account. Nonetheless, there has been a very small number of studies which focused on how students use feedback in revising their drafts. Notably, Hyland (1998) investigated students' reactions to teacher feedback. She collected multiple data consisting of the written data including the student writing (both drafts and revisions) and teachers' feedback, questionnaires, and interviews, teacher think-aloud protocols, and classroom observation. In Hyland's study, students' reactions to teacher written feedback were divided into four categories: (1) Closely followed: a response in which the student closely followed his tutor's advice/suggestion or clearly reflected what was addressed in the session; (2) Initial stimulus: a response in which the student made revisions which went beyond the issues addressed by the tutor's initial

feedback; (3) Avoidance by deletion: a response in which the student avoided the issues raised in the tutorial discussion by deleting the problematic feature without substituting anything else; and (4) Not related: a response in which the student revised the parts which his tutor did not point out or were not discussed in the session. In her study, she focused in more detail on two students who showed a notable difference of feedback use. The results of this study showed that the extent of feedback use varied from student to student. It was also revealed that various factors including cultural and educational backgrounds, their attitude to writing, and their perceptions of offered feedback should be taken into account in order to understand students' uses of feedback. By adopting her categorization of teacher written feedback use, in a previous study, I examined students' responses to what was discussed during the tutorial session in revising their drafts (Nakatake, 2012). The results showed although much of the revision clearly reflected the discussion that took place during the session, others were not related to what was discussed during the session or ignored tutors' advice or suggestions. That study, however, did not conduct a retrospective interview with students. Therefore, the reasons behind those reactions to tutorials have not been revealed yet.

3.3 L2 writing center research

3.3.1 Appropriate tutoring strategies with L2 English writers

Writing centers in the U.S. were originally established to help first language (L1) English writers. However, as the number of second language (L2) English writers visiting writing centers increased in the 1990s (Carter-Tod, 1995, Williams & Severino, 2004), effective tutoring strategies for L2 English writers have been discussed in the field of writing center research.

In the traditional writing theory, tutors are encouraged to take non-directive and collaborative approaches, which help students find answers to problems in their writing through discussions rather than telling them how to change their texts (Williams & Severino, 2004). These approaches are the basis for writing center tutoring practices with L1 English writers. However, Power (1993) reported that traditional non-directive approaches that work with L1 English writers appeared to fail in tutorials with L2 English writers and suggests a directive approach to tutoring with L2 English writers. In addition, Powers suggested that because learners have different educational, rhetorical, and cultural backgrounds from L1 English writers, tutors should teach the ESL learners about rhetorical styles and play a role of cultural informants rather than collaborators. Harris and Silva (1993) also maintained that ESL learners may need more assistance than NESs, not only with language concerns but also with rhetoric and suggested that tutors introduce ESL learners to the rhetorical styles common in U.S. universities. Gillespie & Lerner (2008) maintain that tutors should work with ESL learners in a similar manner as NESs, but that tutors should also consider that ESL writers might need more time for tutorials because of language issues like articles and idioms.

Regarding the treatment of surface-level errors in students' texts, Myers (2003) supports a directive approach to ESL students and encourages tutors to play a role both of writing instructors and foreign or second language teachers. Myers explains that "The central insight in foreign language pedagogy in the last thirty years is that, in fact, language acquisition emerges from learners wrestling with meaning in acts of communicating or trying to communicate. That is exactly what ESL students are doing in writing centers, person to person" (p.64). Like Powers (1993), Cogie, Strain, and Lorinskas (1999) advocate the tutor role of cultural informant in ESL tutoring practice. However, Cogie et al.

mention that some ESL learners may only need assistance with language rather than whole essay issues. Cogie et al. suggest tutors teach self-editing strategies to ESL students in tutoring sessions. Harris and Silva (1993) explain that "tutors need to distinguish between errors that will interfere with the intended reader's understanding of text (global errors) and those that will not (local errors) and to give priority to the former" (p.526). In writing center tutorials, tutors are generally advised to deal first with global errors that interfere with text comprehension rather than local errors which do not interfere with comprehension (e.g., Blau & Hall, 2002; Cogie, Strain & Lorinskas, 1999; Gillespie & Lerner, 2004; Harris & Silva, 1993). Some researchers suggest that when dealing with local errors such as grammar, punctuation, idioms, and word usage, tutors should use a directive approach (e.g., Blau & Hall, 2002; Thonus, 1993; Weigle & Nelson, 2004; Williams & Severino, 2004). Blau and Hall (2002) also suggest that in sessions with NNES students, especially with NNES students who are struggling with English, more directive approach, working line-by-line through a paper, and "an initial focus on sentence-level errors that affect the clarity and meaning of an entire paper can be effective" (p.43). In addition, Blau and Hall (2002) claim that attending equally to global (coherence, content, structure) and local issues (grammar, punctuation, idioms, word usage) is effective in the sessions with NNES students.

3.3.2 L2 Writing center empirical studies

To date, the number of empirical studies on writing center tutorials has been increasing in order to reveal the interactional features of writing tutorials. In particular, as the number of non-native speakers of English using writing centers became larger in the 1990s, empirical studies on writing center tutorials have focused on the difference of interactional features between NS/NS and NS/NNS tutorials. In this section, the findings of

previous studies on writing center tutorials are summarized from the following four perspectives: 1) interactional features, 2) tutor role, 3) the factors of successful tutorials, and 4) learning opportunities.

3.3.2.1 Interactional features

Terese Thonus is a researcher who has actively worked on writing center tutorial interaction from various perspectives for a long time and has provided a great number of valuable findings and significant implications for writing center tutorials. With a focus on the results of Thonus' longitudinal analyses of writing center tutorials as well as other previous studies on writing center interaction, the following interactional features of writing center tutorials are reviewed: 1) communicative dominance, 2) involvement, 3) comprehensibility, and 4) gender/language proficiency.

Regarding communicative dominance, numerous studies reported communicative dominance of the tutors in the interaction and showed that the tutors exhibit more volubility with NNS tutees than with NSs (Ritter, 2002; Thonus, 1995, 1999b, 2002, 2004; Williams, 2004; Young, 1992). Thonus (1995) found that tutors interrupted frequently, and gave a plenty of advice they were not asked to give. Williams (2005) showed that the length of the tutor turn is longer in the sessions with NNS tutees than with NS tutees and tutors make more supportive interruptions to help NNS tutees. In addition, tutors are likely to offer more suggestions to NNS tutees and used less mitigation with NNS tutees (Thonus, 1995, 1998, 2002, 2004; Williams, 2004, 2005). Thonus (1998, 1999b, 2002) provides five directive strategies combined with mitigation in the tutorial interactions: *indirect*, *interrogative*, *first-person modal*, *second-person modal*, and *imperative*, as shown in Table 3.1.

Table 3.1

Directive Strategies

1. Indirect (mitigated):

Maybe the thesis doesn't have to say everything changed on way or the other. (Tutorial F, 195).

2. Indirect (unmitigated):

And when you're unsure about idioms that's a good place to look. (Tutorial H, 80).

3. Interrogative (M):

Is there like some general way you could just say what, what does that, this essay describes? (Tutorial E, 101).

4. Interrogative (U):

And then are you going to have examples (.) of how this script works? (Tutorial B, 25).

5. First person modal (M):

Um (.) if you decide to use this quote, I would suggest that you lop it off. (Tutorial C, 48)

6. First person modal (U):

So I would go with that as well. (Tutorial J, 90)

7. Second person modal (M):

I was just wondering if maybe you just want to make this um a statement rather than a question, just so you can be a little more directive with um (.) gentle reader. (Tutorial A, 81)

8. Second person modal (U):

You need to talk about the intro before you get into the, into the thesis. (Tutorial D, 35)

9. Imperative (M):

So, and then, you know, in some way just to sort of like remind us. (Tutorial G, 30)

10. Imperative (U):

So think about that when you're writing your introduction. (Tutorial L, 157)

(Thonus, 2002, p.119)

Thonus (2002) found that tutor directives were frequent in the tutorial both with NS and NNS, but tutors are more likely to offer explicit directives in the tutorials with NNS tutees (Thonus, 2004). According to Thonus (2002), the most common directive strategy was the second-person modal, and the next most common was imperatives, which was more common in NNS tutorials. Thonus (2004) showed that there were less extended negotiation

sequences in tutorials with NNSs than tutorials with NSs. Thonus (2004) also reported that with NNS tutees, tutors are more likely to use question-answer interrogation sequences rather than negotiation.

With regard to involvement, Thonus (1999b, 2004) showed that tutors were less conversationally involved with their NNS students (fewer turns, fewer topics, shorter and more variable diagnosis phase length) than with their NS students. It was also found that overall, tutorials with NNSs are shorter than those with NSs. She also found that tutors exhibited greater volubility, but fewer overlaps and less laughter in the tutorials with NNSs than with NSs.

In terms of comprehensibility, Thonus (1998, 1999b) found that the tutors use fewer mitigated directives in NNS tutorials than NSs to increase the comprehensibility of their advice or suggestions to NNSs. She also reported that "tutors face a triple-bind: What they believe to be effective tutoring may not be comprehensible, what they believe to be comprehensible may be neither polite nor good tutorial practice, and what they believe to be polite and effective practice with NS tutees may miss the mark altogether with NNSs" (p.12).

Thonus (1999a) investigated the interrelationship between gender and language proficiency. The results showed that female tutors make more suggestions than male ones, that female tutors were more likely to offer unmitigated suggestions, and that NNS and female tutees receive fewer or equal numbers of mitigated suggestions than unmitigated. She also found that institutional context was more associated with tutorial interaction than tutees' gender or NS/NNS status. As lower status discourse participants, both NS/NNS tutees are invariably less dominant than their tutors.

3.3.2.2 Tutor role

The second important factor for analyzing tutorial interaction is the tutees' perceptions of the tutors' role. Several studies reported that NNS tutees expected their tutors to be authoritative or "teacher" and to behave as higher-status interlocutors (Blau & Hall, 2002; Healy & Bosher, 1992; Thonus, 1999b, 2001, 2004). Harris and Silva (1993), for example, noted L2 English writers' unfamiliarity with and confusion over collaborative peer tutoring styles at U.S. writing centers when those L2 students came from cultural and educational backgrounds with expectations of authoritative teacher roles. Thus, Harris and Silva suggested the need for writing center tutors to assume the role of "tellers" (1993, p.533) to some extent. Thonus (2001) examined how tutors, tutees, and course instructors perceived the tutor's role. Thonus found that there was little unanimity in perceptions of the tutor role among them. According to Thonus, the tutor's role is more often compared to instructor roles than to student roles. The results showed that 1) tutors believe that they are directive and of higher status than tutees, 2) tutees believe that tutors have the right and duty to be directive, and 3) instructors believe that tutors act as their surrogates and want them to fill that role. Thonus suggested that tutors should be trained to become "writing instructors of a different sort, supportive yet independent of the classroom" (p.77).

3.3.2.3 Factors of successful tutorials

Some researchers have analyzed the tutorial interactions in writing centers in terms of the success of tutorials. Henning (2001) suggests the three factors that contribute to the perceived success of a tutorial session: 1) "how well the writer and tutor negotiate an agenda" (p.4); 2) "how well the tutor helps the writer gain an understanding of some aspect of writing and helps the writer apply that knowledge" (p.6); and 3) "how well the writer and

tutor establish rapport" (p.9). Thonus (2002) analyzed twelve tutorial interactions with both NS and NNS tutees and found that the most successful tutor behaviors are "1) helping with the definition and the construction of a thesis statement; 2) clarifying and expanding essay content around it; 3) emphasizing student ownership of the paper; and 4) encouraging further contact between the tutee and the course instructor" (p.125). In addition, she identified ten "necessary but not sufficient" (p.126) features of successful tutorials perceived by tutors and tutees as follows:

> 1) The tutor is a student, actively engaged in academic writing in his or her discipline
> 2) The tutor's role as "surrogate" for the instructor is declined by the tutor and also welcomed by the student
> 3) Tutor authority and expertise are not openly negotiated
> 4) The tutor's and the student's diagnoses correspond with each other
> 5) Turn structure resembles that of "real" conversation
> 6) Both tutor and tutee demonstrate high rates of interactional features such as volubility, overlaps, backchannels, and laughter
> 7) Interactional features such as simultaneous laughter, affiliative overlaps, and small talk to promote solidarity are observed
> 8) Negotiation of acceptances and rejections of tutor evaluations and directives is accepted by student
> 9) Tutor mitigation of directives is frequent (for NS tutorials)
> 10) Symmetrical interpretations of discourse phases and directive forcefulness
>
> (Thonus, 2002, pp.126-129)

She also reported that variables such as personal familiarity of tutor with tutee (first-time visit or repeat visit with the same tutor), subject-area match, gender, age, student language

proficiency, and tutor subject-area expertise are unrelated to tutorial success. Weigle and Nelson (2004) conducted a case study on six tutoring sessions between three tutors and three ESL tutees (two sessions for each pair) and identified the factors of tutorials perceived as successful for both tutors and tutees. They reported that the definition of successful tutorials differed depending on tutors. In their study, the following perspective of tutorial success were observed: "the capabilities as a tutor, the tutee's ability to become an independent writer and self-editor, the ability to implement a plan for the session successfully, and the tutee's increased confidence in writing" (p.221). In contrast, it was revealed that the tutees defined success in tutoring in terms of whether they had achieved their writing goals.

3.3.2.4 Learning opportunities

A different approach to the study of writing center tutorials was taken by Ritter (2002), who attempted to link the writing center tutorial interaction with students' learning opportunities. Ritter found that for good or bad, the institutional nature of writing center tutorials constrains the opportunities for ESL writers to engage in interaction conductive to learning. Regarding the positive aspects, tutors can facilitate the learners' awareness to recognize errors in their writing which they may not have noticed or to notice the gaps between their use of English and that of the tutor's through interaction. As for the negative aspects, on the other hand, tutors are in control and might direct the tutorial to the areas which they can work with more comfortably. Ritter argues that as a result, "tutors might prevent students from gaining access to revision and language learning opportunities" (p.269). According to Ritter's study, students' learning opportunities depend on the tutor's actions during the session. Ritter argues that "these opportunities exist when the tutor

invites the learners to speak by opening up the next turn for them" (p. 266). It is evident that tutorials are not for tutors, but for students. Therefore, it is important for tutors to consider how they can help students actively engage in the interaction and how they can deal with their needs through interaction in a writing center.

3.4 Tutorial interaction from the perspective of scaffolding

A different approach to analyze tutorial interactions is adopting the sociocultural perspective of scaffolding. Weissberg (2006) argues that "scaffolding is a central feature of the writing tutorial, since it is through scaffolded dialogue that expert tutors make their unique contributions to the writing development of their student clients" (p.262). In the following section, the definitions of scaffolding are firstly summarized and then how the concept of scaffolding is applied in L2 contexts is reviewed. Finally, studies of scaffolding in writing center interaction are introduced.

3.4.1 Scaffolding

Sociocultural theory is at the heart of the concept of scaffolding. Sociocultural theory was evolved from the work of Lev S. Vygotsky (1896-1934). Vygotsky was a Russian psychologist and theorist of child development. Since Vygotsky's death, Vygotsky's ideas were further developed by his contemporaries such as Luria and Leontiev. After the first of Vygotsky's main writings, *Thought and language,* which was translated into English, published in 1962, his views have become increasingly influential and informed scholars such as Bruner (1985), Wertsch (1985,1998), Rogoff (1990, 1995), and Cole (1996, 1998) (Block, 2003; Mitchell & Myles, 1998).

Central to sociocultural theory is the concept that human mind is mediated. There are

two kinds of mediational tool: physical tools and symbolic (or psychological) tools (Lantolf, 2000). Human cognitive activities are mediated by symbolic tools, one of which is language. Language signifies in sociocultural theory in that it is "tool for thought, or means of mediation, in mental activity" (Mitchell & Myles, 2004, p.194). Block (2003) states that "For Vygotsky, language is the psychological tool which mediates all of our social activity" (pp.90-91). In sociocultural theory, learning is also a mediated process (Mitchell & Myles, 2004). Mitchell and Myles explain,

> Learning is mediated partly through learners' developing use and control of mental tools (language is the central tool for learning). Importantly, learning is also seen as socially mediated, that is to say, it is dependent on face-to-face interaction and shared processes, such as joint problem solving and discussion.
>
> (Mitchell & Myles, 2004, p.195)

Another key concept of sociocultural theory is the dichotomy of other-regulation and self-regulation (Block, 2003). Self-regulated learner is capable of solving problems independently. However, other-regulated learner, who are the child or unskilled individuals, can accomplish with assistance from other more skilled individuals. According to Block (2003), "With other regulation there is appropriate linguistically mediated assistance from a partner or teacher, usually captured in the metaphor of scaffolding" (p.101).

Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD) is also closely associated with scaffolding. Guerrero and Villamil (2000) mention that "the ZPD and scaffolding are two essential concepts in sociocultural theory, a system of ideas based on the work of Vygotsky and colleagues that looks at learning as a fundamentally social act,

embedded in a specific cultural environment" (p.52). ZPD is defined as the "distance between the child's actual development level as determined by independent problem solving and the higher level of potential development as determined through problem solving under adult guidance and in collaboration with more capable peers" (Vygotsky, 1978, p.86). Vygotsky describes,

> "an essential feature of learning is that it creates the zone of proximal development; that is, learning awakens a variety of internal development processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers. Once these processes are internalized, they become a part of the child's interdependent developmental achievement. (1978, p.90).

According to Vygotsky (1978), when a child or a novice learns with an adult or a more capable peer, learning occurs within the child's or the novice's ZPD. Lantolf and Thorne (2007) argue that "the ZPD is not only a model of developmental processes but also a conceptual and pedagogical tool that educators can use to better understand aspects of students' emerging capacities that are in early stage of maturation" (p.220). Although Wood et al. (1976) did not directly connect scaffolding with the theoretical concept of the ZPD, later some researchers have attempted to link scaffolding with the ZPD (see Bruner, 1985; Cazden, 2001; Stone, 1998; Wertsch, 1985) and instruction in the ZPD came to be regarded as scaffolding.

Wood, Bruner, and Ross (1976) is the earliest reference to scaffolding in an educational context. Wood, Bruner, and Ross (1976), who analyzed the kinds of help that

mothers gave their children in trying to build a set of toy blocks, defined scaffolding as " …a process that enables a child or novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts. This scaffolding consists essentially of the adult 'controlling' those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence" (p.90). Wood et al. identified the following six features for successful scaffolding:

1) *recruitment*, in which the tutor captures the child's attention
2) *reduction of degrees of freedom*, in which the tutor simplifies the task at hand
3) *direction maintenance*, in which the tutor keeps the learner on the track
4) *marking critical features*, where the tutor draws the child's attention to key aspects of the task or its solution;
5) *controlling frustration*, where the tutor provides the child with reassurance or a respite from the task; and
6) *demonstration*, in which the tutor models a possible solution to the problem posed by the task

(Wood et al., 1976, p.98).

Wood et al. argue that successful scaffolding depends on how skillfully the tutor manages the interaction between task and tutee's demands.

Lidz (1991) constructed a scale for measuring mediator-child interactions based on Vygotsky's ZPD and Feuerstein's theories (1979, 1980, Jensen & Feuerstein, 1987) and characterized the following 12 important elements of scaffolding:

1) *Intentionality*: Consciously attempting to influence the child's actions. This involves making efforts to keep the interaction going, engage the child's attention, inhibit impulsive behavior, and maintain goal orientation.
2) *Meaning*: Prompting understanding by highlighting for the child what is important to notice, marking relevant differences, elaborating detail, and providing related information
3) *Transcendence*: Helping the child make association to related past experiences and project himself or herself into the future
4) *Joint regard*: Trying to see the activity through the child's eyes; looking at an object that has been brought into focus by the child; using "we" to talk about the experience
5) *Sharing of experiences*: Telling the child about an experience or thought that the mediator had and of which the child is not aware
6) *Task regulation*: Manipulating the task to facilitate problem solving; stating a principle of solution or inducing strategic thinking in the child
7) *Praise/ Encouragement*: Communicating to the child, verbally or nonverbally, that he or she has done something good; keeping high the child's self-esteem
8) *Challenge*: Maintaining the activity within the limits of the child's ZPD. This implies challenging the child to reach beyond his or her current level of functioning, but not so much that the child will feel overwhelmed and get discouraged
9) *Psychological differentiation*: Keeping in mind that the task is the child's and not the mediator's; that the goal is for the child to have a learning experience, not the adult. Avoiding competitiveness with the child
10) *Contingent responsibility*: The ability to read the child's behavior and respond appropriately. It can be compared to a well-coordinated dance between two partners who are very much in tune to one another
11) *Affective involvement*: Expressing warmth to the child; giving the child a sense of caring and enjoyment in the task

12) *Change*: Communicating to the child that he or she has made some change or improved in some way

(Litz, 1991, as cited in Guerrero & Villamil, 2000, p.53)

Although scaffolding has been discussed in various ways, some researchers point out the definition problem of scaffolding. For example, Wells (1998) claims, against Antón and DiCamilla (1998), that they misapply scaffolding and consequently their discussion is not based on the concept of scaffolding in a narrow sense, but rather collaborative learning, because the subjects in their study are peers with little difference in expertise and "there is no deliberate intention to work towards handing over control of the task when the requisite strategies have been mastered" (p.250). He suggests that scaffolding should not be confused with collaborative learning and scaffolding should be used in the context which meets the following three conditions: 1) there is clearly a difference between participants in expertise, 2) the objective is to teach someone something, and 3) the more knowledgeable participant intends to help the partner not only complete the task but also become able to manage the task alone in the future. Therefore, it is necessary to keep in mind Wells's point in an attempt to capture the concept of scaffolding exactly.

3.4.2 Scaffolding in L2 contexts

In L2 contexts, numerous researchers have developed an understanding of scaffolding preserving its essential meaning and have attempted to identify the specific mechanisms of scaffolding.

Aljaafreh and Lantolf (1994) examined how the negotiation of corrective feedback as other-regulation in the ZPD promotes learning. Aljaafreh and Lantolf analyzed the

interactions between the expert (researcher) and the three students who are in the ZPD group. Based on Vygotsky's framework, Aljaafreh and Lantolf listed three effective scaffolded assistances within the ZPD in L2 tutorial contexts: 1) *graduated*, which is sensitive to the learner's level of help required; 2) *contingent*, which is offered only when needed; and 3) *dialogic*, achieved through the medium of dialogue (p.468). Aljaafreh and Lantolf argued that "feedback as other-regulation in the ZPD is not only graduated but is also contingent" (p. 480).

Weissberg (2006) further developed the categories of scaffolding mechanism used by tutors with L2 writers. Weissberg examined how scaffolded feedback addresses global issues such as planning, organizing, revising, and the use of outside source materials, since "previous work on scaffolding in L2 writing contexts has focused mainly on sentence-level issues such as grammar and word choice" (p.252). Weissberg analyzed the linguistic features of scaffolding based on the conversational data of four teacher-student writing conferences by employing inductive analysis (IA). Weissberg constructed the categories of writing tutorial discourse with the three layers of analysis in writing tutorial conversation: a surface discourse layer "mechanism"; a semantic-content layer "topical episode"; and a pragmatic layer "tutor/tutee goals" shown in Table 3.2.

Table 3.2

General Categories of Writing Conference

Topics	Mechanisms	Goals
・Style, "voice" ・Mechanics (grammar, punctuation, paraphrasing) ・Arrangement and organization ・Writing processes and procedures ・Coherence ・Use of source materials ・Citations ・Idea content ・Text format	・Linking moves (lexical/phrasal repetition and paraphrase, expressions of affiliation, and acknowledgement of others' points) ・Negotiating moves (requests for clarification, confirmation checks, comprehension checks) ・Initiating moves (Information questions, proposing a new topic)	・Framing (setting agenda, summarizing, identifying problem areas) ・Instructing ・Problem-solving ・Creating affiliation ・Generating written text ・Evaluating/reflecting on text ・Establishing/maintaining speaker status

(Weissberg, 2006, p.254)

The results of Weissberg's study showed that the most salient scaffolding mechanisms are linking moves such as lexical/phrasal repetition, questioning, phrase completion and extension, summary and paraphrase statements and expressions of affiliation. Additionally, Weissberg suggested that the two essential elements of oral scaffolding are *attachment*, to forge connective links to the student's discourse at the lexical, ideational, and affective levels, and *extension*, to use those links as springboards to instructional points (p.259).

More recently, Ewert (2009) investigated two teacher-learner L2 conferences in the L2 writing classroom. She analyzed the nature of teacher talk by employing Wood et al.'s (1978) features of scaffolding. The results of Ewert's study showed that both teachers used

a variety of scaffolding behaviors in their talk with L2 writers, although its extent of variety is different. It was found that the most obvious scaffolding features for both teachers were *marked critical features*, followed by *demonstrations*, *reducing degrees of freedom*, and *direction maintenance*, while the less represented scaffolding features were *recruitment* and *frustration control*.

Whereas the L2 scaffolding studies discussed above have investigated scaffolding observed in the apparent expert-novice relationship such as teacher-learner or tutor-learner relationship, several researchers have attempted to reveal the scaffolding among peers.

Donato (1994) explored the concept of "mutual" scaffolding among L2 learners and investigated how three adult learners of French mediate each other through collaborative interaction in a classroom by using Wood et al.'s (1978) concepts of scaffolding. Donato found that regardless of their linguistic abilities, the three learners were not only able to provide scaffolded help to each other but were also able to expand their own L2 knowledge and extend the linguistic development of their peers in the process of peer scaffolding.

Villamil and Guerrero (1996) examined the scaffolding dialogues between pairs of L2 writers in reviewing a text written by one member of the pair. Villamil and Guerrero found that both readers and writers provided scaffolding to one another by using the following 14 substrategies of scaffolding

1) *requesting advice*: asking for suggestions
2) *advising*: suggesting revision or recommending that changes be made
3) *responding to advice*: accepting changes or solutions
4) *eliciting*: drawing out opinion or reaction, additional information or content, background knowledge, or understanding of text from peer
5) *responding to elicitation*: giving opinion or reaction, additional information or

content, background knowledge or giving response about meaning as requested by peer

6) *reacting*: making evaluate comments about specific or general aspects of the text

7) *requesting clarification*: asking interlocutor to clarify illegible handwriting or intended meaning,

8) *clarifying*: offering clarification of handwriting or meaning

9) *restating*: interpreting interlocutor's response or paraphrasing text on the basis of understood meaning

10) *announcing*: informing about the contents of paragraph or about missing parts

11) *justifying*: explaining and defending choices or decisions made about the text

12) *instructing*: giving "mini" lessons on grammar, vocabulary, stylistic conventions, or other aspects of writing

13) *giving directives*: ordering peer to take action (read, write, ask, continue with the task, etc.)

14) *making phatic comments*: maintaining social contact rather than communicating specific ideas by means of content-free spaceholders of feedback.

(Villamil & Guerrero, 1996, p.62)

Villamil and Guerrero reported that among those strategies, *advising* and *responding to advice*, *eliciting* and *responding to elicitation*, *reacting*, and *requesting clarification* were most frequently observed scaffolding in the dialogues.

Antón and DiCamilla (1998) observed students of Spanish as a foreign language engaged in a collaborative writing task. They analyzed students' use of L1 (English) as a mediating device in their conversations as they cowrote an essay in Spanish. They found that the students' L1 served them as a scaffold to assist each other in completing the language task. They identified three scaffolding functions of the L1 in the context of L2 learning: a means of generating content for the writing task; a way for students to evaluate

and reflect on the text they had written; and its social use to create an atmosphere of mutual assistance.

Guerrero and Villamil (2000) examined scaffolding dialogues between pairs of L2 writers engaged in reviewing a text written by one member of the pair in the L2 writing classroom. Guerrero and Villamil used previously established categories and features of scaffolding in the ZPD (mainly those in Aljaafreh & Lantolf, 1994; Bruner, 1978; Lidz, 1991; Villamil & Guerrero, 1996; Wood et al., 1978). Guerrero and Villamil found that the reader played a crucial role as mediator and displayed several scaffolding features to facilitate the peer's achievement of the task: a) *recruiting the writer's interest and not letting it flag throughout the interaction*; b) *marking critical aspects of discrepancies in the writer's text*; c) *explicitly instructing or giving mini lessons to the writer on issues of grammar and mechanics*, and d) *modeling* (p.64). Guerrero and Villamil also reported that contingent use of L1 is another important scaffolding mechanism to facilitate the interaction, which supports the results of Antón and DiCamilla (1998).

However, as Wells (1998) points out, these studies are open to question whether they misapply the concept of scaffolding in a strict sense, since the dialogues were conducted between the peers and almost no expert-novice difference was observed. By contrast, Villamil and Guerrero (1996) emphasize the concept of "mutual" scaffolding (Donato, 1994) and argue that although the peers are both two novices, they are "capable of providing guided support to each other through dialogic interaction" (p.68).

3.4.3 Scaffolding and writing center tutorial interaction

As overviewed above, the literature on scaffolding is extensive, yet there has been relatively little investigation of scaffolding in tutorial interaction in the context of a writing

center.

Williams (2002), who referred to scaffolding in the context of a writing center, defines scaffolding as "the verbal support provided to the learner by the tutor that enables the learner to complete a new task" (p.85). She raised questions about how tutors strike a balance between providing the guidance that L2 writers often seek and avoiding editing writers' texts, and argues that the key to solve this question is in the interaction (p.81). Williams drew on the Interaction Hypothesis (Long, 1996), which focuses on the role of negotiation of meaning in language acquisition, and sociocultural theory including Vygotskyan views, and analyzed the oral techniques employed by an expert tutor assisting a novice writer. She found that the tutor provided three different kinds of scaffolded support for the student writer: 1) recasting incorrect utterances, 2) extending and elaborating the student's utterances, and 3) identifying places in the student's text that may require revision.

Thompson (2009) examined tutor's use of verbal and nonverbal scaffolding during the tutorial session in a writing center. She developed a scaffolding framework based on Cromley and Azevedo's (2005) scheme and analyzed one writing center tutorial "assessed as highly successful and highly likely to influence the student's revision" (Thompson, 2009, p.425) between an experienced tutor and a freshman student. In her study, she identified three types of tutoring strategies: *direct instruction*, *cognitive scaffolding*, and *motivational scaffolding*. Each strategy is detailed below.

1) Direct instruction

Verbal: giving explanations, examples, or the answer; explaining the answer; referring to a previous discussion; posing a leading question for a student; and planning what the student should do next.

Nonverbal: topic gestures that refer specifically to some point the tutor wishes to make.

2) Cognitive scaffolding

Verbal: demonstrating; setting up a forced choice between alternatives; hinting to simplify the task, suggest a strategy; give part of an answer, or focus attention; framing or previewing to introduce a new topic; prompting by setting up a response but leaving a blank for the student to fill in; pumping to get the students to elaborate without providing a contextual clue; reading the draft aloud to the student or asking the student to read the draft aloud; responding as a reader.

Nonverbal: topic gesture that act as hints, prompts, or pumps for students or that keep them focused on certain parts of the draft.

3) Motivational scaffolding

Verbal: acknowledging that the task is difficult; using humor; providing negative or positive feedback; reinforcing correct responses from students by repeating them; helping the student maintain motivation and control frustration through sympathy and empathy.

Nonverbal: interactive gestures that intend to build rapport with students.

(Thompson, 2009, pp.427-428)

The results showed that the most frequently used verbal strategies in this conference were

cognitive scaffolding (42.4%), followed by direct instruction (31.2%) and motivational scaffolding (26.4%), which were consistent with the results of Cromley and Azevedo (2005). In addition, it was revealed that hand gestures were highly expressive and communicative like verbal language.

3.5 Writing center studies in Japan

Since writing centers in Japan have a short history, there has been little empirical research done on writing center tutoring practice so far (see Nakatake (2012), Sadoshima (2009), and Sadoshima, Shimura, & Ota (2009) for exceptions). Sadoshima (2009) examined how the tutorial conversations in the writing center affect the students' process of revising their paper through analyzing six tutorial sessions of L1 (Japanese) writing by using of L1 (Japanese). The result supported the opinion of previous research that it is important for writers to spend more time at talk during tutorial sessions. Sadoshima also found that the following four aspects of tutorial talk are important in order to enhance writers' awareness: 1) the tutor responded with shared emotions; 2) the exchange allowed the writer to fully talk about his/her intentions; 3) the writer-tutor exchange focused on the problem that writer himself indicated; and 4) the tutor shared his/her reaction as a reader when they talked about the writer's intention.

Sadoshima, Shimura and Ota (2009) examined the effectiveness of tutoring English writing in the tutees' L1, Japanese. Sadoshima et al. reported that when Japanese students discussed their English papers with their tutors in their L1, Japanese, the students talked more during sessions conducted in Japanese than during those in English and they were more likely to become actively involved in the discussion by asking and answering questions and raising new topics. It was also indicated that students explain their intentions,

suggest revisions, and identify problems in their writing better in Japanese. Furthermore, it was found that when tutoring was conducted in a common L1 for tutors and tutees, the tutees tended to act more as peers of the tutors.

3.6 Limitations of previous research

At the end of this chapter, building on findings and implications of previous research, this study addresses the following unexplored areas of research in L2 writing and L2 writing center.

1) Previous studies have concentrated on the investigations of writing center interaction as pointed out by Thonus (2003) and Williams (2004). Williams (2004) points out the writing center community is reluctant to assess the outcome of writing center tutorials, that is, students' writing after writing center tutorials. Previous research has avoided assessing the outcome of writing center tutorials because it seems to be unable to answer the question on whether the students become better writers. Indeed, very few studies have attempted to associate writing center tutorials with students' revisions after tutorial sessions. Although there are a few studies that investigated the relationship between tutorial interactions and students' subsequent revisions (see Williams, 2004; Nakatake, 2012), neither investigated students' responses to tutor feedback in revision process. For effective writing center practice, writing center studies must be more holistic and longitudinal. To provide better understanding of writing center tutorials, the present study, therefore, investigates the impact of writing center tutorials on student revision and focuses on both tutor feedback and student revision to achieve in depth understanding.

2) With regard to students' responses to feedback, as reviewed in Section 3.2, most of the previous studies focused on the amount of feedback used in students' drafts, and the number of studies that examined how students respond to feedback in revising their drafts are extremely limited (e.g., Hyland, 1998; Nakatake, 2012). Thus, this study investigates how students use what was discussed in the tutorial session and the reasons behind their use of the tutorial discussions through retrospective interviews with students. The results from the present study can offer new insight into the field of L2 writing and contribute to further development not only for L2 writing research as well as writing center research.

3) Most of the previous empirical studies on writing center has been conducted in the context of ESL. As mentioned earlier, since writing centers are relatively new in Japan, only a few empirical studies have so far been made on writing centers in the Japanese EFL context (e.g., Sadoshima, Shimura, & Ota, 2009; Nakatake, 2012). Needless to say, there is a lack of studies that investigate the effects of writing center tutorials on students' revisions in Japan as well. For further development of writing center research in Japan and successful implementation of writing centers in Japan, this study attempts to describe what actually happens in tutorials with Japanese EFL writers in a writing center in Japan through qualitative analysis of tutorial interactions and students' revisions.

4) Although the concept of scaffolding can be applied to tutor-tutee interaction in writing center, very little empirical research on writing center has been conducted in the framework of sociocultural theory. A sociocultural approach provides new and

alternative interpretations of writing center interactions and allows us to deepen our understanding of writing center interactions. With reference to the scaffolding behaviors observed in previous research, this study attempts to identify the scaffolding behaviors in writing center interactions in Japan.

4. Method

This chapter will expand on the methodological framework of this research with a description of the research questions, research setting, participants, data collection and data analysis.

4.1 Research questions

In order to examine the impact of writing center tutorials on students' revisions, the following research questions were formed in this study:

1) What kinds of tutor feedback were offered in writing center tutorials?

2) What kinds of revisions were made after tutorial sessions?

3) How were those revisions affected by what was discussed during the tutorial session when they revise their papers?

4) What are the reasons for the influences?

5) What other factors could affect students' revisions?

4.2 Setting[2]

The setting for this study is a writing center at a large-scale national university called the University of Kanto[3], located in Tokyo, the capital of Japan. Before describing the context of the writing center, some background information about the university where this writing center is affiliated is firstly provided here, since it is highly likely that the context of the university affects the interpretations of the data. The University of Kanto has more than 130 years of history since its foundation, and is

[2] Description of the setting is based on the information provided in the website of the university and its writing center. However, to keep the anonymity of the institution and the participants, referred sources here are not included in the reference list. The information in this section was checked by some of the professors who belong to this university to ensure its correctness.

[3] Pseudonyms are used for the names of the university, the writing center, and the writing program in order to keep its anonymity.

often considered as one of the most leading and prestigious research universities in Japan. The University of Kanto has three main campuses in Kanto area, and facilities affiliated with the university are located all throughout Japan. The University of Kanto consists of ten faculties and 15 graduate schools. According to the data provided by the university, as of 2016, approximately 29,000 students and more than 3,000 international students are enrolled at the university. Focusing on liberal arts as the core of its curriculum, the university offers rigorous undergraduate and graduate programs in various academic fields. All students spend the first two years at the College of Arts and Sciences in order to acquire the fundamental skills for further study. Following the two years, students are admitted into specialized departments for the final two years. The University of Kanto is regarded as one of the most prestigious research universities not only in Japan but also in Asian countries. As a leading research university, The University of Kanto takes on leadership roles in a variety of fields both within Japan and around the world. The globally leading-edge research has been conducted at the University's Graduate Schools, Institutes, and other facilities. The University of Kanto has long been known as premier institution of higher education in Japan. The University of Kanto has a highly selective admission policy based on entrance examinations. Therefore, the students of The University of Kanto are considered to be academically well-prepared for the University's liberal arts education and have higher level of basic academic skills compared to average Japanese university students. The University of Kanto is well known for the excellence of its faculty and students in Japan, and ever since its foundation many of its graduates have gone on to become leaders in government, business, and the academic field.

Next, the context of the writing center where the present study was conducted is described. The writing center, which is called Kanto Writing Center, is unique in that it

is course specific because most writing centers are not course specific. Kanto Writing Center is not an independent learning facility open to the general university community; it only offers services to students who are enrolled in particular English courses in their first year, which are approximately 3,000 students at the College of Arts and Sciences. Kanto Writing Center was originally established under the first-year academic English writing program in 2008. This program is a single-semester scientific academic writing program for first-year undergraduate science students at The University of Kanto, which is called Scientific English Writing Program (SEWP). Background to the introduction of this program is the growing need for English in the field of science and English communication abilities are essential for a successful career as a scientist. In the field of science, most published scientific articles are written in English and there are many opportunities for scientists to give academic presentations in English at both domestic and international conferences where the audience comes from various linguistic and cultural backgrounds. In addition, according to a faculty member of this university, approximately 80% of science students at this university go on to graduate school. At the graduate level, science students are required to write scientific papers in English. However, previous science majored undergraduate students at this university had never received instruction on how to write scientific academic papers in English at the undergraduate level. To meet these needs, this scientific English writing program has been developed to help science major students learn the basis of researching and presenting a science project in English for their future career as global researchers.

In this scientific English writing program, students are required to design and conduct an original small scientific research project (usually an experiment), write a science paper about the experiment in English using the IMRD (Introduction, Methods,

Results, and Discussion) structure, which is the standard format for scientific writing worldwide, and give an oral presentation in English at the end of the semester. In addition, in-class peer tutoring (review) on each other's writing is included in this course. All instructors in this program are native or near-native speakers of English with advanced degrees. This program is taught in English. The average class size is 15 students. According to Itatsu (2016), "active learning is a central philosophy in this program and key components in their active learning include understanding the organization of an academic paper and the logic behind it, learning the importance of the process of writing, and learning to give and receive peer feedback" (p.231). Itatsu (2016) lists the activities in this writing program which most students will experience for the first time as follows:

> -first time taking a course taught in English by an international faculty
> -first time producing any piece of academic writing
> -first time writing a science paper
> -first time searching for academic papers (seeking previous studies)
> -first time performing a 5-minute oral presentation in English (scripts are not allowed)
> -first time engaging in an active learning style classroom
>
> (Itatsu, 2016, p.231)

Considering the Japanese students' lack of academic writing training in English up until the point when they enter universities (e.g., Kobayashi & Rinnert, 2002; Yasuda, 2006; Yoshida et al., 2010), it can be easily imagined that this program might be more or less demanding for many first-year students. This writing center was founded in order to support those students (Itasu, 2016).

At present, the writing center deals with academic writing not only for science

major students but also for humanities and social science students. In addition, the writing center started to offer services to students who are enrolled in a compulsory English course focusing on improving spoken fluency in an academic setting. According to the manual for tutors in Kanto Writing Center, since its establishment in 2008, the mission of Kanto Writing Center is "to facilitate the learning of academic writing and enhancement of critical thinking to first-year science students. Through one-on-one tutorials with tutors, the students are encouraged to develop skills to reflect critically on their own writing and to value the process of academic writing." Kanto Writing Center is open five days a week and offers 40-minute sessions on a one-to-one basis. Students can book a tutorial session beforehand through the online booking system. The sessions in Kanto Writing Center are primarily conducted in Japanese by Japanese graduate students, but currently in Japanese or English by students' choice and tutor availability.

The tutors in Kanto Writing Center are graduate students from various departments and they are native speakers of Japanese or are fluent in Japanese. In 2011, the total number of tutors was nine. According to the director of Kanto Writing Center, at present, there are approximately 30 active tutors who are graduate students in humanities and social sciences at (Itastu, 2016). In order to become a tutor, each applicant submits a writing sample to the director and he or she has to be interviewed by the director. Also, tutors are recommended to take a one-semester course in second-language writing pedagogy (teaching and tutoring English academic writing). This writing center establishes the following guidelines for tutorial practice:

1) During tutorial session, keep "learners' learning" in mind. Refrain from just giving answers to the student's questions. Ask questions that foster the ability of thinking logically.

2) Be friendly and professional. Do not touch students.
3) The session length is 40 minutes.
4) Student-oriented instruction. (The amount of student talk > the amount of tutor talk)
5) Ask questions that encourage the student to discover how to improve the text by him or herself.

(Extracted from tutor manual in Kanto Writing Center, April, 2012; my translation)

After becoming a tutor, they go through tutor training, including tutorial observations and occasional meetings and workshops to share information on the problems and difficulties that each tutor faces. As part of this tutor training, the more experienced tutors give advice on effective tutorial methods to novice tutors.

One of the innovative features of Kanto Writing Center is that the writing center has another support facility, which is called “the SEWP lab” where the students who enrolled in the scientific English writing program can get consultations on their experiments, data collection, and data analysis. Hence, there are two kinds of tutor, writing tutors and science tutors in the writing center. Writing tutors, who come from various disciplines, consult with students on their papers, while science tutors, whose majors are chemistry, physics, and biology, hold science workshops and give advice on the experiment that the students design and conduct for those papers. Sometimes a writing tutor collaborates with a science tutor and provides a joint tutorial session with a student. Joint sessions are often held when students are writing the results and discussion sections of their IMRD structured papers. In a joint session, the writing tutor focuses on issues related to organization and language, while the science tutor provides feedback on how to analyze the data the student obtained in his or her experiment from a scientific and technical perspective.

4.3 Participants

The student participants in this study were 20 Japanese EFL university students in SEWP explained in the previous section during the summer and winter semester of 2011 and the summer semester of 2012. Of the 20 student participants, two are females and 18 are males. They are all Japanese, who speak Japanese as their first language (L1). None of the student participants had ever lived in a foreign country. Table 4.1 profiles each student participant including gender, paper content area, and English proficiency including TOEIC[4] (Test of English for International Communication) and STEP (Society for Testing English Proficiency).

[4] TOEIC (Test of is English for International Communication) is an English proficiency test for non-native speakers of English created by ETS (Educational Testing Service). The test has been adopted not only throughout Japan but around the world as the global standard for English communication skill assessment. In recent years, many companies, schools, and other organizations in Japan are currently utilizing TOEIC as an opportunity to check the English proficiency levels of their workers and students.

Table 4.1

Student Participant Profiles

Student	Gender	Student's Paper Content Area	English Proficiency
S1	Male	Biology	Not tested
S2	Male	Experimental Psychology	Not tested
S3	Male	Experimental Psychology	Not tested
S4	Male	Physics	Not tested
S5	Male	Physics	Not tested
S6	Male	Physics	Not tested
S7	Male	Chemistry	Not tested
S8	Female	Biology	STEP 2nd grade
S9	Male	Biology	Not tested
S10	Male	Physics	Not tested
S11	Male	Physics	TOEIC905
S12	Male	Physics	Not tested
S13	Male	Engineering	Not tested
S14	Male	Physics	Not tested
S15	Female	Physics	STEP 2nd grade, TOEIC870
S16	Male	Geological Science	STEP 2nd grade
S17	Male	Physics	Not tested
S18	Male	Experimental Psychology	STEP Pre 1st grade
S19	Male	Experimental Psychology	Not tested
S20	Male	Experimental Psychology	STEP 2nd grade

Table 4.2 provides a profile of the tutor participants including gender, status, major, and amount of tutoring experience.

Table 4.2

Tutor Participant Profiles

Tutor	Gender	Nationality	Status	Major	Tutoring Experience
T1	Female	Japan	Master	Russian Studies	2011 summer-
T2	Female	dual citizen of the United States and Japan	Master	English Education	2011 summer-
T3	Male	Japan	Master	American Studies	2011 summer-
T4	Female	Japan	Master	International Studies	2011 summer-
T5	Male	Japan	Doctoral	Humanities	2009 winter-
T6	Female	Australia	Doctoral	International social science	2011 winter-
T7	Female	Japan	Doctoral	History	2010 summer-
T8	Female	Japan	Master	American Studies	2011 summer-
T9	Male	Iran	Doctoral	Linguistic	2011 winter-
T10	Female	South Korea	Doctoral	Literature	2010 summer-
T11	Female	Japan	Instructor	Applied Linguistics	2011 summer-
T12	Female	Japan	Master	English Education	2012 summer-

The tutors were 11 graduate students from various departments at the university and one instructor of this writing program. They were either native speakers of Japanese or fluent in Japanese, and all fluent speakers of English. Nine of the tutors are female and three were male. The amount of experience with writing center tutoring varied between the tutor participants. For some, the summer 2011 semester was the first

semester to work at the writing center. Others have worked at the writing center between two and four semesters. Tutoring experience can be one of the important factors which affect tutors' tutorial strategies and the ways of providing feedback with their students during the tutorial session.

In addition, some information about the present researcher is provided here. The researcher was a 27-year-old L1-Japanese female doctoral student at this institution. She started to work as a writing tutor at this writing center in April, 2009, and she continued to be involved in tutoring practice there for several years. Although she was a tutor on the site at the time of the present study, in order to maintain neutrality, she did not tutor on the days of data collection.

4.4 Data collection

With the director's consent, data were collected at the writing center (see Appendix A) during the summer and winter semester of 2011 and the summer semester of 2012.

I began this study by finding students to participate by personally talking to the students who visited the writing center with an appointment before their tutorial session. I gave the students a general description of the study and what would be entailed if they consented to take part in this research. After explaining the study and the procedures, I asked all the students and tutors whether they would be willing to participate in this research. The students and tutors had to agree to be audio-recorded and videotaped during tutorial session. 20 students and 12 tutors signed consent forms (see Appendix B for students, Appendix D for tutors, and Appendix C and E for the English translation) and agreed to participate in the study. Of these 20 students, ten students agreed to be interviewed about the tutorial they received and their revision made after the session. With regard to tutors, seven tutors agreed to be interviewed about the tutorial after the

session.

4.4.1 Tutorial session data

With the students' and tutors' consent, 22 tutorial sessions were audio-recorded by using one voice recorder. All the sessions were conducted in Japanese. In this study, they were also videotaped by using one video camera in order to analyze the tutors' and the students' facial expressions and behavior such as taking notes or underling the text during the session. A voice recorder was put in the center of the table used for the tutorial session to pick up both voices clearly. A video camera was set up as far away as one or two meters from the tutor and the student so that the tutor and the student could interact naturally without being too conscious about the camera. The video-recorded data were used as supplementary data to gain insight into what other factors could affect students' revisions after writing center tutorials (research question 5). All the recorded sessions were transcribed in Japanese, translated into English, and coded by two coders and the author. Japanese utterances are shown in italics.

Table 4.3 provides the detailed tutorial session information. In some tutorials, the students were the same. In other tutorials, the tutors were the same. All sessions were conducted in Japanese.

Table 4.3

Tutorial Session Information

Tutorial	Student	Tutor	First-time visit?	Repeat visit with same tutor?	Session Length (min)	Deadline of submission
A	S1	T1	Yes		61	7 days later
B	S2	T2		No	52	7 days later
C	S2	T3		No	43	2 hours later
D	S3	T4	Yes		36	11 days later
E	S4	T4	Yes		17	12 days later
F	S5	T5	Yes		37	1 day later
G	S6	T1	Yes		56	4 days later
H	S7	T6		Yes	37	17 days later
I	S8	T6		No	44	19 days later
J	S9	T4		Yes	47	14 days later
K	S10	T7	Yes		36	14 days later
L	S11	T4	Yes		25	14 days later
M	S12	T8	Yes		49	3 days later
N	S13	T9		Yes	34	4 days later
O	S14	T8			56	4 days later
P	S15	T10		Yes	19	1 day later
Q	S16	T4	Yes		48	1 day later
R	S17	T4	Yes		48	1 day later
S	S18	T6	Yes		36	4 days later
T	S19	T11		No	58	1 day later
U	S20	T9	Yes		43	48 days later
V	S20	T12		No	45	7 days later

This tutorial session information also includes students' writing center visit, session length, and students' deadline of paper submission. These three factors are helpful to understand the situation that the student is in now. Thus, these supplementary data were used selectively as appropriate when I judged that they could help the interpretation of

the main data.

4.4.1.1 Writing center visit

In this study, before starting the tutorial session, the tutors asked the students whether the tutorial was a first time visit to the writing center or a repeat visit. If the tutors forgot to ask the number of writing center visits, I asked it in the retrospective interview conducted after they submitted their revised draft. The number of writing center visits may affect students' familiarity with tutoring style and tutors, and thus their volubility and behavior during the session. Although the number of writing centers has been increasing year by year, it still cannot be said that the concept of a writing center is widely recognized in Japan. Therefore, writing centers and tutorial sessions are the unknown for many Japanese students and they cannot imagine what the writing center is and had no idea what to do at the center. Compared to first visitors to the writing center, repeat visitors have already known what a tutorial in this writing center is and what they can do during the session. In fact, some repeat visitors are likely to be more actively involved in sessions. In this study, in addition to the number of writing center visits, repeat visitors were asked whether the tutorial represented a repeat visit to a tutor with whom the student had previously worked. Some students intentionally make an appointment with the same tutor with whom the student had previously worked. Others do not care whether the tutor is the same as last time or not, and make an appointment in their available time. In any case, in the writing center, students who have visited the writing center once were more likely to return for further tutorial talk to improve their writing.

4.4.1.2 Session length

In this writing center, one session length was 40 minutes. However, the session length varied depending on the problems the student havs, the quality of students' papers, which section of the paper the student bring to the session. In the writing center, when the deadline of submission is looming, most students bring their full papers to the session. Thus, although they ask the students about which parts they especially want their tutors to check and narrow down the parts they discuss during the session, tutors have to look over the whole text, and in most cases, the number of the parts they discuss during the session is likely to be proportional to text length. As a result, the session length is likely to be longer than the fixed 40 minutes.

On the other hand, there are some tutorials whose session length is extremely short compared to other tutorial sessions like Tutorial E or Tutorial P. With regard to Tutorial E, the immediately prior session was long and drawn out and the start of Tutorial E delayed, which resulted in the shorter session than the fixed 40 minutes. As for Tutorial P, the student had to leave the writing center because of the preparation for her next class, which led to 19 minute session. However, it must be noted that although the session length was shorter than 40 minutes in both tutorial sessions, when they were asked whether they had any other questions or not, they answered that they could discuss all problematic parts they were concerned about and find solutions to them in the time given.

4.4.1.3 Deadline of paper submission

Deadline of students' paper submission is one of the important factors to understand the situation that the student is at the moment. The purpose of visiting the writing center, which section the student brought to the session (text length), and the

points the tutor focused on during the session differ from how much time is left before submitting the final paper. In Tutorial U, for example, the deadline of submission was 48days later and this was the first time for S20 to visit the writing center. He brought his introduction and methods sections to the session. His purpose of visiting the writing center was to ask his tutor to see if all the needed information on his experiment was included in his paper. On the other hand, in Tutorial B, the deadline of submission was two hours later and this was the seventh times for S2 to visit the writing center. He brought his full paper to the session and asked his tutor for the final check, especially for grammar corrections.

How much time is left before submitting the final paper can also affect students' state of mind. If there is still much time left until the student submit the final draft, both the tutor and the student are likely to spend a great deal of time focusing on each problematic point. However, when the deadline of paper submission is looming, some students are nervous or get into crunch mode. Even though the tutors give the students a lot of advice on their papers, they may not be able to incorporate them into their revisions. Therefore, it is crucially important for the tutors to narrow down the points they need to discuss during the session.

4.4.2 Students' written production

In addition to the transcriptions, the drafts that the students brought to the sessions were copied and the copies were retained for subsequent analysis. The writers later also submitted a copy of the revised draft that they completed after the session through e-mail in order to examine the effectiveness of writing center tutorials in the revision process.

4.4.3 Questionnaire

Before conducting retrospective interviews, I asked both the student participants and tutors who had agreed to be interviewed to answer Thompson's (2010) questionnaires consisting of eight questions on the writing center tutorial they engaged in (see Appendix G for students and Appendix H for tutors).The most question items in the two questionnaires parallels each other. Thompson's (2010) questionnaires were originally developed to assess conference success according to the tutor's and student's responses to matching Likert-type scale items. Although the aim of this research is not to assess tutorial success, her questionnaires were employed to provide detailed analysis of each tutorial session and grasp the students' and tutors' attitude towards writing center tutorials. The results of the questionnaire were also used as supplementary data for the following retrospective interviews. The students and tutors were asked not only to answer the questionnaires but also to explain why they chose the answers.

4.4.4 Retrospective interviews

4.4.4.1 Tutee interviews

Within a few days of submitting the revised papers, retrospective interviews were conducted with the students in order to incorporate the students' perspectives on their participation in session and to clarify the reasons for their responses to the writing center tutorials in their revision processes. In this study, ten students agreed to be interviewed. The interviews were conducted in both the researcher's and the student's L1, Japanese. They were audio-recorded with a voice recorder and later transcribed for further analysis (see Appendix F for an example). Prior to the retrospective interviews with students, I finished coding students' revisions according to students' use of tutor feedback. The coding procedures will be described in Section 3.5.

In the interview, firstly I asked them for general comments on the tutorials they received without using established questions for interview in the first place in order to avoid restricting students' alternatives for making comments and avoid researcher's bias. I also asked them about their backgrounds such as past writing center visits, the reasons for visiting the writing center, their English proficiency including TOEIC, TOEFL, STEP, and experience of living or studying abroad. As was mentioned earlier, the number of writing center visits may affect students' familiarity with tutoring style and tutors, and thus their volubility and behavior during the session. The reasons for visiting the writing centers should also be taken into account when interpreting the data. It turned out that there are two types of reasons for visiting the writing center: visit the writing center on their own will or they were forced to go to the writing center by their instructor. The motivation for their tutorials varies depending on the reason, which may affect their behavior during the session and their revisions after the session. Students' English proficiency can be another variable that may influence students' revision strategies. Second, I asked the students why they chose the answer of each question in Thompson's (2010) questionnaire for tutees in order to clearly understand what they meant. Lastly, I asked the student participants why they had made each change, showing copies of the first and the subsequent revised drafts. I also played the videotape back to activate their memories.

4.4.4.2 Tutor interviews

Tutor interviews were conducted in order to investigate their approach to tutorials (tutorial strategies) and what they were thinking during the session. Tutor interviews were usually carried out immediately after the tutorial session, but when the tutor was booked for the next tutorial session, the interview was conducted within a few days of

the tutorial. Seven tutors agreed to be interviewed. The interviews were conducted in Japanese. They were audio-recorded through the use of a voice recorder and later transcribed for further analysis. As is it for tutee interviews, I started a retrospective interview asking the tutors for general comments on the tutorials they offered in order to avoid restricting students' alternatives for making comments and avoid researcher's bias. I also asked them to describe their perceptions of the effectiveness of conferencing and the points they focused on during the sessions. Following this, I asked the tutors why they chose the answer of each question in Thompson's (2010) questionnaire for tutors in order to clearly understand what they meant.

4.5 Data analysis

The data analysis in this study proceeded in three phases: (1) tutor feedback offered during tutorial sessions, (2) types of revision, and (3) students' responses to writing center tutorials in their revision process. Tutorial session data and tutor interview data were used for the analysis of (1). Students' written products and tutee interview data were used for the analysis of (2) and (3). In the subsequent sections, each procedure and measures for analysis will be described in turn.

4.5.1 Tutor feedback

An analysis of tutor feedback was undertaken based on the transcripts of tutorial sessions. What kind of tutor feedback was provided with each revision (both incorporated and not incorporated) was analyzed. All audible speech by the tutor and student was transcribed. After transcription, I compared the transcripts of tutorial conversations with students' revisions and segmented the transcripts into sequences concerned with each revision. This study did not adopt an existing analytical framework

in order to analyze the data obtained in this study, because many existing frameworks were constructed for the analysis of tutorial interactions in ESL contexts and they are considered inappropriate to analyze the features emerged from the tutorial sessions in this study conducted in a writing center in Japanese context. Consequently, original categories for coding tutor feedback were newly created based on the data obtained in the present study. In constructing the framework, a part of the transcripts of tutorial sessions was firstly examined for an initial set of categories, then the resulting categories were modified through further examination of the data. In this process, three subjects of discussion and 11 tutorial strategies as subcategories of the subject of discussion were identified for coding. Finally, the analytical framework with three layers of analysis was constructed: goal, the subject of discussion, and tutorial strategies. The final analytical framework is illustrated in Figure 4.1.

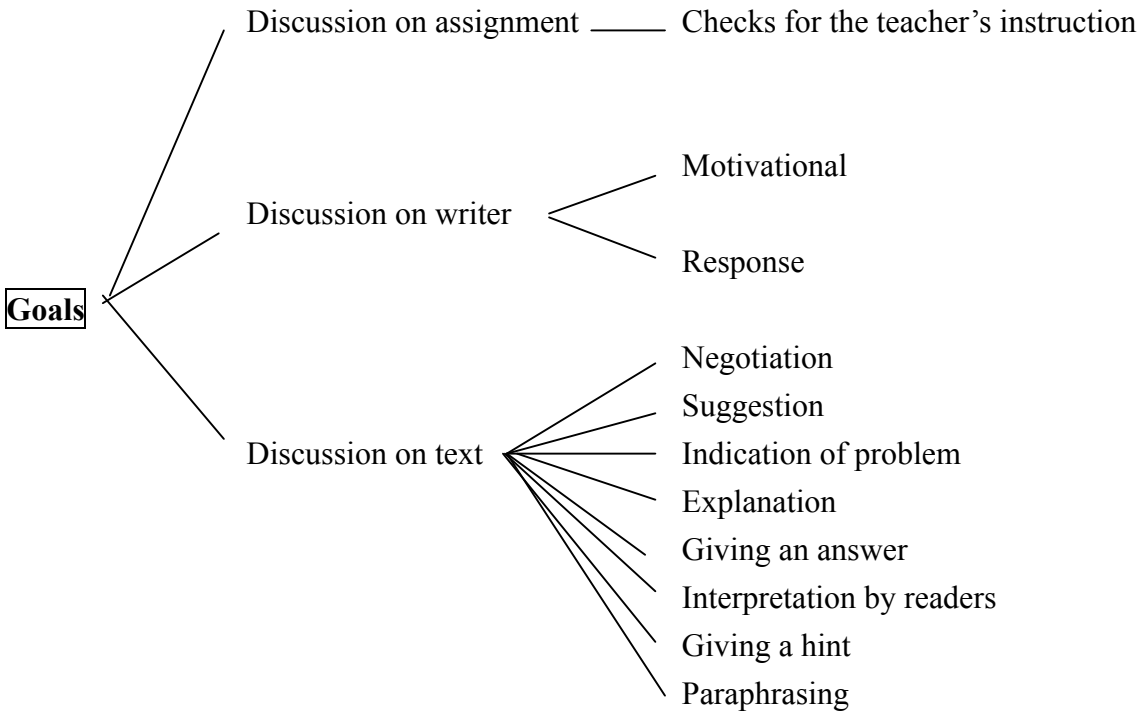

Figure 4.1 Analytical framework for tutor feedback

Each tutor feedback was classified into one of the following subcategories. An example

of each strategy is provided. Japanese utterances are shown in italics and English translations are presented in square brackets.

Negotiation: There are two types of negotiation. The first is negotiation of (for) meaning. Negotiation of meaning includes clarification requests, confirmation checks, and comprehension checks. Clarification requests are used to clarify the student's intentions in the written text. Confirmation checks occur when the tutor elicit confirmation that he or she has correctly understood the student's intentions in the text. Comprehension checks are used to check the student's comprehension of the tutor's suggestions, explanations, or directions. *Negotiations* in the present study is similar to *eliciting* Villamil & Guerrero (1996), is consistent with the second type of scaffolded support shown in Williams (2002), which is *extending and elaborating the students' utterances,* and also observed in Weissberg's (2006) study.

Negotiation of meaning

Clarification requests

T：*Koko de wa nani ga iitai no?* [What do you mean by that?] (Tutorial C)

Confirmation checks

T：*Hyōshiki no koto?* [Do you mean the public signs?] (Tutorial V)

Comprehensions checks

T：*Wakaru kana?* [Does it make sense？] (Tutorial Q)

The second type is negotiation of revisions that is used to clarify revision strategies.

Negotiation of revision

T : *Kore naosō to shitara dōyū fūni shimasu ka?*[How can you improve this part?] (From Tutorial U)

Suggestions: giving a suggested answer(s); suggesting examples or a revision strategy (ies); asking a guiding question; and eliciting additional information. Suggestions such as giving the suggested answer and suggesting examples or revision strategies can be divided into two types: interaction-based suggestions and tutor-initiated suggestions. Interaction-based suggestions occurs after the tutorial interactions with a student. In contrast, tutor-initiated suggestions refers to the suggestions spontaneously made by a tutor without any interactions with a student. *Suggestions* in the present study correspond to *advising* in Villamil and Guerrero (1996) and *cognitive scaffolding* in Thompson (2009).

Giving the suggested answer

T : *Ato, "possible explanation" tte itteru kara, may iranainjanai desu ka?*[And, you wrote "possible explanation", so I think you don't need to use "may" here.](From Tutorial A)

Suggesting examples

T : *Kore mo tatoeba* "show" *toka* "present" *ni sureba īnjanai?*[Why don't you change this into "show" or "present"?] (From Tutorial L)

Suggesting a revision strategy

T: *Koko no bubun o mō chotto gutaiteki ni kaitara iinjyanai kana* [Why don't you write this part more concretely?] (From Tutorial I)

Guiding

T : *Mesoddo tte nani ga daiji?*[What is important in writing the Method section?] (From Tutorial D)

In this situation, the tutor attempts to encourage him to realize what information is missing in his Method section or which part of the text is problematic on his own by asking the student about the important things in writing the Method section.

Eliciting additional information

T : *Soreigai ni kono jikken de erareta kekka o ippanka shite, nanka kō shakai ni kangen dekisō na koto toka attari shimasu ka?* [What else can you generalize the results obtained in your study and give them back to society?] (From Tutorial F)

Indication of problem: pointing out the problems in the draft directly or indirectly. *Indication of problem* in the present study correspond to the first type of scaffolded support of *recasting incorrect utterances* and the third type of scaffolding of *identifying places in the student's text that may require revision* shown in Williams' (2002).

Direct indication of problem

T：*Kankeishi ga ōi ne.*[I think you use too many relative clauses.]

(From Tutorial V)

Indirect indication of problem

T：*Kore desu kedo dō omoi masu ka?* [What do you think of this?]

(From Tutorial N)

Explanation: There are two types of explanation: 1) explaining the suggestion or the reason for the suggestion, and 2) explaining anything to do with writing scientific papers, such as the rules of writing scientific papers, and the structure and functions of each section (Introduction, Methods, Results, Discussion, and Conclusion) of scientific paper. *Explanation* is similar to instructing in Villamil and Guerrero (1996).

T：*Mesoddo de sugoku daiji na no ga jisei no tōitsu.*[Coherence of tense is very important in writing the Method section.] (From Tutorial R)

Giving an answer: There are two types of giving an answer: tutor-initiated and student-initiated. Tutor-initiated refers to giving an answer without being asked by the student including utterances which correct the error or utterances with direct reference to the suggested action. Tutor-initiated giving an answer can be further divided into two ways: verbally and in writing. *Giving an answer* falls into *direct instruction* in Thompson (2009).

T：*Koko ni"the"wairanai.*[You don't need "the" here.] (From Tutorial C)

Student-initiated refers to responding to the student's question or confirmation

S : *"the" wa irenakute ī desu ka?* [Is it OK if I don't add "the"?]

T : *Iya hitsuyō da to omoimasu. Saisho no hōdake.*[No, it's necessary. Only the first part.] (From Tutorial N)

Response: responding to the student's utterance; understanding the student's intention; agreeing with the student's idea or answer; and repeating the student's utterance. An example of agreeing the student's idea or answer is shown in line 3 of the following example. Response is in accordance with a part of *making phatic comments* in Villamil and Guerrero (1996).

1 T : *Bunpōtekini wa ī n desu kedo, demo nanimo kono hyōgen o tsukawanakute mo.*[This expression is grammatically acceptable, but you don't have to use such an expression.]

2 S : when *demo ī desu ka?*[Is it OK if I use *when*?]

3 T : when *o tsukatte mo ī to omoimasu yo*.[Fine. You can use when.]

(Tutorial T)

Checks for the teacher's instruction: Asking a question regarding the instruction from the student' teacher in class

T : *Ato wa koko sa, "I""I""I" tte arundakedo, sensei "I" ni tsuite nanka itteta?*[And here, you use "I""I""I". What did your teacher say about the use of "I"?] (From Tutorial D)

Interpretation by readers: explaining how the readers will interpret the student's text. *Interpretation by readers* can be categorized into *cognitive scaffolding* in Thompson (2009) and is also similar to *reacting* in Villamil and Guerrero (1996).

T : *Kore o yū to gyaku ni yondeiru hito wa dōshite aka janai no tte tabun omoundesu yo ne.* [If you refer to this, the readers will probably wonder why it is not red.](From Tutorial U)

Giving a hint: prompting students by providing alternatives or blanks for the students to fill in; saying part of the answer as a hint. *Giving a hint* falls into *cognitive scaffolding* in Thompson (2009).

1. T : (reads) "15 words used in five experiments were following." *Kore wa tokutei no kotoba o sashite iru yo ne?* [Are they referring to the specific words?]
2. S : *a…hai.*[ah…yes.]
3. T : *Dakara…* ? [So… ?]
4. S : "the"*ga irimasu ka?* [Is "the" necessary?]
5. T : *sōsōsōsō.* [yesyesyesyes.]

(From Tutorial C)

Paraphrasing: paraphrasing the preceding utterance or question. *Paraphrasing* is identified in Weissberg's (2006) study and is also similar to *restating* in Villamil and Guerrero (1996).

1. T：*Kore ga mōsukoshi hakkiri wakatta ra dōyū koto ni tsukaesō?*
   [When you obtain more tangible results, what can you apply it to?]
2. S：*Dōyū koto desu ka?*[What do you mean？]
3. T：*Kore ga wakaru koto no igi tte nani?*[What is the significance of revealing the results?]

(FromTutorial J)

In this situation, in the last turn, the tutor paraphrased the preceding question because she determined that the student did not seem to understand her previous question.

Motivational: acknowledging that the task is difficult; providing positive feedback; helping the student maintain motivation; and using humor. *Motivational* is consistent with *motivational scaffolding* in Thompson (2009).

T：*Ato isshūkan aru shi tabun dekiru to omou. Nannka ne: muzukashī yo ne. Demo naiyō ga shikkari shiteru kara daijyōbu da to omoi masu.* [You have one more week, so I think you can do it. I understand how difficult it is, but the content of your paper is really good. So I'm sure it will be alright.] (From Tutorial V)

In most cases, a sequence of tutorial dialogue concerning one revision contains multiple tutor feedback. Within each sequence, both the tutor and student utterances were divided into turns. One turn could contain more than a single feature. An example of coding tutor feedback is provided.

1. T : *Sorede, saigo koko desu ne. Kono bubun.* "the newer erasers become, the better their performances are". *tte yū no wa dōyū imi de atarashī no?* [Then, finally here. This part. You wrote "the newer erasers become, the better their performances are". Umm, it's a bit confusing. So in what sense "newer"? What does it mean?]
2. S : *Ah:: Rekishi no hensen de*...[Umm…changing times…]
3. T : *Sō desu ne. Hanashi wo kīta kanji dato sō iitai no wa wakarun desu kedo. Ettodesune.(.) Kokode "newer"o tsukacchau to, shinpin to gokai sarete shimau kanōsei ga arun desu yo ne.*[OK. I can guess you are trying to say like that, because you know, I am listening to your story right now. But…well..am, if you use the word "newer" here, um…the readers will take the word "new" for word.]
4. S : *Ah::naruhodo. Tashikani aimai desu ne*.[Yeah…it's ambiguous.]
5. T : *Sō desu ne. Dakara mōsukoshi kangaete mita hō ga. Kore ichibun ni matome naku temo ī node, tatoeba rekishiteki na mono o kangaetemiru to, mā konna fū ni hatten shite kitatte yūfū ni shite. Sono hatten ni ōjite keshigomu wa hatten shite kita mitai na kanji de. Ikutsuka no bun ni waketeshimatte mo kamawanai no de.*

Mōchotto meikaku ni ieru to ī kana to omoimasu.[Yeah**.** So it might be better to think a bit more about this part. You don't need to sum up in a sentence. Um…"Looking back on the history of erasers, erasers have developed in such and such way, and erasers have improved in performance in accordance with its development…you can write like this, for example. I don't see any problem to break this part into several sentences. Please try to write it more specifically.]

(From Tutorial F)

In the first turn, the first portion is classified as indication of problem, and the second portion is classified as clarification requests. The third turn is classified as interpretation by readers. The fifth turn is classified as suggestions. Thus this sequence contains four types of tutor feedback.

4.5.2 Types of revision

At the outset of the analysis, the number of words in each draft was counted. Then I compared the students' first drafts with the subsequent drafts and numbered all the identified revision changes in the text. For the types of revision, I developed new categories based on Williams (2004). Williams (2004) adopts T-units coding system for analyzing students' revisions. A T-unit is defined as "one main clause plus whatever subordinate clauses happen to be attached or embedded within it" (Hunt, 1965, p. 735). Williams (2004) divided the type of revisions into three categories with T-units coding scheme: *Unchanged*, T-units that remained unchanged from the first draft to second draft; *Surface-level change*, T-units that are grammatically changed; and *Substantial*

changes, T-units in which larger chunks of text, at the level of the clause or larger, were added or changed (p.78). In addition, the surface-level changes are subdivided into grammatical and lexical categories. However, this study did not use T-unit coding scheme because many T-units contained several revisions and it was difficult to count the revised T-units. Therefore, this study coded each revision according to the criteria shown in Table 4.4 without dividing the students' texts into T-units. In order to make the revision data more easily-analyzable, I incorporated Villamil and Guerrero's (1998) five categories to analyze student revision (content, organization, grammar, vocabulary, and mechanics) into the initial framework. In addition to their categories, "style", which includes scientific academic writing rules, was added to this framework, because the subject for this study was scientific paper.

Table 4.4.
Criteria for the Type of Revision

Type	Definition
Grammar	subject-verb agreement, word form, tense, number (plural/singular), articles, prepositions, pronouns, conjunctions
Vocabulary	effectiveness in expressing meaning, word choice, idiomatic usage
Mechanics	punctuation, capitalization, use of words for number, spelling, etc
Style	scientific writing style, citations and references
Content	development of idea, elaboration of ideas, adequate/enough support (facts, examples, evidence, details), clarity of ideas or meaning by adding or deleting information
Organization	paragraphing, reorganizing the structure of text by changing the order of sentences within or beyond paragraphs for logical flow,

Examples of Revision Coding

Grammar

Number (plural/singular)

First draft (From S2)

He prepared memory task with 5 categories (numbers, vegetables, alphabets, animals and symbols) and each **categories** was made up with 9 words.

Second draft

He prepared memory task with 5 categories (numbers, vegetables, alphabets, animals and symbols) and each **category** was made up with 9 words.

Tense

First draft (From S15)

The hypothesis **was** that the friction is smallest when ice melt a little.

Second draft

The hypothesis **is** that the friction is smallest when ice melt a little.

Vocabulary

Effectiveness in expressing meaning

First draft (From S4)

In Japanese media's sports news, it was said that the baseballs tended to fly less far than before.

Second draft

Japanese sports media reported that the baseballs tended to fly less far than before.

Word Choice

First draft (From S19)

Figure 2 **means** that human has the subjectivity, but it does not mean that humans do not have the randomness at all, since the SD of human changes **at random** as time passes (Figure 3).

Second draft

Figure 2 indicates that human has the subjectivity, but it does not necessarily mean that humans do not have the randomness at all, since the SD of human changes **randomly** as time passes (Figure 3).

Mechanics

Punctuation

First draft (From S7)

Three different part of solution were obtained by a pipette and measured the sugar content by a brix meter, the temperature was measured at the same time**. (figure 1-D)**

Second draft

Three different part of solution were obtained by a pipette and measured the sugar content by a brix meter, the temperature was measured at the same time **(figure 1-D).**

Spelling

First draft (From S14)

Therefore it appears to be **collect** that the twisted fabrics such as ropes and yarns bring many benefits to people's life.

Second draft

Therefore it appears to be **correct** that the twisted fabrics such as ropes and yarns bring many benefits to people's life.

Content

Adequate /enough support (details added)

First draft（From S11）

The clearest increase in strength was observed.

Second draft

The largest increase in strength was observed **as the surface became finer from #180 to #800.**

Clarity of ideas or meaning by adding information

First draft (From S8)

…there is not a clear **difference** after the three weeks experiment.

Second draft

…there is not a big **difference between the conditions of the water plant of each group** after the three weeks experiment.

Organization

Reorganizing the text within the paragraph for logical flow

First draft（From S9）

According to the results, about 77% of wrong errors is in the range 0.01 ~ 0.02. This indicates that people cannot distinguish errors by about 0.02 × 2.3cm = 0.46mm. On the other hand, over 0.03 is only 23%. This

indicates that people can distinguish errors by about 0.03 × 2.3cm = 0.69mm. Thus, the value of threshold in spatial vision in the participants is in 0.46mm ~ 0.69mm. By these results, my hypothesis that the value of threshold in spatial vision in the participants is over 0.1mm is correct. In fact, these values (0.46mm ~ 0.69mm) are largely different from the theoretical one (0.12mm). If outer factors are not considered, factors which can be considered are inner factors (outer factors cannot be considered in this experiment). **Objects which we see are the vision that is treated by a brain through eyes. Thus, this may suggest that the large difference between practice and theory is caused by the treatment of the brain (David & Torsten, 1979).** The reason why people cannot distinguish tiny difference may be that the brain regards the tiny difference as a trifle (It is difficult to consider other possibilities in this experiment).

Second draft

According to the results, about 77% of wrong errors is in the range 0.01 ~ 0.02. This indicates that people cannot distinguish errors by about 0.02 × 2.3cm = 0.46mm. On the other hand, over 0.03 is only 23%. This indicates that people can distinguish errors by about 0.03 × 2.3cm = 0.69mm. Thus, the value of threshold in spatial vision in the participants is in 0.46mm ~ 0.69mm. By these results, my hypothesis that the value of threshold in spatial vision in the participants is over 0.1mm is correct. In fact, these values (0.46mm ~ 0.69mm) are largely different from the theoretical one (0.12mm). **Thus, this may suggest that the large difference between practice and theory is caused by the treatment of the brain (David & Torsten, 1979). Objects which we see are the vision that is treated by a brain through eyes.** The reason why people cannot distinguish tiny difference may be that the brain regards the tiny difference as a trifle (It is difficult to consider other possibilities in this experiment).

Reorganizing the text within the paragraph for logical flow

First draft (From S8)

I hypothesized that the blue light is the best and the red one is the worst, and that the plants of red group would die, because the color which water plants can use well in its environment is blue while there is not the red light much.

These days, more and more plants are raised in factories, especially for foods. To know the relationship between the growth and the color of light can promote more effective ways in the industry.

Each of four groups of water plants was placed under each colored light (red, blue, green, and transparent). After three weeks, the change of their weights was measured.

Second draft

I hypothesized that the blue light is the best and the red one is the worst, and that the plants of red group would die, because the color which water plants can use well in its environment is blue while there is not the red light much. **Four groups of water plants was placed under each colored light (red, blue, green, and transparent). After three weeks, the change of their weights was measured.**

These days, more and more plants are raised in factories, especially for foods. To know the relationship between the growth and the color of light can promote more effective ways in the industry.

In some cases, one sentence could contain more than one type of revision as shown in the following example.

First draft (From S16)

Then water saturated with sugar is poured into the vessel, and put the vessel into the bigger one filled with fresh water.

Second draft

Then water saturated with sugar **was** poured into the vessel, and **soaked** the vessel into the bigger one filled with fresh water.

The first underline of the sentence is classified as grammar, and the second underline is classified as vocabulary; thus this sentence contains two types of revisions.

4.5.3 Students' responses to tutorial interactions

To analyze students' responses to writing center tutorials, I compared each revision with tutorial discourse, and then made judgments as to whether each revision in the subsequent draft reflected the tutorial interactions in the session. Students' responses to writing center tutorials in their revision process were coded according to the categorization framework shown in Table 4.5. The categorization framework was created based on Hyland's (1998) categorization of students' use of teachers' written feedback and Villamil and Guerrero's (1998) categorization of students' use of peer review. In the final version of the coding scheme of students' responses to writing center tutorials, four categories were used: Directly incorporated, Indirectly incorporated, Not incorporated, and Not discussed (see Table 4.4 for definition). An example of each response is provided.

Table 4.5

Categorization of Students' Responses to Tutorial Interactions

Students' responses	Definition
Directly incorporated	Directly incorporate or clearly reflect what was discussed in the session
Indirectly incorporated	Make revisions based on issues addressed by the tutor's initial feedback
Not incorporated	Not incorporate what was discussed in the session 1) by making no change 2) by deleting the discussed points without substituting anything else 3) by making revisions that are different from the tutor's suggestions
Not discussed	Make revisions seemingly independent of what was discussed in the session

Examples of coding for students' responses

Directly incorporated

Excerpt (1) (from Tutorial D)

T: *Kore tte nante iō to shita no?*[What are you trying to say here?]

S: *Iya tada masatsu ga tte kyōchōshitakatta.* [uh ((laugh)) …I just wanted to emphasize "the friction"…]

T: *Soshitara* "It is the friction which influences…*umm*..which becomes the influence"*toka deī n jyanai?*[Okay, so you can say "It is the friction which influences…umm..which becomes the influence". How is that?]

S: Aa:! [oh:!]

First draft（From S3）

Consequently, friction itself is thought to be changed.

Second draft

Consequently, it is the friction which becomes the influence.

Indirectly incorporated

The following is an example from S16's first draft in which his tutor's feedback acted as an initial stimulus. (The parts that were addressed during the session and revised in the second draft are underlined.)

Excerpt (2) (From Tutorial Q)

T: put *tte amari akademikku raitingu de tsukau noni tekisetsu na kotoba ja nai no ne. Hoka ni* do *toka* nice *toka* good *toka mo sō. Dōshite saketa hō ga iika wakaru?* [Academic writing does not use the word *put*. Other words such as *do*, *nice*, or *good* are also avoided. Do you know the reason?]

S: *Ah::nichijō de yoku tsukau?* [um::we use that kinds of words in daily life?]

T: *Demo* water *toka mo nichijō de yoku tsukau yo ne. Nannde damekatte yūto,* put *tte tagiteki nano ne.* [Yeah, but we use the word like *water* in daily life, too. So the reason is that *put* is a word having multiple meanings.]

First draft (From S16)

Then water saturated with sugar was poured into the vessel, and put the vessel into the bigger one.

Second draft

Then water saturated with sugar was poured into the vessel, and soaked the vessel in fresh water in the bigger one.

The tutorial interaction shown in excerpt (2) acted as initial stimulus for the revision in other part of his paper as follows:

Further revisions based on initial stimulus

First draft

The instrument was put on the stand whose shape was like "L".

Second draft

The instrument was deposited on the stand whose shape was like "L".

Not discussed

First draft (From S7)

The effect of the damage of natto beans by chopsticks are not considered.

Second draft

The effects of the damage of natto beans by chopsticks are not considered.

First draft (From S8)

In addition, this also differs from the common sense that green light is not used well by plants which are green.

Second draft

In addition, this also differs from the common sense that green light is not used well in photosynthesis by plants which are green.

In these excerpts, the underlined parts were added even though his/her tutor had not offered any feedback on these parts.

Not incorporated

The first type of not incorporated revisions is shown in the following example.

Excerpt (3) (From Tutorial S)

1. T：*Koko no* they *wa dare desu ka?*[What do *they* refer to?"]
2. S：*Human beingsdesu ne.*[It is human beings.]
3. T：*Hai. Kore chotto wakarizurai.* [Well, this is a bit confusing.]
4. S：*Wakarinikui desu ka…Judōtai ni suru toka de ī desu ka ne? Moshikuwa people ni suru ka docchi ka ni shiyō to omotte iru n desu kedo.* [It is confusing…Is it OK if I put this sentence into the passive? Or I'm thinking of changing they into people.]
5. T：*Aa:, people ni shite mo docchi demo ī to omoimasu*.[Yeah, I think people can also be OK.]

First draft (From S18)

They also preferred consecutive numbers in ascending order than in descending order.

Second draft

They also preferred consecutive numbers in ascending order than in descending order.

During the session, the tutor pointed out “they” is confusing. However, the student did not revise the part in his second draft.

The next example shows the second pattern of not incorporated revisions in which the student deletes the discussed points without substituting anything.

Excerpt (4) (From Tutorial T)

T: *Kore ga kininaru n dakedo,* connection. Connection *tte yū to* between *nantoka and nantoka janai to nanka…Nanika to nanika ga tsunagatte iru wake desu yo ne?* Connection A and B *janai to meikaku janai to omoimasu.* [My concern is this, connection. If you use the word “connection”, you have to say connection between something and something because connection means something that connects two things, right? I think it is unclear unless you say connection A and B.]

S: A:: hai. [Um:: yes.]

First draft（from S19）

There is no connection with stimulus, however, Figure 3 shows a significant result.

Second draft

Deleted

Although S19 was advised to explain the word “connection” in detail in his first draft, the sentence was completely deleted in his second draft.

The last example indicates the third pattern of not incorporated revisions. In this pattern, the student makes revisions that are different from the tutor’s suggestions.

Excerpt (5) (From Tutorial L)

S: *De, sono sanban me no hagasu chikara no hanashi nandesu kedo, kono katahō no hen kara chikara o kuwaeru tte yū sono edge ni wa an desu ka ne, soretomo the desu ka?* [Umm…this is about the third test, peel strength test. I applied a force pressure only on this edge, and the article of edge is an or the?]

T: *Un…tatoeba one edge to the other tokayū to ī n jyanai kana. Ippen kara mō ippen made tte itta hō ga. Un… end kana, edge janakute.* [Um…for example, how about one edge to the other? It might be better to say one edge to the other. Ah:: oh, end is much better, not edge.]

S: *Hai hai.* [yeah, yeah.]

T: an end to the other *tte yū to wakariyasui kana.* [*an end to the other* is much easier to understand.]

S: *Sō desu ne. Arigatō gozaimasu.* [I see. Thank you very much.]

First draft (from S11)

In this fact, the force perpendicular to the bonded surface was applied from an edge.

Second draft

In this fact, the force perpendicular to the bonded surface was applied from an end.

On the underlined part, although S11's tutor proposed to rewrite "from one end to the other", he only changed the underlined part in his second draft and rejected his tutor's

suggestions that he change “an” end into “one” end and add “to the other” to his original sentence.

4.6 Dependability

Lincoln and Guba (1985) define dependability to mean that the findings are consistent and could be repeated. In order to improve the dependability of the data analysis, two other coders (one is majoring in linguistics and another is majoring in applied linguistics) participated in the process of coding revision types, the students’ use of tutorial discussions in revision process, and tutor feedback. Prior to the coding, I had a preliminary session with each coder separately for an hour to clarify the criteria for coding. In the session, I explained each category and how to code each revision and tutor feedback with the categories showing some examples. Also, we practiced coding with some samples of students’ written products and transcriptions of tutorial conversations. 20 % of all the transcribed data and the students’ first and second drafts was analyzed by two coders and the dependability of the researcher’s coding was confirmed. The agreement ratio regarding type of revision was 96.5%, the students’ use of tutorial discussions in revision process was 98.7%, and tutor feedback was 92.7%. As for the parts in which our identification disagreed, we had a discussion and finally all parts of disagreement reached 100% accordance among three coders.

5. Results

This chapter firstly presents the analytical results of tutor feedback and students' revisions after tutorial sessions, and then discusses what other factors can affect students' revisions. These analyses are triangulated with interview data.

5.1 Tutor feedback

In all tutorial sessions, 381 cases of feedback were provided by tutors. Figure 5.1 represents the breakdown of the focus of tutor feedback.

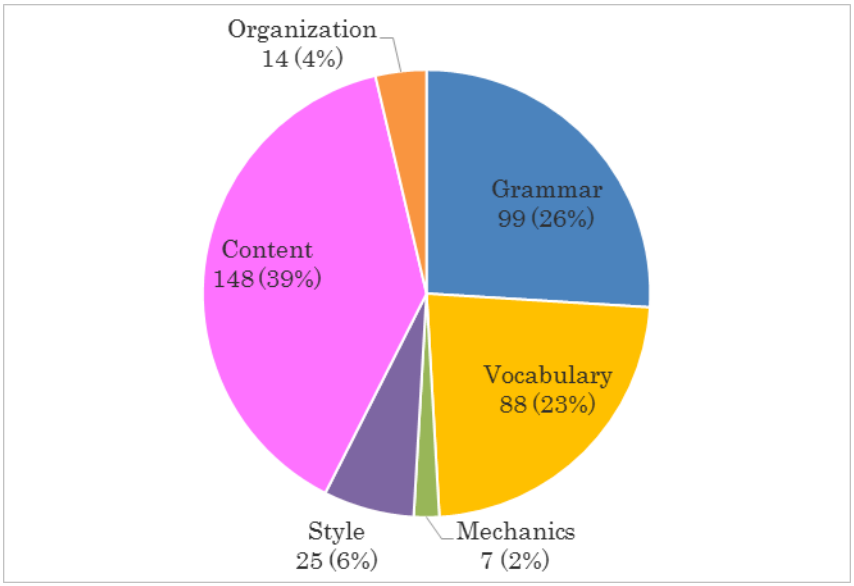

Figure 5.1. The percentages of focus of tutor feedback (N=381)

Results show that tutor feedback focused most often on content (39%) followed by grammar (26%) and vocabulary (23%). This is mainly because in tutor training in the writing center conducted in this study, tutors are instructed to start with global issues such as content, overall structure, sequence of information and then do local issues such as grammatical errors.

Figure 5.2 shows the focus of the feedback according to the section of the paper.

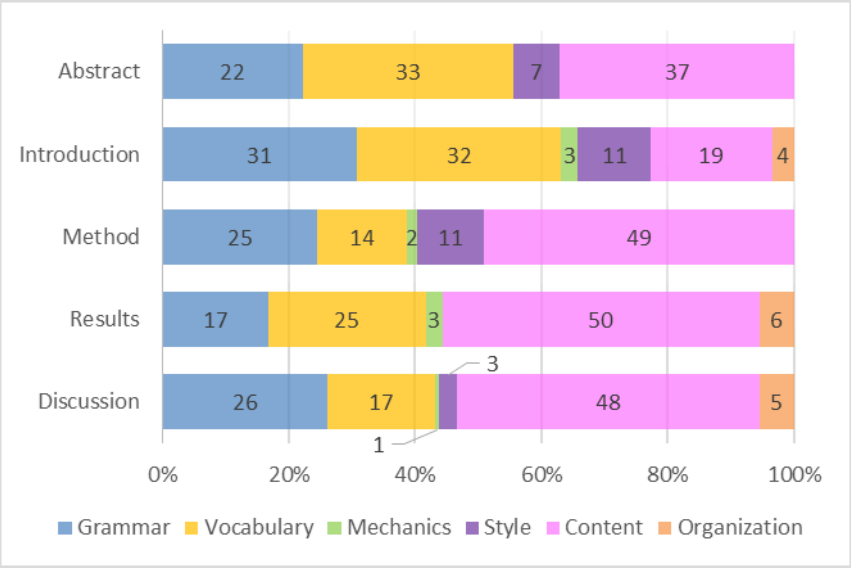

Figure 5.2. The percentages of focus of tutor feedback in each section

Results also suggest that the focus of the feedback varies with the sections of the paper. In most sections, tutor feedback is predominately concerned with content. In contrast, regarding the introduction section, tutors focused more on grammar and vocabulary than content.

Table 5.1 represents the breakdown of tutorial strategies used by tutors. In some cases, the same revision was categorized as a revision related to several tutoring strategies.

Table 5.1

Tutorial Strategies Used by Tutors

Type of tutorial strategies	**Number (Percentage)**
Suggestions	220 (57.74%)
Negotiations	208 (54.59%)
Indication of problem	114 (29.92%)
Giving an answer	100 (26.25%)
Explanations	90 (23.62%)
Response	51 (13.39%)
Giving a hint	39 (10.24%)
Motivational	20 (5.25%)
Checks for the teacher's instruction	16 (4.20%)
Interpretation by readers	12 (3.15%)
Paraphrasing	12 (3.15%)

Note: *N*=381 [Sum of revisions given feedback]

Tutors use a variety of tutorial strategies. *Suggestions* accounted for the highest proportion of all tutoring strategies: *suggestions* were related to 220 revisions out of 381 revisions (57.74%). Excerpt (6) shows a typical example of *suggestions* observed in the current study.

Excerpt (6) (T: Tutor) (From Tutorial I)

T：*Koko no bubun o mō chotto gutaiteki ni kaitara iinjanai kana* [Why don't you write this part more concretely?]

The findings of this study also show that in most cases, tutors make suggestions with an explanation or justification of the suggestion as shown in Excerpt (7).

Excerpt (7) (T: Tutor, S: Student) (From Tutorial D)

T : *Zentaiteki na koto de, nagai bunshō wa saketa hō ga ī kana.* [In general, it might be better to avoid a long sentence.]

S : *Sō desu ka.* [I see.]

T : *Nihongo de mo sō da to omou kedo, chōbun tte yominikui no ne. Tanbun de shinpuru na bun o nanko mo kaita hō ga yomiyasukute, toku ni kagaku ronbun no toki wa jōhō ga tsutawaru koto ga taisetsu dakara.* [I think this is the same in Japanese. A long sentence is not reader-friendly. Using a few short and simple sentences can make the content more reader-friendly. Especially in writing a scientific paper, conveying accurate information to the readers is crucial.]

In Excerpt (7), the two underlined parts illustrate the explanation of the suggestion "it might be better to avoid a long sentence". Explaining the reason why the tutor made the suggestion can help the students more clearly understand why revisions are necessary, which can lead to revisions.

Through retrospective interviews with the tutors, it was found that the tutor participants in the present study had two main reasons for using suggestions. Firstly, the tutors used suggestions in order to avoid imperative expressions and not to impose their answers or ideas on the students but to leave final decisions to the students. The tutors in this study respected the students' intended meanings or ideas and attempt to enhance the students' sense of ownership of their text. Another reason for intentionally using suggestions is that tutors provide feedback based on the recognition that they are not the students' teachers. However, the results of interviews with the students showed that regardless of such tutors' intention, the students make little distinction between

suggestive and directive form. It was also revealed that the students tend to regard their tutors as being as experienced, knowledgeable, and authoritative as their teachers and they believe that tutor suggestions can improve the quality of their texts. Therefore, students are likely to willingly incorporate tutor suggestions into their revisions.

The second most frequently used strategy was *negotiations*: *negotiations* were related to 208 revisions out of 381 revisions (54.59%). As mentioned earlier, negotiation can be classified into two types: negotiation of meaning and negotiation of revision. Negotiation of meaning can be further divided into three types: clarification requests, confirmation checks, and comprehension checks. Within this category, clarification requests and confirmation checks were most often observed. In writing center tutorials, tutors use clarification requests and confirmation checks to negotiate the intended meaning of the students' texts. The results of tutor interviews revealed that tutors use negotiation strategy to raise the students' awareness of problematic points of their texts and also to provide feedback based on the students' intentions or ideas. Through negotiating the intended meaning of their texts with tutors, students realize how their text could be interpreted by readers or which part is hard to understand for readers, which can enhance their awareness of their readers and encourage students to discover how to improve their texts in order to formulate their ideas. In addition, negotiation of meaning is useful for students to organize and clarify what they really want to say. Goldstein and Conrad (1990), in a study of the relationship between teacher-student writing conferences and students' revisions, found that negotiation of meaning plays an important role in successful revisions. Goldstein and Conrad explain that negotiation of meaning requires students to participate more actively in the tutorial discussion by asking questions or answering them, which can lead to better retention of what was discussed during the session. The findings in this study confirmed the results

in Goldstein and Conrad (1990). In this study, *negotiations* led to a large number of incorporated revisions. On the other hand, *negotiation of revision* encourages students to think about how to improve their texts by themselves.

Excerpt (8) (From Tutorial N)

T：*Jā dō naoshimasu ka?* [So what strategies can you use to revise this?]

Typically, tutors firstly use negotiation of meaning to encourage students to organize their thoughts and clarify what they really want to say, and then use negotiation of revisions to help students to find their own answers to problems.

Indication of problem was used to imply that revision is needed and make the students think about how to revise their texts by themselves.

Excerpt (9) (From Tutorial N)

T：*Koko nani ka nuketeimasu ne.* [Is something missing here?]

S：Is *desu ka*？[Is?]

T：*Sō desu ne.* [That's right.]

As shown in the example above, in most cases, after the tutor points out the problem area, the student responds to tutor feedback by guessing the correct answer. In addition, the student may ask the tutor whether the revision based on the tutor's indication would be appropriate. In the present study, this strategy was mainly used along with suggestions and negotiation as shown in the following examples. Indication of problem in each excerpt was underlined and indicated by bold type.

Excerpt (10) (From Tutorial V)

T : *Iitai koto wa wakaru.* ***Demo kankeishi ga ōi ne.*** *Dekitara shugo dōshi wa shinpuru ni kaita hō ga wakariyasui node.* [I know what you want to say, but there are many relative clauses in this sentence. A simple subject and a simple verb of a sentence are much easier to understand.]

Excerpt (11) (From Tutorial V)

T : (reads) "Because it is more important to read the meaning of the letter than the recognition of the existence, it will be easier to memorize letters which you should watch have color." ***Nagai wa.*** *Kaiteiru toki wa kizukanai yo ne. Jā dō shimashō? Chinamini koko dō yū imi?* "the recognition of the existence"? [It's too long. It's quite difficult to find myself writing a redundant sentence, isn't it? How can you change it? By the way, what do you mean by *"the recognition of the existence"*?]

Excerpt (12) (From Tutorial K)

1 T : ***Kore wa chotto tōtotsu na kanji ga shimasu ne***. [It seems a bit sudden.]

2 S : *Hai. Nan te ieba ī n desu ka ne?* [Yeah. What should I say?]

3 T : *Nani ni tsukawareta hiyō desu ka?* [What was the cost used for?]

4 S : *Hane desu ne.*[For blades.]

5 T : *Motto gutaiteki ni?*[Could you be more specific?]

6 S : *Purasuchikku no ita desu kedo. Onaji ryō no zairyō de tsukutta kara onaji mitai na imi de kaita n desu kedo.* [It's a plastic board. I used the word '*same*' in the sense of the same amount of material.]

7 T : 'cost' *tte yū yori mo, onaji zairyō de tsukutta ra tte itta ho ga ī no kamo shirenai desu ne.* [You might want to say "make the blades using the same material" rather than using the word 'cost']

8 S : *Sō desu ne.* [Exactly.].

In excerpt (10), the tutor made suggestions for how to solve the problem after pointing out the problem. Regarding excerpt (11), the tutor used indication of problem followed by negotiation of revision and clarification requests and encouraged the student to get to the answer to the problem by himself. In excerpt (12), since the student asked for advice from the tutor after being pointed out, the tutor started negotiation of meaning with the student, helped the student clarify what he wanted to say, and made suggestions based on it instead of just giving an answer.

In some cases, tutors implicitly pointed out problems with rising intonation.

Excerpt (13) (From Tutorial K)

1 T : same cost? [*same cost?*]

2 S : *Kosuto to yū ka, nandeshō, tsukuru no ni tsukau zairyō mitai na koto desu ne.* [Cost or, well, how should I say, it's just a material used for making it.]

In the situation above, responding to the tutor's indirect indication of problem "same cost?" (line 1), the student realized that he failed to express his intention of this sentence and gave an explanation for his true intention (line 2). Even though tutors do not explicitly point out problems in students' texts, students might be able to recognize the problem by the tutors' intonations or pauses, and deal with it.

Similar to *indication of problem*, *interpretation by readers* was used to implicitly call students' attention to the problem found in their papers, such as the two examples below:

Excerpt (14) (From Tutorial Q)

T：*Kono gurafu o mita toki ni, kono gurafu no doko o mite ī no ka dokusha ni wa wakaranai no ne*. [When readers look at this graph, they might not know where to focus on.]

Excerpt (15) (From Tutorial U)

T：*Hontō ni riyū ga nakereba nani mo iwanakute ī to omoimasu yo. Kore o yū to gyaku ni yondeiru hito wa jā dōshite aka ja nai tte tabun omoundesu yo.* [If you don't have clear reason for it, I don't think you need to mention it. Rather, if you mention it, readers may probably wonder why you did not choose red.]

By responding as a reader, that is, telling the students what readers may think about their texts after reading them, the tutors encouraged them to think about how to articulate their ideas more clearly. This strategy can contribute to enhance the students' awareness of readers in writing.

Basically, *giving an answer* was used to correct the student's grammatical errors, as shown in excerpt (16):

Excerpt (16) (From Tutorial V)

T : (reads) “The result of experiment 1 and 2 is” *Kore futatsu no jikken nan de* ‘results’ *desu ne*. [Here, you talk about two experiments, so you have to say ‘*result*s’.]

In most cases, tutors use other tutorial strategies such as negotiations and indication of problem in order to encourage students to find the answers by themselves at first, and eventually gives an answer,

Giving a hint was used to elicit a correct answer from students instead of giving an answer, such as the following example:

Excerpt (17) (From Tutorial C)

1 T : (reads) “each categories.” *Kore wa fukusūkei kana? Hitotsu no kategorī o sashiteiru yo ne?* [You wrote this in plural form. Is that correct? This refers to one category, right?]

2 S : *Sō desu ne.* [Yes.]

3 T : *Un. Dakara…?* [Okay. So...?]

4 S : category? [category?]

5 T : *Sō sō.* [Yes yes.]

In excerpt (17), the tutor did not correct the student’s mistake “each categories” purposely and encouraged the student himself to correct the mistake by giving a hint (line 1) and prompting by leaving a blank for him to fill in (line 3). Tutors are always conscious of how to help students find answers to problems in their writing in order to achieve the goal of writing centers: to help students become better writers, not

necessarily to create better papers.

Response includes agreeing with the students' opinions and repeating the students' words. An example of this is indicated in the following turns:

Excerpt (18) (From Tutorial U)

1 T : *Kono Tōkyō wa dōshite ōmoji desu ka?* [Why is this "Tokyo" written in capital letters?]

2 S : *Toshi dakara*. [Because it's a city.]

3 T : *Toshi dakara. Aruiwa motto ippanteki ni ieba?* [Okay. Because it's a city. Or what would you say it in more common words?]

4 S : *Koyūmeishi*. [Proper name.]

5 T : *Koyūmeishi. Dakara Kantōdai mo zentaiteki ni koyūmeishi desune. Dakara?* [Proper name. Yes. So the University of Kanto is a proper name, too. So...?]

In this example, the tutor repeated the student's utterances and went on to ask a guiding question. (lines 3 and 5). By doing so, the tutor created the conversational linkages. In other words, tutor's response shows their active involvement and sincere attitude toward the tutorial session, and can play a role of a comforter. As a result, the psychological distance between tutor and student is shortened, which makes it easier for students to actively participate in the session as well. When the tutor responds to the student's idea, the student can feel heard and understood. Tutor response is one of the important factors for creating an atmosphere where students can feel relaxed and actively participate in tutorials.

Motivation strategies are often used when students are asked to make revisions

that require a great deal of thought or at the end of a session. In this study, motivational feedback is likely to be provided after tutors make suggestions that are slightly difficult or demanding for students to incorporate into their revisions, as shown in Excerpt (19).

Excerpt (19) (From Tutorial U)

T: *Yoku kakete iru to omoimasu node, kono bubun wo meikaku ni sureba motto wakariyasuku naru to omoi masu yo.* [I think this is well written, but maybe it could be stronger if you clarify this part.]

Some students may become anxious or discouraged about revising their texts after receiving excessive feedback from their tutors, although they appreciate their useful advice. In such cases, motivational strategies have an effect on fostering students' positive attitudes toward revisions. In general, writing a scientific paper based on a small experiment that they design and carry out is tough work for most first-year science students, and many of them are concerned about whether they can finish writing a paper. Motivational feedback in writing center tutorials plays a role of reducing such students' anxieties face-to-face and gives them a supportive push. In addition, motivational feedback can be thought of as a way to establish rapport with the students and contribute to creating a warm atmosphere during the sessions, which can also lead to build students' positive attitudes toward improving their texts on their own. In the retrospective interview with S18, he remarked that "I could not help but feel anxious about writing a scientific paper on my own because I've never done this sort of thing before. But my concern about writing a paper was relieved and I thought about working hard for revisions after taking a writing center tutoring session. In addition, my tutor not only pointed out the problem areas in my writing but gave me positive comments on my

paper. So I gained confidence in my writing and could successfully finish my paper without losing motivation." Although written feedback can also provide motivational feedback with students, face-to-face motivational feedback in writing center tutorials gets to students' heart much more than written feedback, which could be one of the advantages of writing center tutorials.

Checking for the teacher's instruction is an unique tutoring strategy to this writing center. As mentioned earlier, the writing center in this study is a place to offer individual writing tutorials to students enrolled in certain English writing programs. In other words, all students who visit this writing center take the same scientific academic writing course. However, the rules of writing style such as language use and citations vary depending on instructors. Therefore, even though tutors feel strange with their tutee's writing or feel the need to revise, tutors make a point of asking their tutees what their instructor said in their class. For some teachers, the part the tutor feels the need to revise could be fine. Even though the tutors provide feedback for the good of the student, the feedback might cause a problem of consistency with their teachers' instruction when students submit the revised paper based on the feedback to their teachers. For such occasions, tutors confirm the instruction of the student's teacher.

When students do not seem to understand the tutor feedback or question asked, tutors paraphrase or explain what they said in simpler terms or rephrase the question. In some cases, students ask their tutor "what do you mean?", "Could you say that again?" or "Do you mean this part?", but some students look uneasy or confused. One of the advantages of writing centers is to provide face-to-face writing tutorials in which the tutor can pay constant attention to the student's facial expression and attitude in front of them during the sessions.

In most cases, tutors use tutorial strategies shown in Table 5.2 in various

combinations. All combinations of tutor feedback are presented in Appendix I. The main combinations of tutoring strategies that were frequently observed in this study are as follows:

Table 5.2

Main Combinations of Tutoring Strategies

Combination	Number
Suggestions＋Negotiations	26
Suggestions＋Negotiations＋Explanations	18
Suggestions＋Negotiations＋Indication of problem	17
Negotiations＋Giving an answer	15
Negotiations＋Indication of problem	12
Suggestions＋Indication of problem	12
Suggestions＋Explanation	10

In this study, the combination of negotiations and suggestions frequently occurred during the tutorial sessions. In addition, the combination of negotiation, suggestions, and explanation and the combination of negotiation, suggestions, and indication of problem were also often used. Excerpt (20) shows an example of the combination of negotiations and suggestions.

Excerpt (20) (From Tutorial I)

1 T: *"good" no imi ga chotto aimai kana. Kore wa dōyū imi?* [The meaning of "good" seems to be a bit ambiguous. What do you mean by that?]

2 S: *Ettō, kono bāi kurorofiru, anō shokubutsu ga kōgōsei o suru basho ni kyūshū sareru…* [Ahhm, in this case, chlorophyll, ahh, absorbed into the place where plants photosynthesize…]

3 T: *Hai. Sorenara sōyū fū ni, dōyū imi de "good" nano ka o mō chotto gutaiteki ni itta hō ga ii kana.* [Okay. So, like that, you might explain "in what sense good" more concretely.]

4 S: *Wakarimashita. Jaa "well" toka tsukatte mo ī desu ka?* [I see. Umm, can I use the word "well"?]

5 T: *Daijōbu desu yo.* [No problem.]

Tutors attempt to confirm the student's intended meanings (line 1) before making suggestions (line 3). In other words, tutors make suggestions respecting the students' ideas instead of making suggestions based on the tutors' own interpretations.

5.2 Student revisions after tutorial sessions

The analysis of student revisions is subdivided into two dimensions: type of revision and students' use of feedback in revising their texts. This section reports on the findings of students' revisions after tutorial sessions for Research Question 2: What kinds of revisions are made after tutorial sessions? Next, how students utilize tutor feedback offered in tutorial sessions in the process of revision was analyzed to answer Research Question 3: How were those revisions affected by what was discussed in the

tutorial session when students revised their texts? Finally, the reasons for students' use of tutor feedback were examined in more detail through retrospective interviews with the students in order to precisely understand each student's use of tutor feedback in revising their texts (Research Question 4). All the students' pre-session and revised papers are provided in Appendix J.[5]

5.2.1 Length of paper

Before presenting findings of types of students' revisions and students' responses to tutor feedback, changes in the number of words in their papers are shown in Table 5.3 in order to grasp overall draft-to-draft changes. As can be seen in Table 5.3, the length of the students' drafts varied across students. Whereas some subsequent revisions decreased in number of words, most increased. The changes in length from the first to subsequent draft ranged from －29 to ＋425 characters across students. An average of increase in number of characters is ＋105.82. It can safely be said that the content of the student's paper can be enriched by writing center tutorials. In the course the participants take, there are no restrictions on the number of words in a paper. It should be noted that it does not mean a long paper is superior to a short paper. Instructors might evaluate their students' papers based on the quality of the paper, not the quantity of the paper.

5.2.2 Number of revisions

Table 5.4 presents the number of revisions each student made after writing center tutorials. Results show that there was a large variation among students in regard to the number of revisions after the sessions. Among all the participant students, S8 in Tutorial

[5]Information has been deleted from some student papers in order to protect the authors' privacy.

I made 59 revisions, the largest number of revisions. In contrast, S12 in Tutorial M made only five revisions after the session. The difference in number of revisions can be due to the number of revision problems discussed in a session; thus the small number of revisions does not mean that the student did not follow tutor feedback provided during the session. Another thing to keep in mind is that not all students' revisions are related to what was discussed during tutorial sessions. In other words, some students make revisions that were not discussed during the sessions, which will be described in detail in the later section of this paper.

Table 5.3

Number of words in the first and the subsequent drafts

Tutorial	Student	Draft#1 Total	Draft#2 Total	Change
A	S1	676	732	＋56
B	S2	1618	2043	＋425
C	S2	2043	2027	－16
D	S3	1022	1040	＋18
E	S4	976	1005	＋29
F	S5	872	1233	＋361
G	S6	472	469	－3
H	S7	1425	1451	＋26
I	S8	1154	1125	－29
J	S9	1013	1429	＋416
K	S10	1203	1366	＋163
L	S11	1276	1332	＋56
M	S12	661	670	＋9
N	S13	423	446	＋23
O	S14	1206	1196	－10
P	S15	1298	1335	＋37
Q	S16	1842	2073	＋231
R	S17	1009	1117	＋108
S	S18	1031	1175	＋144
T	S19	2192	2328	＋136
U	S20	332	402	＋70
V	S20	1057	1135	＋78
Mean				＋105.82

Table 5.4

Number of Revisions in Each Tutorial

Tutorial	Student	Number of revisions
I	S8	59
S	S18	53
Q	S16	52
H	S7	47
V	S20	41
T	S19	36
A	S1	35
C	S2	34
R	S17	33
U	S20	30
O	S14	29
K	S10	28
G	S6	27
B	S2	25
D	S3	25
L	S11	22
F	S5	18
P	S15	17
N	S13	15
J	S9	14
E	S4	13
M	S12	5

5.2.3 Types of revisions

With regard to types of revisions, student revisions were classified according to six categories: Grammar, vocabulary, mechanics, style, content, and organization. Figure 5.3 illustrates overall results of types of revisions made by all students in this study after writing center tutorials.

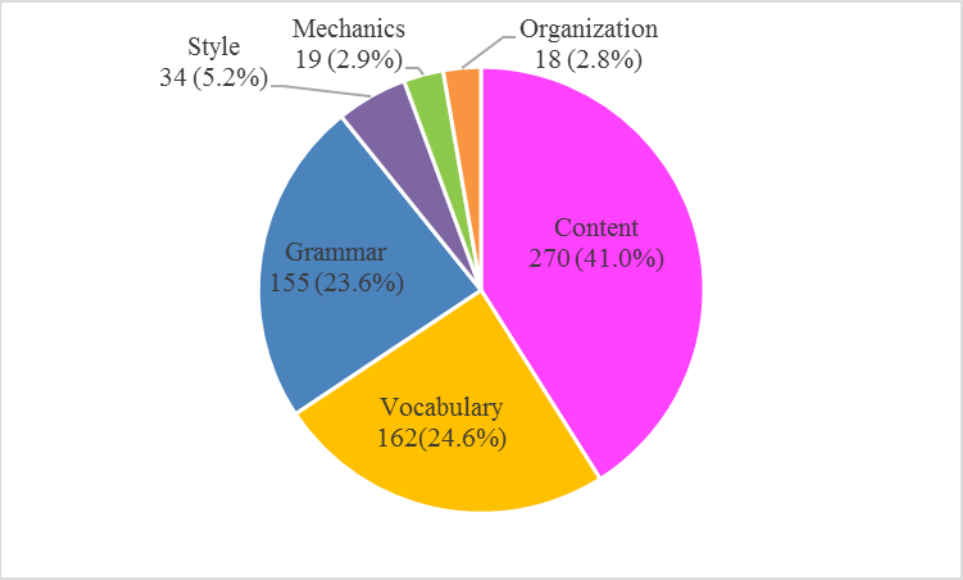

Figure 5.3. Numbers and percentages of types of revisions (N=658)

Overall results of types of revisions indicate that content was the most revised aspect (41.0%) followed by vocabulary (24.6%) and grammar (23.6%) whereas mechanics and organization were the least revised one. Compared to the results in Figure 5.1, it was found that revised aspects are nearly consistent with focus of tutor feedback provided during the sessions. It seems reasonable to suppose that content was the most revised aspect because tutor feedback focused most often on content. In addition to this, it is likely that the student participants in this study have high ability of developing or elaborating their ideas enough to make content revisions based on tutor feedback.

Figure 5.4 focuses on each student's types of revisions. As can be seen, there is considerable individual variation in type of revision. Among all types of revisions, content revisions ranked first in 11 tutorial sessions out of 22, while grammar revisions ranked first in eight sessions out of 22. In the last three sessions, vocabulary revisions occupied the first place. This variation is affected by many factors, which will be discussed further in a later section.

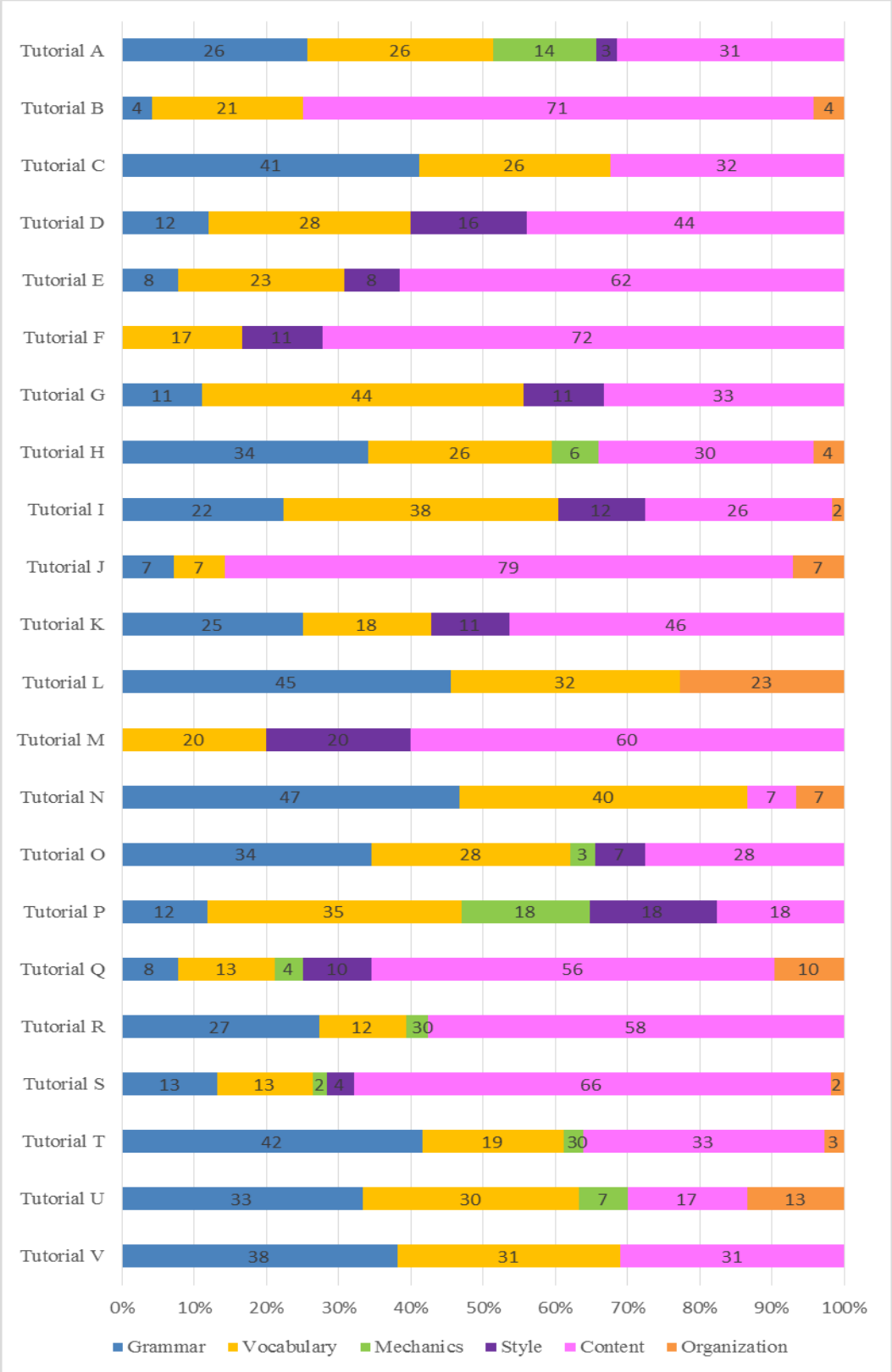

Figure 5.4. Types of revisions for each student

5.2.4 Use of tutor feedback

Figure 5.5 summarizes overall results of students' responses to tutor feedback in the process of revision.

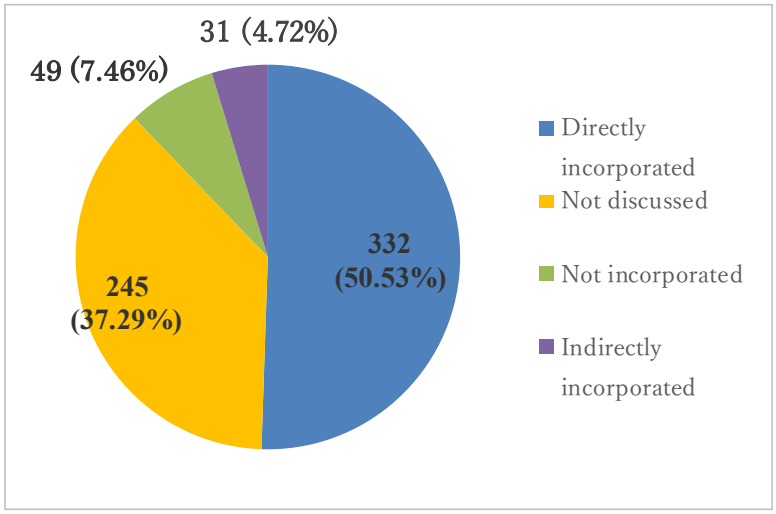

Figure 5.5. Numbers and percentages of students' use of feedback

Results in Figure 5.5 show that most revisions followed tutor feedback offered in the session (50.53%). It is also worth noting that 245 revisions out of 657 (37.29%) were revisions that were not discussed during the sessions. In other words, students were able to make more revisions on their own, for example, based on tutorial discussions in other parts of theirs papers or based on other sources such as peer feedback and teacher feedback in class, beyond what was made available in the tutorial discussion.

Figure 5.6 focuses on each student's use of tutor feedback. Regarding 14 sessions out of 22, incorporated revisions accounted for the greatest proportion of all revisions. As for the rest of the eight sessions, the students made a markedly higher proportion of revisions that were not discussed during the sessions.

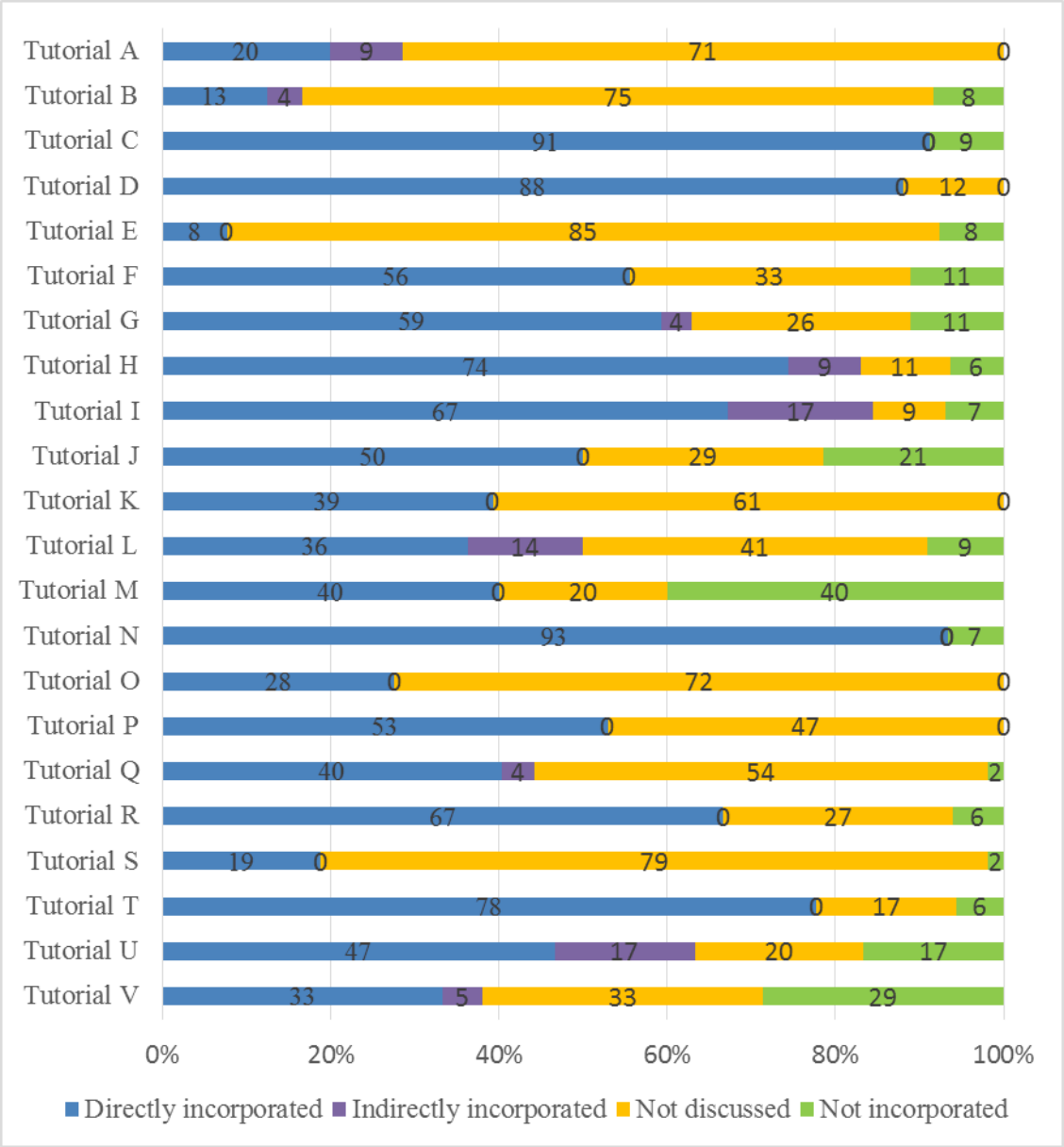

Figure 5.6. Student's use of tutor feedback in each session

Overall results of students' use of tutor feedback according to type of revision are summarized in Figure 5.6.

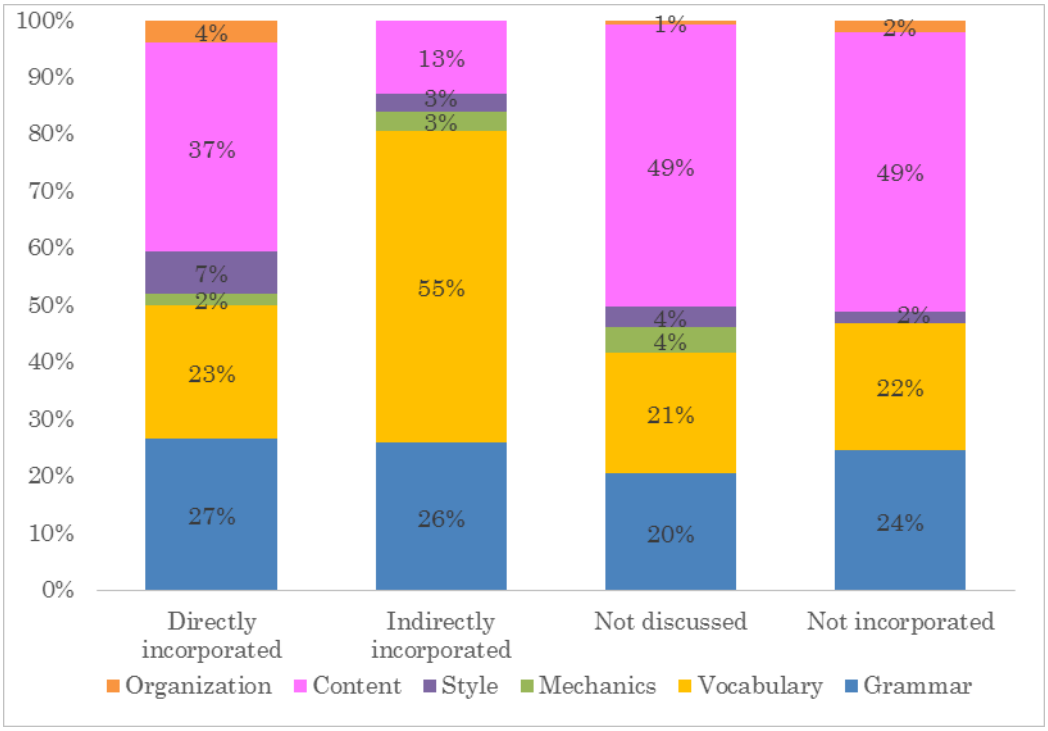

Figure 5.7. The percentages of revised aspects in each response

Results in Figure 5.7 indicate that incorporated revisions, not discussed revisions, and not incorporated revisions are predominantly related to content. Regarding initial stimulus revisions, vocabulary was the most revised aspect.

Table 5.5 represents the relationship between types of tutor feedback and students' use of tutor feedback in revising their texts. Here, tutor feedback was divided into three types: direct feedback, indirect feedback, and mixed feedback. When the tutor provides the correct answer for students or explicitly tells the students how to revise, this is referred to as direct feedback. In contrast, when the tutor indicates that there is a problematic point in the draft, but leaves it to the student to solve the problems without providing any concrete answer, this is referred to as indirect feedback. When the tutor tries a less direct approach but the student seems to need more guidance, tutor uses a combination of direct feedback and indirect feedback. This is categorized as mixed feedback.

Table 5.5

Tutor Feedback and Students' Use of Feedback

Type of feedback	Incorporated	Not incorporated	Total
Direct	48 (94.12%)	3 (5.88%)	51 (100%)
Indirect	238 (84.70%)	43 (15.30%)	281 (100%)
Mixed	46 (93.88%)	3 (6.12%)	49 (100%)
Total	332	49	381

As Table 5.5 shows, most of the tutor feedback offered during the sessions was incorporated into students' revisions. In addition, all three types of feedback led to a significantly larger number of incorporated revisions than not incorporated revisions. The Chi-square test showed no statistically significant difference among students' use of tutor feedback depending on the type of feedback ($\chi^2(2) = 5.70$, $p = .06$, Cramer's $V = .12$). That is, it was indicated that the students responded to indirect feedback in a high ratio just as for direct feedback and mixed feedback, although it can be assumed that it is rather difficult for students to incorporate indirect feedback into their revisions compared to direct feedback because they are required to discover how to improve their texts by themselves.

In this study, whether each feedback was tutor-initiated or student-initiated was also examined (Table 5.6). When a tutor starts the discussion on one problematic part of a student's paper and then provides feedback to the student, this is referred to as tutor-initiated feedback. On the other hand, when a student starts the discussion on one problematic part of his or her paper by asking a question or asking for a comment on the part from a tutor, this is referred to as student-initiated feedback.

Table 5.6

Feedback Initiator and Students' Response to Tutor Feedback

	Incorporated	Not incorporated	Total
Tutor-initiated	309 (87.0%)	46 (13.0%)	355 (100%)
Student-initiated	23 (88.5%)	3 (11.5%)	26 (100%)

Table 5.6 shows both types of feedback led to a significantly larger number of incorporated revisions than not incorporated revisions. The Chi-square test showed no statistically significant difference among students' use of tutor feedback depending on the type of feedback (χ^2 (1) =.046, p>.05, Cramer's *V*= .011). That is, it was indicated whether the feedback was tutor-initiated or student-initiated has less to do with the students' use of feedback. Students are likely to highly incorporate both tutor-initiated feedback and student-initiated feedback into their revisions.

5.2.5 Reasons behind students' use of tutor feedback

When we discuss the results of students' use of tutor feedback provided during writing center tutorials, we must draw attention to the reasons behind the students' use of tutor feedback in revising their texts. This section, therefore, describes the students' intentions in using their tutors' feedback provided during the sessions in revising their texts based on the results of retrospective interviews conducted after they had submitted the subsequent revision. In many cases, the interviews revealed reasons for revisions that had not been apparent from the drafts and tutorial transcripts.

5.2.5.1 Directly incorporated

As Figure 5.5 shows, the students mostly followed the tutor feedback they received during the tutorial session. From the interviews with the students, it was found

that the tutor was considered nearly the same as their instructors. According to the results of a questionnaire answered by the students, eight out of 11 students said that tutors are equal to their instructors or near instructors. In the interview, S11 stated "I think tutors are not as authoritative as instructors, but more experienced, knowledgeable, and reliable than peers. So, I came to the writing center asking for the tutor's advice, which is considered to be high quality. I trust the tutor's ability to make judgments on my writing." S8 stated that "Basically I follow tutor feedback provided during the session, but do not necessarily incorporate all feedback into my revisions. If I do not agree with the tutor's suggestions or change my opinion in the process of revising my paper, I ignore them." It was revealed that students make their own decisions about whether they should incorporate their tutors' suggestions into their revisions or not, and they only incorporate the suggestions they agree with.

5.2.5.2 Indirectly incorporated

Indirectly incorporated revisions, which went beyond the issues addressed by the initial feedback, were commonly observed in the revision of surface-level issues such as voice, verb tense, and word choice. The following is an example from S8's first draft in which her tutor's feedback acted as an initial stimulus. (The parts that were addressed during the session and revised in the second draft are underlined.)

> Excerpt (21a) (From S8's first draft) (in the introduction section)
>
> So, the <u>good</u> color for photosynthesis and the <u>good</u> one for the growth of the plant are not necessarily the same.

Her tutor offered feedback on the underlined word: "The meaning of 'good'

seems to be a bit ambiguous. What do you mean by that? You should explain it more concretely, how good and in what sense good." In S8's revised second draft after the tutorial session, she wrote:

Excerpt (21b) (From S8's second draft)

The color absorbed well during photosynthesis and the effective one in the growth of the plant are not the necessarily the same.

Moreover, the tutorial interaction illustrated above acted as an initial stimulus for revision in the results and discussion sections of her paper as follows:

Indirectly incorporated revision 1 (in the result section)

Excerpt (22a) (From S8's first draft)

Shown in Figure 1, in the four colors (red, green, blue, and transparent), the better colors of light in the growth of water plants were blue and green, and the worse colors were red and transparent.

Excerpt (22b) (From S8's second draft)

Shown in Figure 1, in the four colors (red, green, blue, and transparent), the more effective colors of light in the growth of water plants were blue and green, and the less effective color were red and transparent.

Indirectly incorporated revision 2 (in the discussion section)

Excerpt (23a) (From S8's first draft)

According to the results, the blue and green lights are better for water plants than the red one.

Excerpt (23b) (From S8's second draft)

According to the results, the blue and green lights are more effective color in the growth of water plants than the red light.

These changes illustrate the "indirectly incorporated" type of revisions. When S8 and her tutor discussed the result and discussion section, her tutor did not provide any feedback on these two parts shown in Excerpt (22a, b) and (23a, b). Nonetheless, when revising her draft by herself, she succeeded in revising the related parts in the Results and Discussion section based on a problematic item in the introduction section which her tutor had addressed during the tutorial session. Regarding this point, her tutor did not tell her how to change it. Instead, the tutor asked her about the meaning of "good" in her text and helped her formulate her own ideas for improving the part. As Goldstein and Conrad (1990) suggest, negotiation of meaning by asking questions and answering them in the session can lead to better retention of what was discussed during the session. In addition, it can be assumed that writing center tutorials can raise students' awareness of problematic points of their text, which induce further revisions that go beyond the issues addressed by the initial feedback. In her retrospective interview, S8 remarked that even though she had not received any feedback on those parts, she did her best to find the parts related to the feedback she had received in her tutorial session and make self-directed revisions to them.

5.2.5.3 Not discussed

Regarding not discussed revisions, I focused on 11 sessions (ten tutees who agreed to be interviewed) and analyzed the reasons why they made revisions that were not discussed during sessions. Through the retrospective interviews with the tutees, two

types of undiscussed revisions were identified. One was self-initiated revisions, and the other was revisions made in response to other sources of feedback such as teacher and peer feedback. In addition, the self-initiated revisions can be divided into two patterns: 1) students identify the problematic or unclear parts of their texts by themselves when reading over their texts in the revision process, and 2) students make revisions by being stimulated by tutorial discussion in other parts. Not discussed revision patterns of each student are shown in Table 5.7. Figure 5.8 focuses on types of revisions in self-initiated undiscussed revisions for each tutorial session.

Table 5.7

Not Discussed Revision Patterns of Each Student

Tutorial	Student	Self-initiated	Other sources (Teacher, peer, or other tutor feedback)	Unknown	Total
H	S7	5	0	0	5
I	S8	4	1	0	5
J	S9	4	0	0	4
K	S10	5	10	2	17
L	S11	9	0	0	9
P	S15	0	8	0	8
Q	S16	25	0	3	28
S	S18	36	6	0	42
T	S19	6	0	0	6
U	S20	6	0	0	6
V	S20	14	0	0	14

Note: “Unknown” represents that the student did not remember why he/she made the revisions.

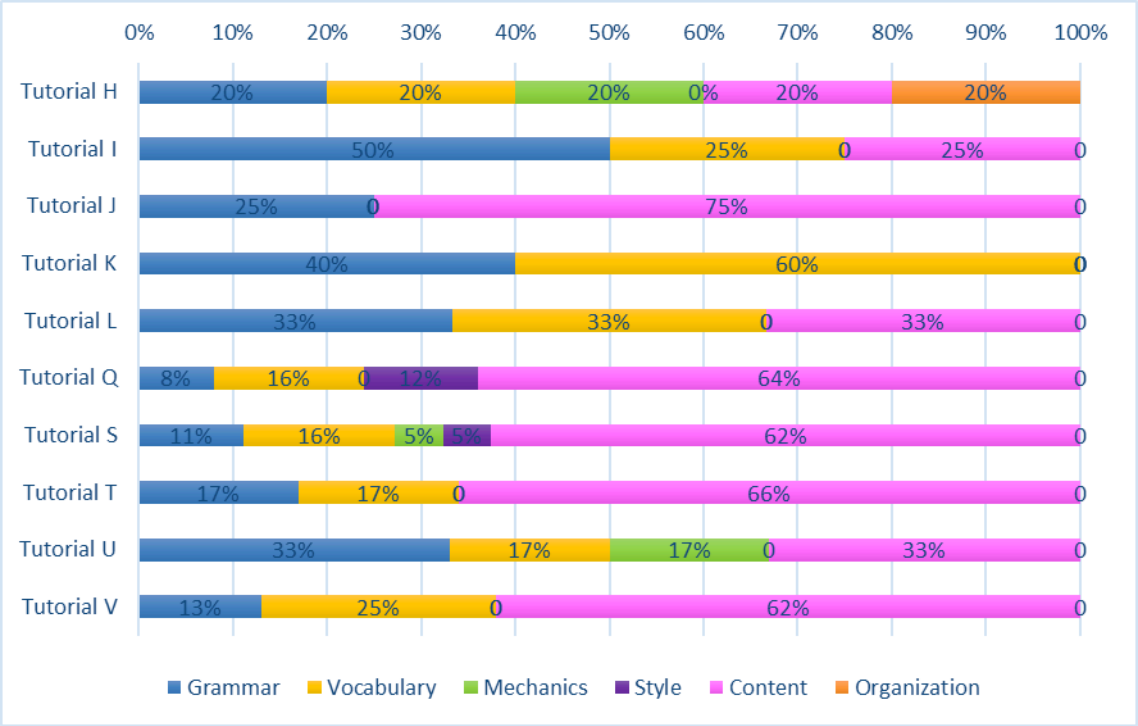

Figure 5.8. Self-initiated undiscussed revisions in each tutorial

Looking at the breakdown of the patterns of not discussed revision, the majority of these were self-initiated revisions. In addition, the results in Figure 5.8 show that self-initiated undiscussed revisions are mostly concerned with content. S16 in Tutorial Q and S18 in Tutorial S made a markedly high proportion of self-initiated revisions that were not discussed in their tutorial sessions (25 for S16 and 36 for S18). These two students in fact made particularly drastic and notable changes to the contents of their texts. In the interview, S16 stated that "I tried making revisions on the problematic parts of my paper that were not discussed during the tutorial session based on the tutorial interactions with my tutor. Tutor's clarifying questions or suggestions on improving my paper at the writing center were really helpful when I revised the other parts of my paper by myself at home." This implies that writing center tutorials can provide impetus for writing autonomously with students.

Let us first look at the self-initiated undiscussed revisions. As shown in Table 5.7,

all students except S15 made this type of revisions. The following is an example of the first pattern of the self-initiated revisions. This pattern is commonly observed in the corrections of surface-level error, which is illustrated below:

Excerpt (24a) (From S7's first draft)

The effect of the damage of natto beans by chopsticks are not considered.

Excerpt (24b) **(**From S7's second draft)

The effects of the damage of natto beans by chopsticks are not considered.

When S7 was asked in the interview why he wrote the underlined word despite receiving no feedback on it, S7 explained that when he read over his draft, S7 found a problem with subject-verb agreement in Excerpt (24a), and decided it is more appropriate to use the underlined "effect" in the plural form in this context because S7 suspected that there might be more than one effect.

Excerpt (25b) shows an example of another type of self-initiated revisions, that is, the self-initiated revisions stimulated by tutorial discussion in other parts:

Excerpt (25a) (From S8's first draft)

In addition, this also differs from the common sense that green light is not used well by plants which are green.

Excerpt (25b) (From S8's second draft)

In addition, this also differs from the common sense that green light is not used well in photosynthesis by plants which are green.

In her second draft, the underlined part was added even though her tutor had

not offered any feedback on this part. In the interview, S8 observed, "My tutor advised me to clarify 'what can be used for what' in other parts of the discussion section. Then, when I looked back at this sentence in revising my draft, I found that this sentence also lacked the information that green light is not used well for what. So I decided to reflect this tutor's advice that I had received in other parts on this sentence."

Another example of this type of revision is shown in Excerpt (26b):

Excerpt (26a) **(**From S11's first draft)

The clearest increase in strength was observed.

Excerpt (26b) **(**From S11's second draft)

The largest increase in strength was observed as the surface become finer from #180 to #800.

In S11's retrospective interview, he explained that he added the underlined part so that readers who are not familiar with sandpaper can easily understand. He pointed out that because he was advised at the beginning of the session to be conscious of readers who are not familiar with the topic of his paper, he became more conscious of his readers in the overall revision process and added the underlined part. From this finding, it can be assumed that writing center tutorials not only provide the impetus for further revisions of the text but also enhance the writers' awareness of their readers.

In the interview, both S8 and S11 observed that through their tutorial sessions they learned revision strategies such as how to reflect on their writing and overcome the weaknesses of their texts. In addition, as mentioned in Section 4.3.2, writing center tutorials can raise students' awareness of problematic points in their texts. Therefore, even though tutor feedback was not offered on all problematic parts in the student drafts,

some students were able to apply their tutors' advice or suggestions on one problematic point to their overall revision, which led to revisions in places which their tutors had not pointed out. This indicates that writing center tutorials can contribute to foster autonomous writers, which is the mission of the writing center. To help students be able to make such self-initiated revisions is exactly what the writing center is trying to do. In this regard, this study can provide indirect evidence of its efficacy of writing center tutorials in helping students become better writers. This is one of the valuable findings that were only revealed by the retrospective interviews.

Another pattern of not discussed revision is that students revise their papers based on other sources of feedback they received in their classes. In the case of S10, for example, he had received peer feedback before completing his second draft. Therefore, S10's revisions heavily reflected his peer's feedback. In fact, half of his undiscussed revisions resulted from peer feedback. On the other hand, one of S8's undiscussed revisions resulted from teacher feedback. Thus, when students revise their draft after the tutorial session, they do not necessarily reflect only what was discussed during the session. Other sources of feedback, such as teacher and peer feedback, also need to be considered when analyzing students' revisions after writing center tutorials. In addition, students may discover how to improve their texts on their own. Students engage in writing neither only in classes nor only during tutorial sessions. They keep thinking about their writing at home. It is important to keep in mind that the process of student writing can be influenced by a variety of stimuli, and also students potentially have the power to find answers to problems in their writing or develop their ideas.

5.2.5.4 Not incorporated

In this study, "Not incorporated" revisions include the following three types of

responses: 1) the student ignores the tutor's suggestion or advice with no change of text (keeping the original text), 2) the student rejects the tutor's suggestion or advice by deleting text without substituting anything else, and 3) the student make revisions that are different from the tutor's suggestion or advice.

In this study, nearly 80% of all the students made revisions that did not follow tutor feedback received during the tutorial session. Whereas the majority of feedback on grammar and vocabulary were explicitly addressed in the tutorial session, feedback on content was mostly indirect. Through retrospective interviews with the students, three reasons for not incorporating tutor suggestions were identified: 1) students forgot to make revisions; 2) students had no idea how to revise; and 3) students made self-initiated decisions not to follow tutors' advice or suggestions because of their preference for writing in a certain way or because they disagree with the tutors' advice or suggestions. Table 5.8 shows the details of each student's reason for not incorporated revisions. Table 5.9 presents the types of revisions for each reason for not incorporating tutor feedback.

Table 5.8

Reasons for Not Incorporating Tutors' Feedback for Each Student

Tutorial	Student	Forgot to revise	No idea on how to revise (Unchanged or delete)	Self-initiated decisions	Total
H	S7	0	1	2	3
I	S8	2	0	2	4
J	S9	0	3	0	3
L	S11	0	0	2	2
Q	S16	1	0	0	1
S	S18	1	0	0	1
T	S19	0	0	2	2
U	S20	2	1	2	5
V	S20	4	5	3	12

Table 5.9

Types of Revisions in Each Reason

Reasons	Grammar	Vocabulary	Mechanics	Style	Content	Organization	Total
Forgot to revise	7	1	0	0	2	0	10
No idea on how to revise	0	4	0	0	6	0	10
Self-initiated	3	1	0	0	8	0	12

Although the number of revisions that do not follow tutor feedback was very small in each tutorial, the reasons for not incorporating tutor feedback into revisions differed considerably among students. S11 in Tutorial L and S19 in Tutorial T made only revisions that did not follow tutor feedback due to the third reason (self-initiated decisions). In contrast, S16 in Tutorial Q made this sort of revision only because she forgot to revise it (the second reason). S20 in Tutorial U and V did not incorporate tutor feedback into his revisions due to all reasons. The results in Table 5.9 show that students are likely to forget to revise grammatical errors the tutor pointed out during the

session in revising their texts even though the feedback is explicitly addressed. The revisions made by the students due to the second reason were concerned with vocabulary and content. The revisions that do not follow tutor feedback based on their self-initiated decision were also predominantly related to content.

The first reason for not incorporated revisions is that students just forgot to make revisions. In this study, S8, S18, and S20 exhibited this kind of response. In the retrospective interview with them, all of them told me that they did not realize, until the author pointed it out, that they had made no revisions on one problematic point that the tutor had indicated during the session even though they did remember receiving tutor feedback on it. S18, for example, stated, "I forgot to revise the areas my tutor advised me to revise because when I revised my paper at home after the session, I was preoccupied with other areas of my paper and just finishing my paper took all of my effort." In the retrospective interview, all of them told me they regretted not revising those parts before submitting the final draft.

The second reason for not incorporating tutors' feedback was found in the retrospective interviews with S7, S9, and S20. They tried to follow their tutors' suggestions, but they did not know how to revise their texts and therefore ignored their tutors' feedback. The following are the parts S7 and S20 failed to revise.

Excerpt (27) (From S7's first draft)

The results depend on kind of sugar.

Excerpt (28) (From S20's first draft)

Theirry et al. (2009) showed that people whose native language has a terminology that represents a certain color could perceive their color greater than people whose native language doesn't have.

Regarding Excerpt (27), S7 was asked to give a more detailed explanation. When he was asked to clarify what he wanted to say in this sentence during the session, he could explain it in Japanese. However, he remarked in the interview that although he had attempted to explain it in English in the same way as in Japanese, he did not know how to explain it in English and gave up revising the part. As for Excerpt (28), S20's tutor advised him to avoid too many relative clauses. In the interview, he mentioned that "during the session, I thought I could deal with this problem, but when I attempted to revise them at home after the tutorial session, I ended up failing to make revisions." In the end, they decided to ignore their tutor's advice and made no revisions.

The third pattern is that students ignore or reject their tutor's suggestion when they disagree with it. The following illustrates this pattern.

Excerpt (29a) (From S11's first draft)

In this fact, the force perpendicular to the bonded surface was applied from an edge.

Excerpt (29b) (From S11's second draft)

In this fact, the force perpendicular to the bonded surface was applied from an end.

On the underlined part in Excerpt (29a), S11's tutor proposed to rewrite "from an end to the other," but he only changed the underlined part in his second draft but rejected his tutor's suggestion that he add "to the other" to his original sentence. He observed that if he had added "to the other," the underlined part might be different from his intended meaning.

In addition, students' own writing preferences or approaches to writing can affect whether they reflect their tutors' suggestions or not. The following example illustrates this category:

Excerpt (30) (From S11's first draft)

This study tested the tensile, shear, and peel strength of two joined objects that are covered with different roughnesses of sandpapers and adhered with double-sided tape.

During the session, S11 asked the tutor whether "roughness" can be used in the plural form. His tutor made the following suggestions on the underlined word "roughnesses" in excerpt (30): "Okay. Then, how about 'different degrees of' or 'different levels of' or 'different types of'? If you write like this, you don't need to

worry about whether ‘roughness’ should be used in the plural form or not, right?” In the retrospective interview with S11, he explained that although he agreed with my tutor’s idea in the tutorial session, in revising this part, he felt more uncomfortable about using ‘of’ two times in a row, such as ‘different degrees of roughness of sandpapers’, than about using ‘roughness’ in the plural form. For this reason, he did not follow the tutor’s suggestion and chose to make no revisions on this part.

Another example of this category is shown in Excerpt (31):

> Excerpt (31) (From S7’s first draft)
>
> In conclusion, when eating natto, the stirring times would be as many times as possible within 500 times.

In the case of S7, his tutor advised him to add another result of his study: The more times natto was stirred, the more the sugar content increased. However, he rejected this tutor’s advice and did not rewrite this sentence in his second draft. In his retrospective interview, he observed: “I want to sum up my conclusion succinctly. I thought my tutor’s suggestion is valid, but if I followed the tutor’s suggestion, my conclusion would seem to become redundant. That is why I ignored the tutor’s suggestions.”

To summarize, these students made their own decisions about whether or not to incorporate their tutor’s suggestions into their revisions based on their writing preferences and their approaches to writing. They only incorporated their tutor’s suggestions they agreed with. Both S7 and S11 felt that they had ownership of their own texts and did not feel obliged to incorporate any suggestions they disagreed with. The students were thus the ones who made the final decisions about their texts. This finding

that students can reflect on their own writing and make self-directed decisions on their text revisions after receiving writing center tutorials is worth noting, as it implies that writing center tutorials can help to foster autonomous writers. However, regarding the first type of "not incorporated revisions", tutors need to find some way of avoiding it such as having students take notes during the session or summarizing the points discussed during the session and then finalizing revision plans with students at the end of a session. It should be noted whether this behavior can lead to the improvement in text quality needs to be further investigated in future research.

5.3 Findings from the questionnaires

In this section, findings from the questionnaires and the individual interviews with 10 tutees and six tutors are reported, and based on the findings, writing center tutorials, student revisions after tutorials, and the relationship between writing center tutorials and student revision is discussed from a multilateral perspective. Individual tutee and tutor responses to the questionnaire items are presented in Table 5.10 and Table 5.11 respectively. Through both questionnaires and interviews, it was revealed that there are a variety of perceptions and attitudes towards writing center tutorials depending on tutors and students. In the following section, the findings for each question are provided in detail.

Table 5.10

Individual Tutee Responses to Each Question

Question	**Responses**				
	S7 (Tutorial H)	S8 (Tutorial I)	S9 (Tutorial J)	S11 (Tutorial L)	S18 (Tutorial S)
1. Who talked the most during the session? 1 2 3 4 5 Tutor Tutee	2	2	2	1	3
2. How did you view the tutor? 1 2 3 4 5 As an Instructor As a peer	4	1	2.5	2	1
3. Did the tutor sufficiently answer your questions? 1 2 3 4 5 No Yes	4	5	5	5	5
4. How comfortable were you in the session? 1 2 3 4 5 Not comfortable Very comfortable	5	5	5	3	5
5. What was the tutor's level of expertise? 1 2 3 4 5 Not very expert Very expert	4	4	4.5	4	4
6. Did the tutor give you encouragement or point to the good parts of your draft? 1 2 3 4 5 None Very much	4	4	3	1	3
7. How successful was the session? 1 2 3 4 5 Not successful Very successful	5	4.5	4	4	4.5
8. To what extent did you incorporate the results of this session in your subsequent draft? 1 2 3 4 5 None All	4.5	5	4.5	4	3

Table 5.10

Individual Tutee Responses to Each Question (continued)

Question	**Responses**					
	S10 (Tutorial K)	S15 (Tutorial P)	S16 (Tutorial Q)	S19 (Tutorial T)	S20 (Tutorial U)	S20 (Tutorial V)
1. Who talked the most during the session? 1 2 3 4 5 Tutor Tutee	3	3	1	2	2	2
2. How did you view the tutor? 1 2 3 4 5 As an Instructor As a peer	2	2	1	4	1	1
3. Did the tutor sufficiently answer your questions? 1 2 3 4 5 No Yes	5	5	5	2	5	5
4. How comfortable were you in the session? 1 2 3 4 5 Not comfortable Very comfortable	4.5	5	5	5	3	5
6. Did the tutor give you encouragement or point to the good parts of your draft? 1 2 3 4 5 None Very much	4	5	4	4	4	5
7. How successful was the session? 1 2 3 4 5 Not successful Very successful	4	4	4	3	4	5
8. To what extent did you incorporate the results of this session in your subsequent draft? 1 2 3 4 5 None All	5	4	4	5	5	5

Table 5.11

Individual Tutor Responses to Each Question

Question	**Responses**					
	T7 (Tutorial K)	T10 (Tutorial P)	T4 (Tutorial Q)	T11 (Tutorial T)	T9 (Tutorial U)	T12 (Tutorial V)
1. Who talked the most during the session? 1 2 3 4 5 Student Tutor	4	3	4	4	4	4
2. Did you believe that you sufficiently addressed the student's questions? 1 2 3 4 5 No Yes	4	3	5	2	5	4
3. What did you believe the student's comfort level to be in the session? 1 2 3 4 5 Not comfortable Very comfortable	3	5	2	3	2	4
4. How directive do you think your comments or questions were? 1 2 3 4 5 Not directive Directive	3	3	3	4	4	4
5. How much positive feedback do you think you gave? 1 2 3 4 5 None Very much	2	4	3	4	4	4
6. What did you perceive your role to be in the session? 1 2 3 4 5 Instructor-like Peer	2	2	2	2	2	2
7. How successful do you think the session was? 1 2 3 4 5 Not successful Successful	4	4	4	4	5	4
8. To what extent do you think that this session will influence the student in revising his or her writing? 1 2 3 4 5 Not at all Very much	4	4	5	5	4	4

5.3.1 Findings from the tutee questionnaires

Findings for Question 1：Who talked the most during the session?

Regarding this question, three tutees out of ten marked 3, five marked 2, and two marked 1. That is, most students responded that their tutors seemed to have talked more than they did. In regard to the reason for having such impression, S7 in Tutorial H, for example, he mentioned in the interview that it was because the tutor gave him a lot of advice on his draft. S9 in Tutorial J stated that, "I brought my draft which was almost done to this session and asked my tutor to proofread it. So, I did not spontaneously say something or ask questions; rather, the tutor mainly asked me questions about the parts which were difficult for readers to understand. " Likewise, S8 in Tutorial I also stated that, "Looking through my draft, the tutor spent much time explaining which parts of my draft she could not understand and why, and asking me questions about them."

Which then, in fact, talked the most during the session in each tutorial session, tutor or tutee? Actual volubility in the tutorials was measured by three different methods: the total word utterances, the number of turns, and word utterances per turn. The following tables show the percentage of the total word utterances of students and tutors in each tutorial session (Table 5.12), the percentages of the number of turns of students and tutors in each tutorial session (Table 5.13), and the average number of word utterances per turn of students and tutors in each tutorial session(Table 5.14).

Table 5.12

Percentages of Total Word Utterances

	Student	Tutor
Tutorial H	23.31%	76.69%
Tutorial I	18.56%	81.44%
Tutorial J	18.77%	81.23%
Tutorial K	36.03%	63.39%
Tutorial L	29.63%	70.37%
Tutorial P	16.09%	83.91%
Tutorial Q	15.02%	84.98%
Tutorial S	43.29%	56.71%
Tutorial T	18.23%	81.77%
Tutorial U	17.93%	82.07%
Tutorial V	7.18%	92.82%

Table 5.13

Percentage of Turns

	Student	Tutor
Tutorial H	47.10%	52.90%
Tutorial I	42.21%	57.89%
Tutorial J	48.65%	51.35%
Tutorial K	40.74%	59.26%
Tutorial L	53.70%	46.30%
Tutorial P	33.33%	66.67%
Tutorial Q	46.88%	53.12%
Tutorial S	48.96%	51.04%
Tutorial T	42.86%	57.14%
Tutorial U	44.88%	55.12%
Tutorial V	42.06%	57.94%

Table 5.14

Average Number of Word Utterances per Turn

	Student	Tutor
Tutorial H	20 words	60 words
Tutorial I	23 words	74 words
Tutorial J	25 words	104 words
Tutorial K	24 words	29 words
Tutorial L	30 words	84 words
Tutorial P	16 words	44 words
Tutorial Q	26 words	106 words
Tutorial S	37 words	46 words
Tutorial T	18 words	59 words
Tutorial U	15 words	55 words
Tutorial V	15 words	142 words

As answered by the participant students in the questionnaire, the actual volubility data have shown that the tutor talked more than the student in all tutorial sessions. Interestingly, three students out of ten (S10 in Tutorial K, S15 in Tutorial P, and S18 in Tutorial S) replied that they talked as much as the tutor (they marked 3). In the case of S18 in Tutorial S, compared to other tutorial sessions, there is indeed not much of a difference in the percentage of the total word utterances between the student and the tutor (S18: 43.29%, tutor: 56.71%). On the other hand, in the case of S10 in Tutorial K and S15 in Tutorial P, the data have shown that the tutors apparently talked more than the students in terms of the total number of word utterances, but both S10 and S15 felt that they talked nearly as much as their tutor. These findings imply that the number of turns may have more influence on the answer to the question "Which talked the most during the session?" than the total number of word utterances. Even though the total number of word utterances of the tutor is larger than that of the student, if the tutor and the student construct utterances in turns by negotiating or asking and answering questions, the student may feel that he or she produce the same amount of talk as the tutor. It can be also assumed that because students formulate an idea

or debate in their head for answering questions asked by their tutors, they may feel as if they have talked a lot, though they did not put into words. They may mix up what they indeed talked with what they thought in their mind. Overall, the findings from the questionnaire imply that volubility during the session can be less influential on revisions after tutorial sessions. However, considering the case of S20 in Tutorial U and V, it can be assumed that the fact that the tutor talked more than the S20 during the session might have produced the results that the percentage of not incorporated revisions is the highest of all the participant students. S20 in Tutorial V forgot to revise two areas that his tutor advised him to revise because he was provided too much advice by the tutor during the session, which may lead to the distraction of attention in revising his text. It can be also possible that he wanted to ask questions about his problematic parts in his text during the tutorial session, but he could not because his tutor talked a lot and therefore he might have failed to revise them.

Findings for Question 2: How did you view the tutor?

As mentioned previously in 5.2.4.1, almost all participant students view the tutor as more instructor-like than peer-like. Through the interviews, three reasons for the answer were identified. The first reason was found in the comments of S9 in Tutorial J, S11 in Tutorial L, S15 in Tutorial P, and S20 in Tutorial U and V. For them, tutors are apparently different from peers in that they are more experienced, knowledgeable, and reliable than peers in terms of both English ability and academic writing skills in English. The second reason is related to the focus of feedback. S10 in Tutorial K mentioned that he views the tutor more instructor-like because the tutor mainly focuses on content during the tutorial, though peers basically focus on grammatical errors in the text during the peer review in class.

S16 in Tutorial Q views the tutor as an instructor and mentions that he visits the writing center in order to ask for tutor advice and feedback instead of the instructor because the instructor does not sufficiently check his draft in class. S7 in Tutorial H too, stated that he wants to receive instruction from the tutor instead of his instructor at the writing center. That is, they calls on the tutor to serve as an instructor, which is the third reason for viewing the tutor as more instructor-like than peer-like. They also states that they want to feel relieved to be proofread by the expert tutor because they are doubtful of or lack confidence in both their peer's English ability and academic writing skills in English.

Interestingly, S19 in Tutorial T marked 4, which means he views the tutor as more peer-like. He mentioned that "Instructors have a kind of answer and attempt to conform what I want to say to the answer. On the other hand, tutors attempt not to impose their answers or ideas on the students and gives me advice based on my intended meanings or ideas. Tutors have every respect for what I really want to say and provide a student-centered tutorial session for me. In this point, tutors are different from instructors for me."

Findings for Question 3：Did the tutor sufficiently answer your questions?

In the interview, most students indicated that the tutors sufficiently answered their questions. S7 in Tutorial H, who marked 4 (the tutor fairly sufficiently answered your questions), stated that, "The tutor did not check all of my text because of lack of time. With more time, I wanted my tutor to check the parts that I had revised based on the tutor's advice provided in the last tutorial session." Although S10 in Tutorial K marked 5, he indicated that he had wanted his tutor to check not only the parts where he asked for feedback but also other parts of his draft, although his tutor answered all questions he asked. On the other hand, S19 in Tutorial T, who marked 2, stated:

> What I wanted to ask my tutor in this session was whether there were no problems with my experiment and how to analyze the data obtained in my experiment. However, when I told her about this, she advised me to visit the SEWP Lab to get advice from science tutors, and in this session, she gave me feedback on the parts of my text where I had not expected to be provided feedback. In this sense, I think the tutor did not sufficiently answer my questions, although such feedback was very useful. This is why I marked 2 in this question.

Through the interviews, it was suggested that whether the tutor sufficiently answered the student's questions can more or less influence students' revisions after the tutorials. In other words, some students could have made more revisions if they have had more time to discuss their texts with the tutor and asked all questions they wanted to ask.

Findings for Question 4：How comfortable were you in the session?

In this study, most students felt comfortable in the tutorial session. The meaning of "comfortable" seems to more or less vary among individuals. For example, S8 in Tutorial I, who marked 5, mentioned that she felt comfortable in the session because she has visited the writing center several times in the past. S15 in Tutorial P and S7 in Tutorial H, who also marked 5, stated that tutor's fully understanding of the content of their research and what they want to say in their paper brings a sense of safety. In addition, S7 in Tutorial H stated that, "I felt comfortable in the session in that I was able to ask all the questions I wanted to ask the tutor, the tutor looked through not only the whole text but also the details, and the tutor seemed to be thoroughly familiar with how to write a scientific paper." S20 in Tutorial U and S11 in Tutorial L, who marked 3, replied that this was the first time to use the

writing center and they have no other sessions for comparison, so they could not express what is comfortable to them or what a comfortable session is for them.

The findings from the interviews have shown that whether the student feel comfortable in the session seems to have influence on students' revisions after writing center tutorials. However, it is suggested that it is very important for tutors to fully understand the content of the student's paper and to be thoroughly familiar with academic writing skills, which can provide students with a sense of security and comfortable tutorial sessions.

Findings for Question 5：What was the tutor's level of expertise?

Almost all participants rated the tutor's expertise highly. S7 in Tutorial H who marked 4, for example, stated that compared to instructors who are regarded as the most expert of the three (instructors, tutors, and peers), tutors are regarded as moderately expert. Likewise, S19 in Tutorial T stated that he marked 4 because he thinks tutors give him more specialist advice than peers. S8 in Tutorial I, who also marked 4, stated that, "I think my tutor is not a fully expert because when I asked her questions about scientific matters, she could not always answer my questions and check out them on Google or something". She proceeded to make an interesting remark, which is worth noting: "But rather, that would be better. Even though the tutor is not an expert in my research field, I can learn how to acquire high level of English proficiency and academic writing skills in English through the tutorial with her because she is the same EFL learner as I am. In this sense, non-native English tutors are better." S15 in Tutorial P who marked 4 also said a similar thing: "Although writing tutors are not expert at scientific research and my research field, they are expert at teaching how to write academic papers in English. My tutor is not an expert in my research field, but she checked out technical content or matters on the Internet with me."

S11 in Tutorial L who marked 4 answered this question from a bit different perspective. He mentioned that he had marked 4 because his tutor had said she could not explain English grammatical rules in Japanese, though he had wanted his tutor to ask about English expressions.

The results of this question indicate that most students rated the tutor's expertise highly. It can be also assumed that because students view tutors as fairly expert and place their trust in tutors' English ability as well as academic writing skills in English, they basically follow tutor feedback in revising their texts after the tutorial sessions.

Findings for Question 6 : Did the tutor give you encouragement or point to the good parts of your draft?

Regarding this question, it was found that the feeling of being encouraged or praised varies among students. S7 in Tutorial H who marked 4 was definitely encouraged or pointed to the good parts of his draft by the tutor and clearly remembered what he had been said by the tutor. In the interview, S7 stated, "I was particularly glad to be told that my research topic is interesting, my experiment is designed to minimize errors, and overall, my paper is well-organized." S8 in Tutorial I too, who marked 4, mentioned that she was happy to be told that her experiment is very interesting, which served as a source of motivation for revision after the tutorial session. S8 described the reason for marking 4 in this question was that S8 was not aware of whether or how often she had been encouraged or praised during the session because S8 had focused on how to revise her texts. In addition, she indicated that the tutor's encouragement and praises during the session not only increase her motivation for revision but also allow her to feel more comfortable in visiting the writing center again. S19 in Tutorial T who marked 4 mentioned that he had been especially influenced by tutor encouragement given in the last part of the session and tutor

encouragement had eliminated anxieties about his writing. S16 in Tutorial Q who marked 4 stated, “I may feel demotivated if only suggestions or negative feedback are offered by the tutor during the session, because only suggestions or negative feedback make me feel that my paper is so terrible and it is no use revising if so terrible. However if the tutor gives me encouragement or points to good parts of my paper, I will be able to keep going because I think my paper will be further improved if I try harder.” S9 in Tutorial J, who marked 3, mentioned that the reason for less encouragement or praises by the tutor is that the tutor was asked to check his final draft in this session. Interestingly, although S11 in Tutorial L marked 1, he recognized the importance of tutor encouragement and praises and they surely provide motivation to make revisions. As shown in student participant profiles in 3.3, S11 has high English ability and in the interview, he stated that he had had little difficulty writing a paper. It can be assumed that encouragement or praises provided by the tutor during the session may have an insignificant influence on such student’s revision process.

The findings of this question revealed that many students remembered what kind of encouragement or praises had been given by the tutor during the session, which can increase their motivation for revision. However, it was indicated that how many times they were encouraged or praised during the session have little influence on their revisions after the tutorials. Rather, the fact that they were encouraged or praised even though it is just once may influence their motivation for revision.

Findings for Question 7：How successful was the session?

Many students evaluated their tutorial session as highly successful. In this study, it was found that the perception of tutorial success varies among students and several factors seem to have contributed to the success of tutorial session. For S7 in Tutorial H, tutorial success seemed to be measured in terms of the degree of completeness of revision after the

session. S7 stated, “I marked 5 for this question because I thought I could submit the revised draft based on all tutor feedback provided in the session with confidence.”

For S10 in Tutorial K, S15 in Tutorial P, and S19 in Tutorial T, tutorial success is associated with whether the tutor sufficiently checked their paper. For this question, S10 and S15 marked 4 and S19 marked 3. All of the three mentioned that they had not marked 5 because their tutors had not check all part of their text because of lack of time. In addition to this, S19 stated, “In revising my paper after the session, I found that some parts of my text need more help by the tutor. Although I managed to revise those parts by myself, I could not be satisfied with them.” S11 made similar remarks to S19 about the reason for marking 4. S15, who has visited the writing center three times, expressed her perceived success of the tutorial session by comparing to other sessions she had before: “In the first tutorial session, my tutor just understood the content of my experiment by asking me many questions. In the second session, she gave me feedback on my paper. In the third session, she gave me feedback on my paper I had revised based on the feedback I received in the previous session, which gave me the greatest satisfaction.” For S15, how much appropriate feedback the tutor gives after fully understanding the content of her paper seems to be another important factor in tutorial success. In contrast, S8 in Tutorial I who marked 4.5. provide different perspective. She stated, “Even though the tutor gives me different advice from what I had expected, if my revised paper becomes more reader-friendly, I regard the session as successful.” She also mentioned that she had got different advice from the ones given in the previous session. Whatever the case may be, the point is whether the student can obtain useful advice which makes his or her paper better from tutor.

S9 in Tutorial J who marked 4 felt that this session was successful because the tutor pointed out the problematic parts of his text he had not noticed and he could ask questions about the content, structure, or coherence which he could not ask in peer review.

S18 in Tutorial S who marked 4.5 gives four reasons for successful tutorial: because the structure of text was clarified during the session, because he could clarify what he really wants to say during the session, because not only grammar or vocabulary mistakes but also the content of his paper and the structure of text were checked by his tutor, and because he realized that he could alter his perspective of and attitude towards writing and improve his writing skill in English.

S16 in Tutorial Q who marked 4 refers to tutorial success slightly differently. In the interview, S16 said, "Although I am satisfied with this tutorial session, I regret I could not make effective use of the writing center. In other words, I felt that if I had visited the writing center before, I could have received more useful feedback from the tutor in this session and the quality of my revised paper after this session might have been more improved. This is why I marked 4, not 5."

Findings for Question 8：To what extent did you incorporate the results of this session in your subsequent draft?

Among ten students, three students marked 5, two students marked 4.5, four students marked 4, and one student marked 3. The answer to this question is relatively consistent with the students' actual revisions. Through the retrospective interviews with the students, it was found that students basically follow tutor feedback in revising their draft after the session, but they do not necessarily follow tutor feedback for various reasons. S11 in Tutorial L marked 4 because he did not intentionally incorporate tutor feedback into his revisions. S7 in Tutorial H marked 4.5 because the feedback was different from what he really wanted to say or he was not satisfied with the feedback. This indicates that the students take responsibility for their papers and make their own decision on the use of tutor feedback, which corresponds to the meaning of autonomy mentioned in the introduction

chapter. S1T6 in Tutorial Q who marked 4 mentioned that he thought he had applied a large part of what was discussed during the session to his revisions but he could not have applied all of them because he had not had enough time before the deadline. S18 in Tutorial S who marked 3 also mentioned that he had wanted to incorporate all tutor feedback into his revisions but he could not have done because of lack of time. S15 in Tutorial P marked 4 because she followed all tutor feedback but she made self-revisions on the parts which she had failed to ask her tutor during the session. S7 in Tutorial H, S15 in Tutorial P, and S16 in Tutorial Q also mentioned that they did not mark 5 because they made self-revisions that were not discussed during the sessions. In the interviews, they stated that reflecting on their writing, which is one of the central aspects of autonomy, resulted in such self-initiated revisions.

5.3.2 Findings from the tutor questionnaire

Findings for Question 1：Who talked the most during the session?

Regarding Question 1, "who talked the most during the conference?", five tutors out of six marked 4 and one marked 3. The answers to this question are relatively consistent with the students' answers as reported above. T4 in Tutorial Q who marked 4, for example, mentioned that, "I cannot help but talk more than my student because the student is passive during the session." Most tutors recognize that it is ideal that the student talks more than the tutor at a writing center, but in fact it seems to be difficult.

Findings for Question 2: Did you believe that you sufficiently addressed the student's questions?

In regard to Question 2, "did you believe that you sufficiently addressed the student's questions?", most tutors replied that they sufficiently addressed the student's questions. The

answers to this question is relatively consistent with the students' answers as reported above. In this study, only T11 in Tutorial T marked 2. T11 stated that she could not sufficiently answer her tutee's questions because the questions were mostly about science.

Findings for Question 3: What did you believe the student's comfort level to be?

Interestingly, in most tutorial sessions, the tutors underestimated the student's comfort level in the session. T4 in Tutorial Q who marked 2, for example, stated the student have seemed to be upset because what was during the session was different from what he had intended to ask the tutor and also feel depressed by being required to revise his text drastically. However, S16 in Tutorial Q felt very comfortable during the session. T9 in Tutorial U who marked 2 guessed the student might have been nervous because the session was videotaped, while the student stated in the interview that he had not been nervous in particular.

Findings for Question 4: How directive do you think your comments or questions were?

Through Question 4, "how directive do you think your comments or questions were?", it was found that all tutors are basically conscious of not being too directive. In addition, some tutors stated that they used different types of feedback (directive or indirective) depending on the content of the feedback. T7 in Tutorial K and T10 in Tutorial P who marked 3, for example, explained that they use directive feedback on local issues such as grammatical errors, citations or referencing style and use indirective approach for global issues such as content, overall structure, sequence of information. Adding to this, T7 stated, "all comments or questions do not have to be indirective. Directive feedback is also required for teaching the rules of academic writing to be followed." T11 in Tutorial T

marked 4 answered this question in a different way. She mentioned that her attitude toward the student might have been slightly directive and authoritative. Knowing when to be directive and when not to is essential for effective tutoring. Tutors are required to acquire various approach for attending to students' motivation as much as possible.

Findings for Question 5: How much positive feedback do you think your comments or suggestions were?

In regard to how much positive feedback tutors think they gave, it was found that most tutors consciously give praise and encouragement. T10 in Tutorial P who marked 4 mentioned that she always kept in mind to make positive comments in order to help them persist with the task after the session. She also indicated that she naturally make praise comments because the student came to writing center many times and she saw how much the student's text had improved than before. In contrast, T4 in Tutorial Q marked 3 because there are a lot of problematic parts to be improved in the student's text and she had little chance to give positive feedback. However, she took care not to demotivate the student. T7 in Tutorial K who marked 2 stated, "I do not often intentionally give positive feedback. Of course, I give praise where it is due and it is important to give positive feedback not to discourage the student. Whether tutors give students positive feedback or not depends on students." The common point among them is even though tutors do not make praise comments in the session, they are careful not to discourage the students. Tutors build rapport and collaborate with students so that they will be motivated to participate actively in a tutorial session and make revisions after the session.

Findings for Question 6: What did you perceive your role to be in the conference?

In terms of tutor role in the session, it was revealed that all tutors viewed their role as

more instructor-like, although the reasons for choosing 2 (instructor-like) vary depending on tutors. This result supports the one observed in Thonus (2004), who showed . T7 in Tutorial K who marked 2, for example, believed that students expect tutors to be more authoritative than peers. She also mentioned that tutor role varies depending on students, especially students' communication ability. In this context, T4 in Tutorial Q who marked 2 explained that if the student is passive and do not ask many questions during the session, the tutor role automatically become instructor-like. T10 in Tutorial P who marked 2 indicated that although she thinks it is ideal for tutors in writing center to be like peers, she wants to be a kind of person who can provide more helpful advice than peers in the classroom. In addition, according to her, tutor role can vary with the number of the student's writing center visits, in other words, what is going to be discussed in the session. For example, in the first and second sessions, tutor role can be more peer-like, that is, there is a lot of discussion on unclear parts of the text or a lot of exchange that elicit the student's opinions or ideas. In the latter sessions, students mostly visit writing center to ask tutors for final check of their drafts. Thus, tutor role becomes more instructor-like unconsciously. As shown above, interestingly, although all three of them marked 2 in this question, each has different reasons.

Findings for Question 7: How successful do you think the session was?

In this study, most tutors evaluated their sessions as highly successful, with one tutor rating session success as 5 and five tutors as 4. Three main attributes have emerged from the interview data based on the questionnaire. The first point is whether tutors fulfill all demands of the student in the session. More specifically, whether tutors can point out all parts to be improved in the text within a given time and give useful and appropriate advice to solve the problems the student had can be a crucial aspect influencing the success of the

tutorials. Second, students' satisfaction with the session or tutor feedback given in the session can also significantly contribute to tutorial success. In the interview, T11 in Tutorial T mentioned that she marked 4 instead of 5 because she was afraid that she could not solve all the problems the student had and also could not provide satisfactory feedback on the parts the student had really wanted to discuss in the session. Third, improving not only the text but also the students' awareness to produce appropriate writing is an important factor for successful tutorial. T9 in Tutorial U, for example, mentioned that she judged the session as highly successful because the student had understood why he had to revise the parts she had pointed out. Also, she expected that the student would be able to autonomously revise his text in the future based on what has been discussed in this session. Likewise, T10 in Tutorial P explained that leading the student to discover how to improve the text and revise the text autonomously results in the success of the session. She also mentioned that in unsuccessful tutorial sessions, the student turns a deaf ear to the tutor's advice and refuses to discuss how to improve the text.

In addition to these points, T11 in Tutorial T indicated that the improvement of the quality of students' writing after the session can also contribute to the success of the tutorials. She suggests that the effects of the tutorial session on revision success and the improvement of writing quality might be judged by changes in quality of the instructor's comments, not solely by the grade the student receives on his or her paper. Moreover, she stated that whether the tutorial session has long-term effect on students' writing might be related to the success of the tutorials, even though the student would not notice the effects or the tutors could not check it. According to her, for instance, the session will finally be judged as successful when what the student has learned in the session is helpful in writing scientific paper in the future. Another interesting point was found in T7's comments. She explained that the comfort level in the session can also be associated with perceived

success.

Findings for Question 8: To what extent do you think that this conference will influence the student in revising his or her writing?

In regard to Question 8, "to what extent do you think that the session will influence the student in revising his or her writing?", all tutors realized that the session would significantly influence their students' revisions, with two tutors ranking influence as 5 and four tutors as 4. T4 in Tutorial Q marked 5 because she asked her tutee to make a lot of substantial revisions in the session. T11 in Tutorial T who marked 5 believed the student would incorporate all her advice into his revisions because the advice was not so complicated and also he was highly motivated student. T10 in Tutorial P who marked 4 stated, "she has always incorporated my advice into her revisions and I am sure that she will do so this time too. In this session, I gave advice on references, but I am a bit worried about whether she could find appropriate references to her research." T7 in Tutorial K marked 4 because she provided feedback on only limited parts of the student's text. In short, the results of interviews indicate that the influence of tutoring session can be judged in the light of the quality of feedback in some cases or the quantity of feedback in other cases.

5.3.3 Summary

It is important to note that even though the participants marked the same number in the questionnaire, there was a large variation among individuals in regard to the reasons for their response. Based upon the findings from the questionnaire data, it was indicated that tutees' perceptions of tutor feedback, tutor expertise, and the tutorial session seem to influence their revisions to some degree. In addition, writer autonomy described in the introduction was observed in the findings from Question 8 of tutee questionnaires. In this

study, the students made their own decisions on the use of tutor feedback in revising their texts. Some students could find their own solutions on their writing problems or apply their tutors' advice or suggestions about one problematic point to their overall revisions in the revision process, which led to self-initiated revisions that were not discussed during the sessions. This can be due to the development and exercise of the reflective skills of planning, monitoring and evaluating their writing in the words of Litter (2002) mentioned in the introduction chapter. Therefore, these findings imply that writing center tutorials can contribute to foster students' autonomy as writers as mentioned in the introduction chapter. Furthermore, It is suggested that it is important for tutors to understand students' various attitudes towards writing center tutorials in exploring more effective tutoring in the future. The findings of the questionnaire will offer new insights for future tutoring practice.

5.4 Other factors

The results of this study revealed that there is individual variation among students' revisions. To understand the variation, this section discusses what other factors could affect students' revisions made by students after writing center tutorials. Through the retrospective interviews with the students, the following factors were identified as the ones that may affect students' revisions after writing center tutorials: 1) students' English proficiency, 2) students' motivation, 3) deadline of paper submission, 4) types of revision problems students were being asked to revise, and 5) writing center visits. It seems likely that all these factors are interrelated with each other and may be an important influence on the revision process.

5.4.1 Students' English proficiency

One important factor that affected students' revisions found in this study is students' English proficiency. Even though students want to or try to make revisions based on their

tutor feedback, some students may not have sufficient English proficiency to revise properly in English, and have difficulties with revising their texts based on tutor feedback because of their lack of English proficiency. In the interview with S9, for example, he remarked that "I think my English is not good. I tried to revise the parts being asked to revise by my tutor, but I had no idea how to say it in English and finally I gave up revising the parts." In contrast, if students have high English proficiency enough to express what they want to say, they seem to be more likely to revise their texts. They also seem to be likely to attempt revising other problematic parts that were not discussed during the sessions. S11 has high English proficiency [his reported TOEIC score was 905] because the high school he graduated from is SELHi (Super English Language High School) which concentrates heavily on English education, designated by the Ministry of Education, Culture, Sports, Science, and Technology.

In this study, the students were asked whether or not they have English qualifications and also whether they have had experience of living or studying abroad as a measure of their English proficiency. Not all of the students in his study, however, have English qualifications or took a standardized English test for this study. It cannot be said for sure that students' English proficiency can affect their revisions based on the results of this study. However, in the interview, some students remarked that if they had a good command of English, they might have been able to make increased revisions. Therefore, it is probably safe enough to say that students' English proficiency can affect to some extent their revisions. Future research will be required to measure the participants' English proficiency and examine precisely whether English ability can affect their revisions.

5.4.2 Self-motivation

Another important factor that appears to play a role in the revision processes is students' self-motivation. Students with various motivations visit the writing center:

students who lack confidence in writing a scientific paper in English, students who are highly motivated towards improving their writing, students who want to get a good grade in the class, students who are reluctant to work on the task but do not want to fail the class because the class is compulsory, and students who have no idea what to do to accomplish the task. In some cases, students visit the writing center because they are told to do so by their instructors. In the current study, all the participants voluntarily visited the writing center.

If students have high motivation towards writing, they are likely to attempt not only content revisions which require deeper analyses or explanation but also actively deal with the problems that were not discussed during the sessions. In this study, for example, S11 showed himself to be a very self-motivated writer and was actively involved in the discussion. He not only revised in reaction to the tutor's feedback, but also made other revisions that were not discussed during the session. His high motivation towards improving his writing is considered to be one of the factors that resulted in self-initiated revisions. In addition to his high motivation, his high English proficiency as mentioned earlier enabled him to make increased revisions. However, even though students have high motivation towards revising but have inadequate English proficiency, they may have difficulty making revisions. In this study, it was found that such students are likely to visit the writing center again to seek further feedback from tutors on their revised texts and attempt revisions many times. There are also some cases in which students are likely to give up making revisions in response to tutor feedback even though students have high motivation but have their deadline coming up and have inadequate English proficiency. In this way, several factors are intricately interrelated with each other and lead to students' revision decisions.

Not only students' motivations for visiting the writing center but also their

motivations for revising their texts after the tutorial sessions can affect students' revisions. Some students may become demotivated when they receive excessive feedback beyond their capacity or ability to handle it. In light of the student's situation at hand, tutors should provide appropriate amount of feedback to avoid demotivating students.

5.4.3 Deadline of paper submission

How much time is left before submitting the final paper can also affect students' both types of revisions and use of tutor feedback. Regarding the types of revisions, if the deadline is looming, it is assumed that grammar, vocabulary, mechanics, and style are more likely to be revised than content, because such types of revisions can be dealt with in a short time. If students have enough time before the deadline, they can spend a great deal of time revising their papers. In Tutorial U, for example, the deadline of paper submission was 48 days later and this was the first time for S20 to visit the writing center. He brought his introduction and methods sections to the session. His purpose of visiting the writing center was to ask his tutor to see if all the needed information on his experiment was included in his paper. After the tutorial session, S20 had sufficient time to make revisions, especially to deal with content revisions thoroughly based on his tutor feedback. On the other hand, S16 and S18 confessed that they could not incorporate all feedback given by their tutors during the sessions due to lack of time, although they acknowledged that their tutors gave very useful feedback to them. They explained that they obsessed with completing their papers to submit them in time and did not have enough time to deal with all revision problems that were asked to revise by their tutors during the session. This finding indicates that to what extent the students have completed their papers when they come to take a writing center tutorial can play a role in their revisions after the sessions. Interestingly, S7, S8, S15, and S18 actively made the self-motivated revisions their tutors identified because they want the tutors in the writing center to check their revised drafts. This implies that these positive

attitudes related to the deadline of paper submission can also affect students' revisions after writing center tutorials.

Deadline of students' paper submission is one of the important factors to understand the situation that the student is in now. The purpose of visiting the writing center, which section the student brought to the session (text length), and the points the tutor should focus on during the session differ depending on how much time is left before submitting the final paper. Deadline of paper submission can greatly affect tutoring sessions as well as revisions themselves. Before starting the tutorial sessions, tutors should therefore check the deadline of the student's paper submission and provide an appropriate amount of feedback with students according to their deadline. There is a limit to the number of what can be discussed in a session. If there is still much time left until the student submits the final draft, both the tutor and the student can spend a great deal of time focusing on each problematic point. However, when the deadline of paper submission is looming, some students are nervous or get into crunch mode. Others may leave all the decision-making to tutors. Even though the tutors give the students a lot of advice on their papers, they may not be able to incorporate all of them into their revisions. If the deadline of the student's paper submission is looming, tutors must provide feedback the student can handle. Otherwise students may become rather confused, anxious, or demotivated. It is crucially important for the tutors to narrow down the points they need to discuss during the session and not to make them reluctant to revise their texts. Taking advantage of face-to-face tutorials, tutors have to provide suitable feedback for each student, monitoring the student closely.

5.4.4 Types of revision problems being addressed

In order to understand how students revise in response to tutor feedback provided during tutorials, we must look not only at the nature of tutor feedback offered to students, but also at the types of problems students are being asked to revise. Students tend to easily

deal with surface-level problems such as grammatical errors because they can revise them mechanically to some extent. In contrast, content revisions require deeper analyses or explanation, or developing their papers by being more explicit in their arguments. Consequently, problems related to content are less likely to be revised. In this study, it was revealed that among content revisions, issues related to background research was less likely to be dealt with by some students. Through the retrospective interviews with them, it was found that they have difficulties in searching background studies and incorporating them into their papers when they write the Introduction section or the Discussion section. S20, for example, stated in the interview that "My tutor advised me to find more relevant previous research, but I didn't know how to search for articles relevant to my research and how to incorporate that background research into my paper."

Whether students can deal with revision problems that they were asked to revise can be highly associated with English proficiency. Due to a lack of their English proficiency, they may not be able to revise the parts that they were asked to revise by their tutors, although they might be able to explain them in their first language, Japanese. S20 in Tutorial V, for example, was asked to avoid too many relative clauses and also avoid using too long sentences in some parts of his paper. In the interview, he mentioned that "during the session, I think I can deal with these problems, but when I attempted to revise them at home after the tutorial session, I ended up failing to make revisions." Regarding the underlined part in Excerpt (26), S16 was asked to make more explicit what the required level is by his tutor.

Excerpt (26) (rom S16's first draft)

Then, the level of liquid was dropped to **the required level** by slightly straightening the tip straw.

During the session, when S16 and his tutor negotiate the meaning of "required", S16 could explain what the required level is in Japanese. However, he explained in the interview that he had attempted to explain it in English in the same way as in Japanese, but he did not know how to explain in English and gave up revising the part.

S9's difficulties with revision seem not to be solely due to a lack of English proficiency. A lack of comprehensive writing skills also appears to play a role in revisions. S9 experienced difficulties providing more detailed explanation. The following excerpt shows an example of a revision problem the tutor identified but S9 failed in revising.

> Excerpt (27) (from S9's first draft)
>
> By these results, my hypothesis that the value of threshold in spatial vision in the participants is over 0.1mm is correct. In fact, these values (0.46mm～0.69mm) are largely different from **the theoretical one** (0.12mm).

On the underlined part in Excerpt (27), his tutor advised him to specify whose theory is or clarify what you meant by "theoretical" and also explain why the results in his study are different from the theory of previous studies. He attempted to revise this part, but he ended up leaving it unchanged. He mentioned that he was struggling with gathering evidence or information to support his argument. In writing center tutorials, it may be necessary for tutors to take into account students' both English proficiency and comprehensive writing skills and determine to what extent they should make concrete suggestions.

Through the retrospective interviews with students, it was also found that in general, many students have great difficulty writing the discussion section of IMRD paper, which requires students to elaborate on the issues raised in the Introduction section, suggest

potential future research and applications, and limitations of the experiment. In order to provide more effective tutorials, it is important for tutors to keep in mind what problems students encounter in revising their drafts after writing center tutorials. It should be noted that the results described above cannot be necessarily applied to the cases of other writing centers, because the written products in the present study are scientific papers. However, the findings are expected to be useful for future development of writing instruction in classes.

5.4.5 Writing center visits

In this study, before starting the tutorial session, the tutors asked the students whether the tutorial was a first time visit to the writing center or a repeat visit. If the tutors forgot to ask it, I asked it in the retrospective interview conducted after they submitted their revised draft. Although the number of writing center visits may not have a direct influence on student revisions, it can be assumed that it may affect students' familiarity with tutoring style and tutors, and thus their volubility and behavior during the session. Although the number of writing centers in Japanese universities has been increasing year by year, it still cannot be said that the concept of a writing center is widely recognized in Japan. Therefore, writing centers and tutorial sessions are unknown for many Japanese students and they cannot imagine what the writing center is and had no idea what to do at the center. Compared to the first visitors to the writing center, repeat visitors have already known what a tutorial in this writing center is and what they can do during the session. In fact, some repeat visitors were more likely to be actively involved in sessions. They can freely ask questions on the points that they are concerned about, having useful discussions that result in revisions. S2, for example, had visited the writing center several times prior to Tutorial B and C. In Tutorial B and C, S2 mostly took control of the tutorial conversation and almost all exchanges were initiated by S2, which might have resulted in revisions. In addition,

regarding types of revisions, different characteristics emerged in S2's revisions after Tutorial C. S2's revisions after Tutorial C have characteristics different from other students' revision types: the number of grammar revisions was larger than content revisions. Behind this is the fact that he had visited the writing center many times prior to Tutorial C as mentioned above and was provided with considerable feedback on content. In addition, the deadline of submission was two hour later. For these reasons, he asked his tutor to check surface-level errors rather than content at the beginning of the session in Tutorial C. As a result, S2 made different types of revisions between after Tutorial B and after Tutorial C: content revisions accounted for the highest percentage of all types of revisions after Tutorial B but the number of grammar revisions was largest after Tutorial C. Writing center visits is the factor that can affect both focuses of tutor feedback and types of revisions.

In this study, in addition to the number of writing center visits, repeaters were asked whether the tutorial represented a repeat visit to a tutor with whom the student had previously worked. Some students intentionally make an appointment with the same tutor with whom the student had previously worked. Others do not care whether the tutor is the same as last time or not, and make an appointment in their available time. In any case, in this writing center, students who have visited the writing center once are more likely to return for a further tutorial talk to improve their writing.

That is being said, there seems to be little difference in revision type and use of feedback between first-time visitors and repeat visitors. However, it can be assumed that repeat visitors can feel more relaxed during the session, make better use of the limited 40 minutes, and have useful discussions that result in self-motivated revisions. In that sense, writing center visits can be an indirect factor that influences students' revisions.

Compared to other factors mentioned above, writing center visits may not be highly associated with revisions. However, if students have high motivation towards improving

their writing and also feel only one session is not enough to achieve their writing goals, they may visit the writing center again. Repeat visitors in this study are all such writers. In addition to these reasons, S9 and S20 stated in the interviews that they came to take tutorials in order to compensate for their lack of English proficiency. In the interviews, some students mentioned that they finally made satisfactory revisions thanks to multiple tutorial sessions in the writing center. For these reasons, writing center visits can have an indirect influence on students' revisions, mutually interrelating with other factors.

The results in this study suggest that, in order to understand how students revise in response to tutor feedback, we must look not only at the nature of the comments themselves, but also at other factors such as the types of problems students are being asked to revise and individual student factors.

6. Discussion

Through a series of triangualted data collection and their analyses, the present study examined the effects of writing center tutorials on students' revisions in a Japanese EFL context. Regarding the first research question, "what kinds of tutorial feedback were offered in writing center tutorials?", it was revealed that tutor feedback in this study most focused on content followed by grammar and vocabulary. The results were different from those of Blau and Hall (2002). Blau and Hall reported that in their sessions with NNES students, "tutors, in attempting to be collaborative by asking Socratic questions, instead fell into the trap of asking closed questions, questions that had only one correct answer, not questions that opened up thinking or discussion" (p.33). However, in this study, most of the tutor feedback was on the content, which requires developing the student's idea or discussion. One possible reason is that the tutors in this writing center are instructed to start with global issues such as content, overall structure, sequence of information and then do local issues such as grammatical errors in tutor training. As mentioned in 3.3.1, in writing center tutorials, tutors are generally advised to deal first with global errors that interfere with text comprehension rather than local errors which do not interfere with comprehension (e.g., Cogie, Kim & Sharon, 1999; Gillespie & Lerner, 2004, 2004; Harris & Silva, 1993). Therefore, the result that tutor feedback in this study most focused on content implies that the instructional principle of writing centers has been faithfully practiced in this writing center. Another possible reason could be the use of the student participants' L1, Japanese. In the writing center where the present study was conducted, the tutorial sessions were conducted in the students' L1, Japanese. The results obtained in the present study support those of Sadoshima, et al. (2009) which showed the effectiveness of tutoring English writing in the students' L1. The results of this study indicated that if a tutorial was given in a students' L1, problems that were reported in L2 writing center research such as difficulty

in dealing first with global issues and then addressing local issues in L2 tutoring practice, could be resolved. However, in U.S. writing centers where students with a variety of languages and cultural backgrounds visit, it might be difficult or actually impossible for a tutor to give a tutorial in each student's L1. In Japan, it might be feasible because in many cases, the tutors' and the students' L1 are the same. The results of this study revealed that it can be possible to preferentially deal with global issues in the tutorial sessions even with EFL students, based on the instructional principle of writing center.

In addition, the findings from the present study showed that the tutors used various tutoring strategies simultaneously to increase the student's active participation and to move the discussion toward more effective ways of improving their drafts. Among the tutoring strategies observed in the present study, *suggestions* and *negotiations* were most frequently used. These results confirmed those of Villamil & Guerrero (1996) and Thompson (2009). In addition, the tutoring strategies used for discussion on text and discussion on writer in the present study mostly correspond to scaffolding mechanisms in previous work on writing center tutorials (Williams, 2002, 2004; Thompson, 2009), on peer discussions (Villamil & Guerrero, 1996; Guerrero & Villamil, 2000), and on teacher-learner talk (Weissberg, 2006), although the labeling is different. *Suggestions* in the present study correspond to *advising* in Villamil and Guerrero (1996) and *cognitive scaffolding* in Thompson (2009). *Negotiation* is similar to *eliciting* in Villamil and Guerrero (1996), and is consistent with the second type of scaffolded support in Williams (2002), which is *extending and elaborating the students' utterances. Negotiations* are also observed in Weissberg's (2006) study. *Indication of problem* in the present study correspond to the first type of scaffolded support of *recasting incorrect utterances* and the third type of scaffolding of *identifying places in the student's text that may require revision* shown in Williams' (2002). *Explanation* is similar to instructing in Villamil and Guerrero (1996). Response is in accordance with a part of

making phatic comments in Villamil and Guerrero (1996). *Giving a hint* falls into *cognitive scaffolding* in Thompson (2009). *Motivational* is consistent with *motivational scaffolding* in Thompson (2009). *Interpretation by readers* can be categorized into *cognitive scaffolding* in Thompson (2009) and is also similar to *reacting* in Villamil and Guerrero (1996). *Paraphrasing* is identified in Weissberg's (2006) study and is also similar to *restating* in Villamil and Guerrero (1996). Thus, tutor feedback observed in this study illustrate a number of scaffolded mechanisms by which tutors help L2 student writers find solutions to problems in their texts. The results of this study indicate that scaffolding did indeed occur in writing center tutorials in Japan and that it played a role in finding solutions to the writing problems in the students' texts. Therefore, it can be suggested that scaffolding signifies in the context of writing center tutorials on L2 English writing. Scaffolding is the key factor that characterizes writing center tutorials in that the novice students can solve problems or achieve a goal that they would not be able to achieve by themselves under a more capable tutor's assistance. The present study shows the function of scaffolding in writing center tutorials is to collaborate with students so that they will be actively engaged in the tutorial as well as establish rapport with students.

The finding that negotiation was one of the most frequently used tutoring strategies in the present study is different from Thonus' (2004) one that showed less extended negotiation with NNES students. As is the case in the type of tutor feedback, it can be assumed that the use of the student's L1 serves as a scaffolding to assist the student in completing the task, which support the results of Anton & Dicamilla (1998) and Guerrero & Villamil (2000). In this study, through the retrospective interviews with the tutors, it was revealed that why tutoring strategies such as suggestions and negotiations were used most. Regarding the use of suggestions, it was found that the tutors in this study used suggestions in order to avoid the imperative form and not to impose their answers or ideas but to leave

final decisions to the students. They also respected the student' intended meanings or ideas and attempt to enhance the students' sense of ownership of their text. This implies that the philosophy of writing centers is reflected in actual tutoring practices in this writing center. With regards to the use of negotiations, the tutors used negotiations to help the students clarify what to revise, how to revise, and why revisions are necessary and also encourage students to discover how to improve their texts by themselves. Negotiation of meaning is well known to play an important role in SLA. The role of negotiation of meaning in SLA is referred to the Interaction Hypothesis (Gass, 1997; Long, 1996; Pica, 1994). In the Interaction Hypothesis, negotiation of meaning facilitates learners' language acquisition in that it increases comprehension of input, makes learners aware of problems on their utterance, and gives learners the opportunity to modify their utterances in response to interactional feedback and produce output that is comprehensible to their interlocutor. This process may contribute to a better understanding of the roles of negotiation of meaning in writing center tutorials with regard to students' revisions. In writing center tutorials, negotiation of meaning can enhance mutual understanding of the text written by the student, help students find out the problematic points in their texts, and give the student the opportunity to think about how to improve their texts in order to give readers a better understanding of what they really want to say, which results in facilitating the student's subsequent revisions. In addition, some studies show that negotiation leads to students' active involvement in the tutorials (e.g., Goldstein & Conrad, 1990; Mendonca & Johnson, 1994; Nelson & Murphy, 1993; Patthey-Chavez & Ferris, 1997; Thonus, 1998; Williams, 2002, 2004), which was also supported by the results of the present study.

In conclusion, as for the tutoring strategies used in the writing center tutorials, the results of this study show that some specific tutoring strategies are not always effective; rather, the important thing is for tutors to use appropriate tutoring strategies depending on

types of revision problems students were being asked to revise or students' levels of both English ability and writing skills. In this study, it was found that most tutors are conscious of not being directive in providing feedback during the session and thus frequently use suggestions and negotiations, since they provide feedback based on the mission of "producing better writers, not better writing" (North, 1984, p. 438). The point is how skillfully tutors provide feedback that matches tutees' demands within a limited amount of time, make a collaborative atmosphere, get the students to actively participate in the tutorials, and encourage them to make satisfying revisions.

Regarding the second research question, "what kinds of revisions were made after tutorial sessions?", the results showed that content revisions accounted for the highest percentage of all types of revisions, followed by vocabulary and grammar. It was found that revised aspects are nearly consistent with focus of tutor feedback provided during the sessions. It seems reasonable to suppose that content was the most revised aspect because tutor feedback focused most often on content. In addition to this, as Williams (2004) reported, it can be assumed that negotiations that take place during the tutorial sessions, the students' active participation in the sessions, and scaffolded feedback by the tutors could all result in revisions on content. Furthermore, it is likely that the student participants in this study have high ability of developing or elaborating their ideas enough to make content revisions based on tutor feedback. It was also found that there was considerable individual variation in type of revision.

The answers to research question three to five were discovered through interviews. As to the research questions three and four, the students' use of the tutorial discussions in revising their drafts, it was revealed that the students mostly incorporated what was discussed during the tutorial sessions. This is supported by Williams (2005), which reported that the writers rarely reject the tutor's suggestions. The findings from the retrospective

interviews with the students indicate that this could be due to the students' perceptions of tutor role as an authority figure. From the perspective of scaffolding, it can be argued that in some cases, scaffolding by the tutor enables the students to incorporate tutor feedback provided in the session into their revisions. In other words, if the student is within his or her ZPD and scaffolded support by more skilled tutor is provided to the student, he or she can carry out the task, in this sense, make revisions. On the other hand, even if scaffolded feedback by the tutor is provided to the student, if the student is outside the ZPD and the student is being asked to make revisions beyond their English ability or writing ability, the student may be unable to make revisions. Since ZPD is where learning is facilitated by an expert's assistance, if the student is outside the ZPD, learning does not occur. In Williams' (2002) words, "novice second language writers, working collaboratively within their ZPD can move beyond their current level of competence by jointly constructing new knowledge in collaboration with peers" (p.84). If the revisions may not be normally accomplished by the student alone, particularly as regards substantial revisions, incorporation of tutor feedback into revisions can be considered as the outcome of scaffolding by the tutors.

The results from the present study also showed that the students not only followed tutor feedback provided during the tutorial session but also made self-initiated revisions that were not discussed in tutorial sessions. In the retrospective interviews, some students stated that they learned revision strategies such as how to reflect on their writing and overcome the weaknesses of their texts through the tutorials, they were able to apply the process to other problematic points of their texts. In other words, it can safely be said that tutorial interactions with the tutor in their ZPD enabled the students to accomplish the higher levels of task or solving a problem which they could not accomplish alone, that is, make self-initiated revisions that were not discussed during the sessions. In this regard, it can be assumed that these self-initiated revisions that were not discussed in tutorial sessions

can be the definite success of scaffolding by the tutor during the tutorial session. In addition, this finding that some students could make such self-initiated revisions implies that writing center tutorials can contribute to foster autonomous writers. Regarding not-incorporated revisions, through retrospective interviews with the students, three reasons for not incorporating tutorial discussions were identified in this study: (1) students forgot to make revisions; (2) students had no idea how to revise; and (3) students made self-initiated decisions not to follow tutors' advice or suggestions because they disagreed with the tutors' advice or suggestions or because of their preference for writing in a certain way. Even students who did not follow the tutor feedback made their own decision about whether or not to incorporate their tutor feedback into their revisions. This implies that the students had ownership of their texts and made self-directed decisions on their revisions. This finding that students can reflect on their own writing and self-directed decisions on their text revisions after receiving writing center tutorials is worth noting, as it implies that writing center tutorials can help to foster autonomous writers. However, in cases where the students did not follow tutor feedback because they forgot to revise or because they had no idea on how to revise, such students' behaviors, in a sense, might be regarded as a failure of scaffolding by a tutor during the tutorial sessions. If more appropriate scaffolded feedback had been given by the tutor, the students could have incorporated tutor feedback into revisions. In this regard, as Aljaafreh and Lantolf (1994) suggest, tutors are required to "try to be sensitive to the learners' actual level of competence, in Wertsch's terminology, 'lure' them into functioning in an appropriate way without making the task frustrating" (p.469).

The results of the present study also showed that there was a large variation among students in regard to what types of revisions they made and how they responded to their tutor feedback in revising their drafts. In addition, through the analysis of the students' use of the tutorial discussions in revising their drafts, it can be assumed that individual factors

are more related to whether the student makes revisions or not than the types of tutor feedback (how issues are addressed). In response to research question five, through the interviews with the students, it was suggested that in addition to tutor feedback provided during the sessions, the following individual factors were interrelated with each other within students and may be important influences on their revision process: 1) students' English proficiency, 2) students' motivation, 3) deadline of paper submission, 4) types of revision problems students were being asked to revise, and 5) writing center visits. One of the crucial factors that affected students' revisions found in this study is students' English proficiency. Even though students want to or try to make revisions based on their tutor feedback, some students may not have sufficient English proficiency to revise properly in English, and have difficulties with revising their texts based on tutor feedback because of their limited English ability. Students' self-motivation also plays an important role in the revision processes. If students have high motivation towards writing, they are likely to attempt not only content revisions which require deeper analyses or explanation but also actively deal with the problems that were not discussed during the sessions. However, even though students have high motivation towards revising but have limited English ability, they may have difficulty making revisions. The third factor of affecting students' revisions is deadline of paper submission. If the paper is due soon, surface level errors are more likely to be revised than global issues such as content and organization, because such types of revisions can be dealt with in a short time. When the deadline of paper submission is looming, even though the tutors give the students a lot of advice on their papers, the students may not be able to incorporate all of tutor feedback into their revisions. With regards to the fourth factor, types of revision problems being addressed, problems related to content are less likely to be revised, because such revisions require deeper analyses or explanation, or developing their papers by being more explicit in their arguments. As

shown in Williams (2004), the sentence-level issues discussed during the session are more likely to get revised than global issues. In addition, whether students can deal with revision problems that they were asked to revise can be highly associated with English proficiency. Due to their lack of English ability, they may not be able to revise the parts that they were asked to revise by their tutors. A lack of comprehensive writing skills also appears to play a role in revisions. Regarding the fifth factor, writing center visits, although there seems to be little difference in revision type and use of feedback between first-time visitors and repeat visitors, it can be assumed that repeat visitors can feel more relaxed during the session, make better use of the limited 40 minutes, and have useful discussions that result in self-motivated revisions. In this regard, writing center visits can be an indirect factor that influences students' revisions. Finally, the important point to remember is the existence of other agents such as peer feedback provided during peer review and teacher feedback in class. As observed in this study, indeed, some students revised their papers based on peer feedback and teacher feedback they received in their class. Human cognitive activity can always be influenced by various factors. Thus, when students revise their paper after the tutorial session, all the revisions might not come from tutorial discussions. In other words, only writing center tutorials do not affect students' subsequent revisions. It should be kept in mind that our thought is shaped by a complex mix of various agents.

7. Conclusion

This is a case study in a specific writing center setting. Other kinds of students in other kinds of settings might all yield different results. Therefore, the findings presented here cannot be said to be generalizable to other students or contexts. Instead, this research satisfies transferability even if its generalizability is rather weak. Edge and Richards (1998) listed four important criteria for qualitative, naturalistic research to replace the traditional criteria for quantitative research: credibility, transferability, dependability, and confirmability. Among these four, transferability in qualitative research corresponds to generalizability in quantitative research. Edge and Richards (1998) explain transferability as follows:

> A naturalistic inquiry will not deliver a generalization which can be abstracted and 'applied'; instead it seeks to produce understandings of one situation which someone with knowledge of another situation may well be able to make use of.
>
> (Edge & Richards, 1998, p.345)

Even if this study is just one situation, it provides descriptions and interpretations of one writing center in Japan which are rich enough to be made use of in future studies and to shed light on different situations. The present study also informs future large-scale study with a larger corpus of varied writing center tutorials in order to explore the effective tutoring practices in writing centers, which can be adopted in tutor training.

In addition, this study examined only the relationship between tutorial discussions in a session and the revisions that appeared in the subsequent draft. I recognize that future research needs to examine the long-term effects of writing center tutorials on students' writing and revision. A large-scale and longitudinal study, especially one in which the types

of feedback and learners' proficiency levels were controlled, would allow us to observe which type of feedback triggers what kinds of revisions or reactions among students at different levels of proficiency. Furthermore, the success and quality of the students' revisions were not taken into account in this study. Future research will be required to investigate the long-term effects of writing center tutorials on revision success and the improvement of writing quality. Which individual factors can affect students' revision success should also be investigated. However, it should be kept in mind that the assessment of the success and improvement of students' revision and writing should be taken into account with caution, because the mission of writing centers is producing better writers, not better writing. Assessing the improvement of students' writing, in a sense, may require writing center tutorials to improve students' papers, which seems to be contradictory to the mission of writing centers. It must be acknowledged that investigating the effects of writing center tutorials on students' revisions and writing itself might include the assessment of improvement after the tutoring, and might also be necessary to demonstrate persuasively the educational and institutional value of writing centers to public or the administration. The questions, then, arise, what is "a better writer"? and what is a good writing center tutorial in order to produce better writers, not better writing? Considering how to define a better writer and how to measure better writers can offer a good solution to the issue on the assessment of the outcome of writing center, which remains to be solved.

Although much remains unexamined regarding whether writing center tutorials can improve the quality of student writing, the present study was successful in discovering that tutorial interactions can bring some positive changes in students' revision processes: internalize tutor feedback or what was discussed during the session, reflect on their texts critically, and become conscious of the importance of reader awareness in revision processes. These internal changes within students are important, and to make student

writers self-conscious about such attitudes for writing is the role of writing center tutorials, which eventually lead to foster autonomous writers.

Although quite a number of studies have been conducted on the impacts of teacher or peer feedback on students' revisions, only a few studies have been attempted to explore the relationship between writing center tutorials and students' revisions. For this reason, the present study can make a valuable contribution to future writing center research, especially research that focuses on Japanese EFL student writers. In addition, this study analyzed the transcripts of audio- and video-recorded tutorial conversations between tutors and students, students' written products, and interview transcripts. Through the triangualated data analyses, this study succeeds in revealing the effects of writing center tutorials on students' subsequent revisions from diversified perspectives.

The present study can be theoretically valuable in that it has provided insights based on empirical data regarding the relationship between writing center tutorials and students' revisions. To the best of my knowledge, this is the first study that has explored the influence of writing center tutorials on students' subsequent revisions after the tutorials in a Japanese EFL context. As mentioned earlier, there have been a large number of writing center studies that focused on writing center interaction, but very few studies have attempted to link tutorial talk with students' subsequent revisions. In order to understand the effectiveness of writing centers and to provide more effective tutorials for students, not only tutorial interactions during the sessions but also how students respond to what was discussed during sessions should be investigated. This study succeeded in showing what actually happens in Japanese writing center tutoring sessions and what students do after the sessions based on empirical research. This study definitely needs much more elaboration, but it still can be valuable as the first step in unraveling how writing center tutorials can contribute to fostering autonomous writers.

This study can also be significant in that it has recorded the interviews with students that took place after they revised their papers in response to tutor feedback. Their comments in these interviews were invaluable in helping us understand what was happening as they responded to feedback while they revised and also be aware of student writing through interactions. Although many studies have investigated the effects of feedback on student writing and revision, very few studies have conducted interviews with students regarding their use of feedback in their revision processes. In this point, the results of this study based on the interviews with students would provide valuable insights for future development of studies that will examine the effects of feedback on student writing.

Moreover, this paper examines an innovative topic in both L1 and L2 writing research and writing instruction. The present study is believed to be valuable for the further development of writing instruction in the classroom as well as in writing centers in Japan. In the field of writing instruction, the effects of feedback on student writing and revisions has been a subject of considerable interest to teachers and researchers. Additionally, in current writing instruction, feedback varies by whether it is provided by a teacher, a peer, or a computer and whether it is provided in written or oral (conference) form. Nonetheless, the number of empirical studies on the effects of writing tutorials on student revision still remains small. Therefore, the results of this study can provide new insights for future writing instruction.

The results of this study have some pedagogical implications for future writing center tutorials. The first pedagogical implication concerns future tutoring practice. As mentioned earlier, tutors are required to use appropriate tutoring strategies for each student based on his or her situation, English proficiency, and personality. For example, when the student's paper is due soon, it might be better to avoid making too much suggestions or asking the student to drastically change the organization of the text. Even though the tutors give the

students a lot of advice on their papers, they may not be able to or cannot afford to incorporate them into their revisions. Considering time constraints, therefore, it is crucially important for tutors to narrow the focus of the discussion during the session. In addition, it would be better to use motivational strategies effectively. In such cases, some students, are nervous or get into crunch mode. The most important thing is not to demotivate the students and discourage them from improving the texts. Thus, by interweaving motivational strategies and other strategies, it is important for tutors to reduce the students' anxieties and foster their positive attitudes toward improving their texts on their own. Also, the student whose paper is due soon, or even not soon, may visit the writing center for a grammar check or proofreading, which is common. In this case, it is important to respond to their request to some extent in order to meet their needs, but at the same time, tutors should not give up guiding them to find solutions to problems in their writing through tactful questioning and dialogue. Regarding grammar check, however, it is recommended that tutors should do an error analysis of the student's text to recognize typical patterns of student errors in order to avoid merely resulting in cleaning up the student's text. Still, language instruction including grammar check cannot be easily ignored in EFL contexts, since the students are EFL writers as well as EFL learners, which will be discussed later in more details. In sessions with the students who have limited English ability, tutors might be required to use more directive approach as Blau & Hall (2002) suggests, and also play a role of foreign language teacher, as Myers (2003) suggests. Tutors have to keep in mind that excessive indication of problems might demotivate and more confuse them. As Blau & Hall (2002) suggest, the balancing act of global and local issues might be also required. In addition, for such students, scaffolding such as reduction of degrees of freedom, in which the tutor simplifies the task at hand, and modeling, in which the tutors model a possible solution to the problem (Wood et al., 1976) might be effective. If the subject of the student

writing is out of the tutor's area of expertise, as is often the case, the objective perspective as a reader might yield results. Some tutors become nervous or anxious because they are unfamiliar with the topic of the student writing. By using tutoring strategies such as negotiation and interpretation by readers, tutors can ask questions without hesitation on the parts they cannot clearly understand in order to understand the student's intended meaning, which can help the student organize his or her thought, encourage the student to be more conscious of readers and discover how to articulate his or her idea more clearly. In order to provide tutorial sessions with students who have various backgrounds as mentioned above, tutors are advised to learn a variety of tutoring strategies and explore their effective use through daily tutorial practices. The results of the present study also showed what problems students encounter in revising their drafts after tutorials. In the present study, it was found that finding previous studies on the experiments they wish to conduct is one of the difficulties the students enrolled in the writing program have. Since the experiments are meant to be simple, sometimes it is simply difficult to find a science paper written on the subject. Other times they may locate a related science paper, but find the scientific jargon and language too difficult to decipher. The students, therefore, have difficulty finding a suitable science paper that meets the purpose of the course. This can be applied to the design of writing course development as well as future tutoring practice in writing centers. It may be necessary for teachers and tutors to keep those problems in mind and discuss, develop, or enhance future writing courses or programs that enable students to learn difficult writing skills such as analysis, explanation, and explicitness. We cannot expect that students who visit a writing center will understand the purpose and effectiveness of writing center tutorials. Since the quality of their tutorials and revisions can be affected by student perceptions, it might be more effective to let students know the role and function of a writing center and how writing center tutorials can serve. At the same time, we need to

give students new perspectives on writing through tutorial interactions in a writing center and break the rules they may have learned through classroom writing activities previously.

The implications of the present study also include the roles of writing centers in Japanese EFL contexts. As mentioned earlier, one of the biggest differences between U.S. writing centers and Japanese ones is the educational environment. In U.S. writing centers, grammar correction in ESL student writing has become a much-discussed issue. However, ESL students such as international students at U.S. universities, who are in an educational environment where daily communication is conducted in English, are immersed in English. In contrast, Japanese students seldom have an opportunity to be exposed to English outside of English class. Therefore, writing centers in EFL contexts can be places where students can not only receive feedback on their English writing but also learn English because our language of daily communication is Japanese.

In general, tutors are advised to avoid proofreading students' papers in writing centers. However, the fact that students can feel more confident about using English by promoting their linguistic accuracy of English cannot be ignored. As Myers (2003) supports, in tutoring with EFL students, it might be necessary for tutors to provide explicit language instruction and play a role both of writing instructors and foreign language teachers. In addition, as Blau & Hall (2002) suggest, the balancing act of global and local issues will be required, instead of trying to force themselves to reject grammar corrections. Tutors have to help students become aware of language issues by themselves and heighten their language awareness through tutorial discussions. Providing language help with students is required to respond to their demand and can also be an essential part of the teaching and learning of English writing especially in the EFL contexts like Japan. The students in writing centers in Japanese context are in most cases, not only EFL writers but also language learners. Tutors in Japanese EFL writing centers can facilitate the students' language learning by working

on language issues. Writing centers in Japanese EFL context need to reconsider what EFL students really mean when they ask for help with language issues. In addition, as Fujioka (2011) suggests, it will be necessary to help students develop the view of writing as a process, not writing as a product, and engage in the practice of a writing process outside writing center tutorials.

Another issue for writing centers in Japanese context is that, although all the tutors in Japanese writing centers have high English proficiency, most of them are generally not native English speakers. In other words, tutors are EFL learners. In this regard, I believe that tutors in Japanese EFL writing centers have an advantage precisely because they are not native English speakers. Tutors can be role models as Japanese EFL learners who have acquired a high level of English ability and academic writing skills in English. Tutors have experienced the same issues our students face when writing in English as a foreign language. Hence, tutors can understand why students make certain mistakes or write in certain ways, and can therefore respond adequately to the tutees' needs. At the same time, tutors are continuing their efforts to improve their own English proficiency, which leads them to become even more confident tutors.

A third issue to be discussed in Japanese context is that Japanese students are not familiar with tutoring style. In Japan, the idea that the tutor and the students have the same authority is culturally hard to be accepted. The students tend to think that tutors are a kind of instructor for them, that is, the tutors perform a more authoritative role than the students. Therefore, students tend to be passive and follow their tutors' advice without any question, and during the sessions, some students do not become actively involved in the discussion. This could be due to the educational environment in Japan. In Japanese schools and universities, one-sided teaching by the instructor is common in regular classes (except courses such as seminars) and, as a result, the students tend to become passive. Therefore,

when they hear that they can be given support on their writing at the writing center the students often misunderstand or expect that they will receive feedback, mainly grammar correction or proofreading, on their writing without any discussion. Fujioka (2011) suggests developing students' positive experiences with learning from peers outside writing centers tutorial sessions will be required.

The linguistic, social, and cultural context in Japanese writing centers is significantly different from the U.S. cases. Therefore, it is necessary to construct a writing center suitable for the Japanese EFL learners. EFL students rely on writing center tutorials for assistance in both language and writing aspects. Writing centers in Japan are places where students can not only receive support for their English writing but also engage in English learning beyond the regular curriculum. Writing centers in Japanese EFL contexts are also a place where tutors can improve their English ability and gain teaching experience, because some tutors aspire for careers as English instructors at universities. In this way, Japanese EFL writing centers have multiple functions for both students and tutors. It is crucial for administrators and faculty members of writing centers to have a critical view of the role and significance of writing centers in order to produce better writers, not better writing in Japanese EFL contexts.

The results of this study suggest various potential future applications. They can be applied not only to L2 writing instruction but also to L1 writing instruction. As described above, providing effective feedback to students is a great concern for any teacher of writing and an important area for both L1 and L2 writing research. The results of the present study can also be useful for peer review in writing courses. In addition, beyond the boundaries of writing instruction, they can be applicable to classroom interaction between a teacher and students and collaborative learning in various subjects. Regarding other practical situations, tutoring strategies and the attitudes towards tutoring can be applied to company training

such as on-the-job training. In sum, the results of this study can be potentially applicable to various activities to develop human autonomy through interactions. The findings from the present study will be a valuable for future writing center research in that they develop our understanding of how writing center can best serve students. Face-to-face interaction with students enables tutors to guide students through an analysis of a situation, adapting comments to the immediate needs of the students. Unlike written feedback, the tutor can provide students with feedback based on their intentions thanks to face-to-face tutorial interactions. Through interactions with a tutor, students can reorganize their ideas and clarify what they really want to say. Through tutorial interactions, tutors can help students develop and articulate their ideas. Therefore, it is the "interaction" between a tutor and a tutee that is the critical factor of writing center tutorials. The results of this study indicate that interactions with a tutor in writing center tutorials play a significant role in students' writing and revisions. Tutorial interaction in a writing center is different from classroom writing instruction because of the role of the tutor and because the tutor can provide more appropriate and beneficial feedback for students through face-to-face interaction. Helping students discover how to improve their texts through interactions is a key point of writing center tutorials. Fostering autonomous writers through face-to-face tutorial interactions with tutors who are not students' teachers and do not give grades beyond the classroom is the educational value of writing centers. Studying the effects of writing center tutorials on students' revisions offers an insight into how interaction can contribute to the process of writing and the development of student autonomy. Writing center research sheds light on the importance of interactions in the process of writing and can suggest a new perspective and possibility of both L1 and L2 writing instruction in Japan. I hope the present study will serve as a stepping stone to the further development of future writing center research and both L1 and L2 writing instruction in Japan.

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Appendix A

Application for Permission to Conduct Data Collection

Investigator Maiko Nakatake
The University of Tokyo

Dear Kanto Writing Center Manager Prof. Kato

I am a Ph.D student in the Dept. of Language and Information Science at the University of Tokyo conducting research on writing tutorials at a writing center. I would like to ask you to allow me to conduct the following data collection in Kanto Writing Center. The purpose of this study is to examine the effects of writing center tutorials on student revisions in an English-as-a-foreign-language (EFL) writing center in Japan. Participation in this study will require a) audio and video recordings of writing tutorials in the writing center and b) interview for approximately 30 to 60 minutes about the tutorial at a time of tutors' and students' convenience within a few days of the tutorial.

Participation

Participation in this study is voluntary; tutors and tutees may decline to participate without penalty. If they decide to participate, they may withdraw from the study at any time by notifying the investigator without penalty and without loss of benefits to which they are otherwise entitled. If tutors or tutees have any questions about this research, they can contact the investigator by e-mail at nakatake@phiz.c.u-tokyo.ac.jp.

Confidentiality

All of the information collected in this study will be confidential and will only be used for research purposes. This means that the identity of tutors and tutees will be anonymous. The information obtained in this study may be printed in a dissertation, published in journals, or presented at conferences but each tutor's identity will be kept strictly confidential.

Thank you very much for taking the time to read this letter. If this meets your approval, please sign below.

Signature _____ Date _____

Appendix B

調査協力同意書（学生用）

SEWP (Scientific English Writing Program)受講者の皆さんへ

私は、現在、日本の大学ライティング・センターで行われているチュートリアルについて研究している、博士課程の学生です。この度、学生の皆さんには、この書面にて、本研究調査へのご理解とご協力をお願いいたします。

本研究の目的は、EFL（外国語としての英語）の環境にある日本のライティング・センターにおける英語ライティングのチュートリアルを調査することです。本調査に協力していただける場合は、以下の 2 点にご協力いただきます。

a) チュートリアルでの会話を録音、録画させていただきます。
b) チュートリアルに持参した原稿のコピー、およびチュートリアル後に書き直した原稿のコピーを提出していただきます。

今回の調査への協力は任意です。たとえ参加を辞退しても、そのためにあなたが不利益をこうむることは一切ありません。この調査への参加に同意されてもその同意はいつでも自由に撤回できますので、その際は調査者にお知らせください。また、この調査への協力は SEWP の成績とは一切関係ありません。本調査に関して何か分からないことや疑問に思うことがありましたら、どんなことでも結構ですので遠慮なく調査者にご質問ください。

この調査で得た情報はすべて研究目的のみに使用されます。どの情報も機密扱いされます。あなたの個人情報は匿名にして扱います。この調査結果を口頭発表する場合や、論文として発表する場合にも同様に匿名になります。

以上、この研究にご協力頂ける場合は、この研究調査の目的、内容、条件をご理解いただいた上で、添付した「参加同意書」にご回答の上、次回中竹に参加同意書をご提出ください。

連絡先
中竹　真依子
東京大学大学院総合文化研究科
E-mail: msylvmknktk106@yahoo.co.jp

(continued)

調査協力同意書

調査者　中竹真依子
東京大学大学院総合文化研究科
E-mail: nakatake@phiz.c.u-tokyo.ac.jp

本研究の目的は、EFL（外国語としての英語）の環境にある日本のライティング・センターにおける英語ライティングのチュートリアルを調査することです。本調査に協力していただける場合は、以下の２点へのご協力・ご理解をお願いいたします。

1) チュートリアルでの会話の録音およびビデオ録画
2) チュートリアルに持参した原稿およびチュートリアル後に書き直した原稿のコピーの提出

今回の調査への協力は任意です。たとえ参加を辞退しても、そのためにあなたが不利益をこうむることは一切ありません。この調査への参加に同意されてもその同意はいつでも自由に撤回できますので、その際は調査者にお知らせください。また、この調査への協力はSEWP の成績とは一切関係ありません。本調査に関して何か分からないことや疑問に思うことがありましたら、どんなことでも結構ですので遠慮なく調査者にご質問ください。

上記の２項目に加えて、チュートリアルの内容に関してメールで質問させていただいたり、30 分～60 分程度の日本語でのインタビューをお願いする場合があります。インタビューにご協力いただいた方には、わずかですが謝礼（図書カード 500 円）をお支払いいたします。

本調査において収集された情報はすべて調査目的のみに使用されます。どの情報も機密扱いされます。あなたの個人情報は匿名にして扱います。この調査結果を口頭発表する場合や、論文として発表する場合にも同様に匿名になります。

以上、この研究調査の目的、内容、条件をご理解いただき、協力していただける場合は、下記にご署名（自筆）をお願いいたします。

インタビューの依頼：　　可　　・　　不可
英語の資格（英検・TOEIC など）：＿＿＿＿＿＿＿＿＿＿＿＿
海外在住経験　あり・なし（滞在期間　　ヵ月、　　年）
ご署名：＿＿＿＿＿＿＿＿＿＿＿＿
連絡先（メールアドレス）：＿＿＿＿＿＿＿＿＿＿＿＿

2012 年　　月　　日

Appendix C

INFORMED CONSENT STATEMENT

Investigator Maiko NAKATAKE
The University of Tokyo

You are invited to participate in a research study. The purpose of this study is to investigate writing tutorials on second-language (L2) writing in an English-as-a-foreign-language (EFL) writing center in Japan. If you agree to participate in this study, a) audio and video recordings will be made of writing tutorials you have in the writing center, b) copies will be kept of the writing you bring to the tutorial and of the subsequent revision you write after the tutorial, and c) you will be interviewed for approximately 30 to 60 minutes about the tutorial at a time of your convenience within 5 to 7 days of the tutorial.

Participation

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time by notifying the investigator without penalty and without loss of benefits to which you are otherwise entitled. If you have any questions about this research, you can contact the investigator by e-mail at nakatake@phiz.c.u-tokyo.ac.jp.

Confidentiality

All of the information collected in this study will be confidential and will only be used for research purposes. This means that your identity will be anonymous; in other words, no one besides the researcher will know your name. The information obtained in this study may be printed in a dissertation, published in journals, or presented at conferences but your identity will be kept strictly confidential.

I have fully explained this study to the student. I have discussed the activities and have answered all of the questions that the student asked.

Investigator's signature _____ Date _____

I have read and understand the above information. I have received a copy of this form. I agree to participate in this study.

Participant's signature _____ Date _____

Appendix D

調査協力同意書（チューター用）

調査者　中竹真依子
東京大学大学院総合文化研究科
E-mail: nakatake@phiz.c.u-tokyo.ac.jp

私は、現在、日本の大学ライティング・センターで行われているチュートリアルについて研究している、博士課程の学生です。この度、チューターの皆さんには、この書面にて、本研究調査へのご理解とご協力をお願いいたします。

本研究の目的は、EFL（外国語としての英語）の環境にある日本のライティング・センターにおける英語ライティングのチュートリアルを調査することです。本調査に協力していただける場合は､以下の 2 点へのご協力･ご理解をお願いいたします。
1) チュートリアルでの会話の録音およびビデオ録画
2) そのチュートリアルに関するインタビュー（約 30 分～60 分程度）

今回の調査への協力は任意です。たとえ参加を辞退しても、そのためにあなたが不利益をこうむることは一切ありません。この調査への参加に同意されてもその同意はいつでも自由に撤回できますので、その際は調査者にお知らせください。本調査に関して何か分からないことや疑問に思うことがありましたら、どんなことでも結構ですので遠慮なく調査者にご質問ください。

本調査において収集された情報はすべて調査目的のみに使用されます。どの情報も機密扱いされます。あなたの個人情報は匿名にして扱います。この調査結果を口頭発表する場合や、論文として発表する場合にも同様に匿名になります。

以上、この研究調査の目的、内容、条件をご理解いただき、協力していただける場合は、下記にご署名（自筆）をお願いいたします。

英語の資格（英検・TOEIC など）：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿
教員経験　あり・なし（　　年）

ご署名：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿
連絡先（メールアドレス）：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

2012 年　　月　　日

Appendix E

INFORMED CONSENT STATEMENT (for tutors)

Investigator Maiko NAKATAKE

The University of Tokyo

You are invited to participate in a research study. The purpose of this study is to investigate writing tutorials on second-language (L2) writing in an English-as-a-foreign-language (EFL) writing center in Japan. If you agree to participate in this study, 1) audio and video recordings will be made of writing tutorials you have in the writing center and 2) you will be interviewed for approximately 30 to 60 minutes about the tutorial at a time of your convenience within 5 to 7 days of the tutorial.

Participation

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time by notifying the investigator without penalty and without loss of benefits to which you are otherwise entitled. If you have any questions about this research, you can contact the investigator by e-mail at nakatake@phiz.c.u-tokyo.ac.jp.

Confidentiality

All of the information collected in this study will be confidential and will only be used for research purposes. This means that your identity will be anonymous; in other words, no one besides the researcher will know your name. The information obtained in this study may be printed in a dissertation, published in journals, or presented at conferences but your identity will be kept strictly confidential.

I have fully explained this study to the student. I have discussed the activities and have answered all of the questions that the student asked.

Investigator's signature _____ Date _____

I have read and understand the above information. I have received a copy of this form. I agree to participate in this study.

Participant's signature _____ Date _____

Appendix F

Transcript of S11's Retrospective Interview[6]

Maiko: *Zenkai ukete moratta chūtoriaru ga hajimete nanda yone?* [The tutorial you took the last time was your first time, right?]

S11: *Hai.* [Yes.]

Maiko: *Dō deshita ka? Hajimete no chūtoriaru o uketa kansō wa?* [How was it? What is your impression of taking your first tutorial?]

S11: *Sō desu ne. Kekko shitsumon shita naiyo dake ja naku te sorekara iroiro kuwashi hanashi o hirogete iroirona ronbun nit suite no chishiki o oshiete itadaketa no de sugoku yaku ni tachimashita.* [It was veryūseful because I was able to ask questions and learned other related things about various papers.]

Maiko: *Sokka. Sono raitingu sentā ni ikō to omotta kikake wa?* [I see. What made you decide to go to the writing center?]

S11: *Sō desu ne. Hitotōri ronbun o kakiowatteta n desu kedo, yappari jibun hitori de jisho dake de kaita node yappari hoka no hito ni chotto mitemorau to yūka, sō desu ne. fuan na tokoro mo ikutsu ka ate.* [I had basically finished my paper when I went, but since I wrote it on my own with the help of a dictionary, I felt like having someone else to take a look. There were also some parts I was not sure about.]

Maiko: *Hitotōri kaku made wa toku ni sono katei de dōshitemo tsumatte raitingu sentā ni ikanakya tte yū, ikitai na to yū tokoro wa toku ni nakatta?* [In the process of your writing, was there any particular time when you felt stuck and thought that you had to or wanted to go to a writing center?]

S11: *Sō desu*. [Not really.]

Maiko: *Hitotōri juncho ni kakete ite?* [You think you were able to write pretty well without any trouble?]

S11: *Hai. Sō desu ne*. [Yeah, I guess.]

Maiko: *Jā sono jissai uketa chūtoriaru no naka de mazu hitostume no shitsumon wa, chūtā-san to S11-kun wa dotchi ga ōku hanashita to omou? Godankai hyōka de yū to, chūtā-san? JIbun?* [OK, then let me ask this: when you actually took the tutorial, who do you think spoke more, the tutor or yourself, S11-san? How about if you evaluate that on a scale of one to five? Your tutor or you?]

S11: *Wariai de?* [By proportion?]

Maiko: *Un. Wariai de.* [Yes, by proportion.]

S11: *Hotondo chūtā-san datta to omoimasu.* [I think the tutor was the one who spoke most of the time.]

Maiko: *Jā tsugi wa S11-kun kara mite chūtā-san tte insutorakutā teki sonzai desu ka? Soretomo ky shitsu de pia rebyū tte shita to omoundesu kedo, sono pia no imēji ka dotchi ni chikai?* [OK, then how about this: Do you consider the tutor as an instructor? Or do you think the tutor was like a peer, if you remember the time when you did a peer review in the classroom? Which image is closer to you?]

S11: *2 gurai desu ka ne. Insutorakutā no*. [Maybe about two, as an instructor.]

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[6] This interview transcript is provided as an example. All of the other interviews were transcribed similarly.

Maiko: *Pia to no chigai tte nan da to omou? Kurasumeto no chigai tte*. [How do you think an instructor is different from a peer or a classmate?]

S11: *Sō desu ne. Yappari kurasumēto yori mo sono chūtā-san no hō ga yappari tabun kuwashi to omoimasushi, keiken mo aru to omou node.* [I think an instructor is rather a tutor than a classmate, because of the knowledge and experience.]

Maiko: *Tsugi ga tantō shiteita chūtā-san wa S11-kun no shitsumon ni jyūbun ni kotaete imashita ka?* [Next. Was the tutor in charge able to answer your questions well?]

S11: *Sō desu ne. 5 desu.* [Yes, I say five in that sense.]

Maiko: *Jissai chūtoriaru no igokochi wa dōdeshita ka? Godankai de.* [How comfortable were you during the actual tutorial, on a scale of one to five?]

S11: *Igokochi desu ka?* [How comfortable?]

Maiko: *Igokochi*. [Yes, that's right.]

S11: *Sō desu ne. Toku ni*. [I am not particularly sure.]

Maiko: *Chotto kinchō shichatte sowasowa shitari toka, gyaku ni kinchō suru koto naku dekita ka tte*. [Did you feel a little nervous or anxious, or on the other hand, were you very relaxed with nothing in particular to be nervous about?]

S11: *ūn, rirakkusu shiteta kana.* [Well, I think I was relaxed.]

Maiko: *3 gurai kana?* [About three then?]

S11: *Hai. Sono gurai desu ne.* [Yeah, I guess.]

Maiko: *Tsugi wa chūtā-san no reberu teki ni sugoi ekisupāto da to omotta ka, Amari ekisupāto ja nai to omotta ka? Zenzen shinpai shinakute ī kara ne. Watashi wa chūtā-san to wa zenzen tsunagari naku te, daisansha teki sonzai dakara, betsuni S11-kun ga zenzen ekisupāto ja nakatta to itte mo sore ga chūtā-san ni iku koto a nai kara, zakkubaran ni hanashite hoshii to omoimasu*. [What do you think about the tutor's level of expertise? Was she very expert or not very expert? Expert means the professional level. Don't worry, because I have no relation with the tutor and am like a third party. Even though you say that the tutor was not an expert at all, that will not be communicated to her, so please be frank and talk about your opinion.]

S11: *Kanari kuwashi to 4 gurai desu ke ne*. [Probably about four, because she was pretty knowledgeable.]

Maiko: *Tsugi ga chūtā-san wa tatoeba hagemashi no kotoba o kakete kuretari toka, konna tokoro ga ī ne toka tte yū kotoba tte atta? Uketa inshō wa?* [Next. Did the tutor give you some words of encouragement, or positive feedback about you? What is your impression?]

S11: *Un, toku ni kioku ni wa nai desu ne*. [Well, I don't remember that in particular.]

Maiko: *Toku ni hagemashi toka wa nakatta to yū koto ne. Jā, kore wa akumademo S11-kun no shukan de ī n dakedo, konkai uketa chūtoriaru tte umakuitta to omou?* [You mean that you did not really receive any words of encouragement? Then, please tell me your subjective opinion, what is the significance of the tutorial you took this time? Do you think it went well?]

S11: *Sō desu ne. Hitotōri junchō ni kaketa to omoimasu*. [I think so. I think I was able to write it well in general.]

Maiko: *4 gurai?* [About four?]

S11: *Sō desu ne*. [Yes.]

Maiko: *5 ni naranakatta riyū wa doitta took?* [What is the reason that you did not give five?]

S11: *Yappari shidō shite moratte ie ni kaette kara, yappari koko wa dō datta no ka mitai na.* [After I went home after the tutorial, there was something I had to reconsider.]

Maiko: *Aā atta?* [Oh, you had those?]

S11: *Sō desu. Sore ga atta yōna ki ga shimasu.* [Yes, there was something, I think.]

Maiko: *Dorekurai atta? Kore ne kakinaoshita ato no yatsu na n dakedo, mae no ho ka. Dokorahen de toku ni sō kanjita? Mae no ho o mita ho ga ii? Kakinaosu mae no ho.* [How much? This is your revised paper, but did you feel it in the earlier part? Where did you feel that way? Do you want to look at the previous version? I mean the version before revising.]

S11: *Mae no hō ga kekkyoku tashika nanoka gimon ni.* [I think it was in the earlier part. I was not sure about something.]

Maiko: *Koko gimon ni omotta?* [Did you have a question here?]

S11: *Hai. Daijōbu desu ne.* [No, that was OK.]

Maiko: *Koko wa?* [How about here?]

S11: *Koko mo toku ni. Kore ja nai desu ne.* [That's fine too. It is not that.]

Maiko: *Jā sakki no toko gurai kana?* [Then how about that part we just discussed earlier?]

S11: *Sō desu ne*. [Yes, that may be it.]

Maiko: *Chotto are nandakke to omotta tokoro aru?* [Is that where you got confused a little?]

S11: *Sō desu ne.* [Yes.]

Maiko: *A naruhodo. Dewa saigo ni doregurai konkai no chūtoriaru, chūtoriaru de hanashiatta koto o kakinaoshi ni hanei shita? Jibun no naka de toriireta?* [I see. How much did you reflect what you talked about with the tutor during tutorial in your rewriting this time, or incorporate it?]

S11: *Tabun zenbu dewa nakatta kamo shirenai. Demo hotondo 4 kurai desu kane.* [I think I did not reflect everything, but probably about four.]

Maiko: *Zenbu ja nakatta to yū nowa sore ga itoteki ni?* [You did not reflect everything intentionally or did you forget about it?]

S11: *Itoteki ni.* [Intentionally.]

Maiko: *Itotekini? Sore tte dokorahen?* [Oh, intentionally. In what area?]

S11: *Yappari sakki no.* [I think it's the same place we just talked about.]

Maiko: *A yappari koko? Naruhodo.* [Oh, I see.]

S11: *Etto.* [Well.]

Maiko: OK *desu. Ja sono nagare de kikō. Kore sa, tashikani watashi kono nani kenkyū shiteiruka to yū to kono mae to ato de jissai ni dōyū kakinaoshi o shitanoka to yū no o miteite. Sono kakinaoshi, kawatteiru tokoro o zenbu chekku shiteiru none. De saisho ni koko. Koko toka kotchi wa oboeteru? Koko, kono fukusuke no tokoro o kiitanda yone? Koko chūtā-san wa nanka* "different degrees of" *tte ittetandakedo oboeteru?* [That's OK. Let's talk about it more. In my study, I am looking at your revisions after the tutorial session, and checked all the changes you made. I first looked at this….and this…. Do you remember this one? And

this too, do you remember what you talked about this? You were asking about this, something about a plural form. When we look at this part, do you remember the tutor said something about "different degrees of?"]

S11: *Hai*. [Yes, I do.]

Maiko: *Sore o fumaete kore wa konomama ni shite aru kedo, sore wa dōyū ito de?* [Based on that, you left it as is. What was your intention?]

S11: *Tashika, kokoni* "degrees of" *o iretara* "different degrees of roughness of" *mata* "of" *ga koko ni atte sore ga chotto nanka iya na kanji ga shita node. Mō kore de ii kana to omotte*. [It is probably because I did not like the repetition of "of" like in "different degrees of roughness of" if I used "degrees of" here, so I decided to leave it.]

Maiko: *Mō kore de ī to ?* [You decided to leave it as is?]

S11: *Hai*. [Yes.]

Maiko: *Naruhodo ne. akarimashita*. [I understand.]

S11: *Ato* degree *toka* level *toka chotto dore ga ii noka de kekkyoku imaichi.* [Also, I was not sure about using "degree" or "level," and ended up not using any.]

Maiko: *Mayotta?* [Were you not sure about it?]

S11: *Hai. Demo mā nashi de ī nokana to.* [Correct, but then I guessed it would be OK without it.]

Maiko: *Nashi de iika to yū ketsuron ni itatta n dayo ne?* [You concluded not using any.]

S11: *Sono futatsu ga*...[Those two…]

Maiko: *Naruhodo ne. Kore no shimekiri tte istu dakke?* [I see, could you remind me when the due date was?]

S11: *Shimekiri wa kono itta tsugi no hi nande senshu no kayobi ka, iya konshu no kayobi desu*. [It was due on the following day, so last Tuesday. No, this Tuesday.]

Maiko: *Mikka mae gurai ka. Demo kono kakinaoshita yatsu o ja mo fainaru o teishutsu shite? Otsukaresama desu. Ja getsuyobi uketa chūtoriaru ga saisho de saigo no?* [About three days ago? Oh, then you submitted the revised version as the final paper. Congratulations. So, the tutorial you took on Monday was the first and last?]

S11: *Sō desu ne*.[Yes.]

Maiko: *Tsugi koko nan dakedo. Koko wa* edge *janakute* end *ga iinjanai ka tte chūtā-san ga itteta node?* [How about this part? The tutor said "end" might be better than "edge" here?]

S11: *Sō desu ne*. [Yes.]

Maiko: *Sore wa S11-kun ga kakinaoshita n dakedo, sono ato ni chūtā-san ga* from an end to the other *tte itteta n dakedo, so?* [You revised it, but after that, the tutor said "from an end to the other." Is that correct?]

S11: *Hai*.[Yes.]

Maiko: *Sore o demo kaitenakatta n dakedo sore wa dōshite?* [And you did not rewrite it. Is there a reason?]

S11: *Chikara no kuwae kata ga kore na n desu kedo katahō no* end *kara* other *dato kotchi kara konna inshō desu yo ne?* [I thought about what to emphasize. If I say "from an end on one side to the other," it gives an impression of something like this.]

Maiko: *ō naruhodo*. [Oh, I see.]

S11: *Demo jissai niwa ko chokkaku o kuwaeta node soko wa chotto nante yū ka*. [But actually, it was about a right angle, so it was not very accurate.]

Maiko: *Imi ga kawatchau to omotta no ne?*[You thought it may change the meaning?]

S11: *Sō desu ne*. [Right.]

Maiko: *Wakarimashita. Tsugi koko wa tabun chūtoriaru no aida dewa tokuni shitsumon shitenakatta to omou n dakedo. Kore wa jibun de kangaeta tte koto?* [I understand. Next is this one. This is something you did not really ask during the tutorial. Did you think about it by yourself?]

S11: *Tabun sō desu ne*.[Yes, probably.]

Maiko: *Kore* "length of error?" *wa?* [How about this "length of error?"]

S11: *Kore wa jibun de kakinaoshita*.[Oh, I rewrote it by myself.]

Maiko: "largest," *kore wa dōyūfu ni nani o omotte kakinaoshita?* [How about "largest," what did you think when you wrote it?]

S11: *Kore wa* "clear" *dato nanka chotto shukanteki na. kekkyoku jibun de kangaeta n desu kedo oki no ho ga yori kyakkanteki na kanji ga suru node*. [I eventually wrote it myself, because "clear" sounds a little subjective. I thought "largest" had a more objective meaning.]

Maiko: *Naruhodo ne*. [I see.]

S11: *Sore wa toku ni konkai.* [Especially in this case.]

Maiko: *Jā fainaru pēpā o dashita toki ni minaoshite yappari koko wa chotto a desu ne to*. [Do you mean that you reviewed again when you submitted the final paper and reconsidered it?]

S11: *Sō desu ne*. [Yes, that's right.]

Maiko: *Jā kotchi mo sōyatte yominaoshite ite?* [So, did you reread this part too?]

S11: *Sō desu ne. Kotchi mo sō desu*. [Yes, it is the same here.]

Maiko: *Koko mo. Koko wa saisho* "observed" *de tomatteta kedo kotchi dato kore ga* "observed as the surface became finer from #180 to #800" *ni natte iru n dakedo*. [This one too, the sentence ended with "observed" first, but here it says "observed as the surface became finer from #180 to #800."]

S11: *A kore mo chūtoriaru to wa kankei nai.* [Ah, this is not relating to this tutoring session.]

Maiko: *Naruhodo. Kankei naku.* [I see, it is not related.]

S11: *Sō desu. Doreguraui no arasa no, 180 to 800 tte dotchi no hō ga komakai ka tte futsu sando pēpā ni kuwashiku nai hito wa wakaranai to omou node, kō kakeba 800 no hō ga komakai tte yū no ga wakatte moraeru kana to omotte.* [Yes, regarding the roughness level, I realized that people who are not familiar with sand paper do not know which one of 180 or 800 is finer. If I write this way, they would understand that 800 is finer.]

Maiko: *Naruhodo ne. Sokka sokka. Wakarimashita. Mazu kakinaoshi no hō wa kore ga atta n dakedo, kore wa kotchi ja nakunatte ita. Sore wa chūtā-san ni nakushite tte iwarete?* [Oh, I see. I understand. This was included in the rewriting, but was gone here. Did the tutor say to take it away?]

S11: *Toku ni nakusu yō ni wa iwaretenakatta to omoimasu kedo, nanka konomama da to kasetsu ga nan datta noka kotchi o yomanai to wakaranai to omotte ite, sore o tsugi no bunshō de tashika hakkiri to kaite, de somosomo kotchi no* "as

expected" *to yū no wa boku jishin wa kasetsu dōri ni tte yū imi de kaita tsumori datta n desu kedo.* [I was not told to take it away in particular, but I thought the hypothesis was not clear unless reading this part. I believe the following sentence was clear about it. From the first place, I meant "according to the hypothesis" when I wrote "as expected" here.]

Maiko: *Naruhodo ne. Yosō shita tōri tte koto mo ne, kasestu dōri ni tte yū koto ne.* [OK, you meant "as expected," meaning "according to the hypothesis."]

S11: *Sore dato yappari tsutawarinikui node kono bun o tsukekuwaete sotchi wa nozoita.* [It was difficult to communicate it this way, so I added this sentence and removed the other.]

Maiko: *Naruhodo ne. Ato wa jā kore wa chokusetsuteki niwa sakujo shiro to iwareta kedo jibun nari ni kangaete?* [I see. Then, how about this? You were advised to delete it directly, but you considered about it by yourself?]

S11: *Sō desu*. [Right.]

Maiko: *Soshite kore o kuwaeta*. [And added this one.]

S11: *Hai.* [Yes.]

Maiko: OK. *Tsugi wa koko ga* "showed" *ni natte te kotchi* "is" *ga* "was" *ni. Kore wa tokuni watashi ga kīta kagiri dewa iwaretenakatta to omou n dakedo itteta?* [OK, next is this "showed" here and "was" that used to be "is." I don't remember you were told about it, were you?]

S11: *Iwarenakatta to omoimasu.* [I don't think so.]

Maiko: *Kakokei ni shiteiru n da yone. Dotchimo*. [You changed both of these to past tense.]

S11: *Sō desu ne. Tango no chigai wa sokomade are de nanka atta toki wa toitsu shitakatta dake nandesukedo, kakokei ni shita no wa naosu mae ni tashika konomae raitingu sentā ni itta toki ni disukasn demo kihonteki ni kekka o mo ikkai kaite mitai na kanji de kore wa mo kekka toshite kakokei ni shite sore o teishutsu shiyō to omotte kakokei ni shimashita.* [That's right. I just wanted to make them consistent if anything, when I changed it to past tense. Before revision, I made it in present tense to mean something in general based on results. When I went to the writing center the last time, I remember writing the results one more time in the discussion in principle, and so I decided to make it past tense as results and submit it]

Maiko: *Naruhodo ne. Chokusetsuteki ni chūtā-san ni koko o shiteki sareta wake dewa naikedo, jibun de chokusetsteki ni wa iwarete inai kedo hoka no iroiro adobaisu o ukete kokomo tte kangaeta?* [I see. It was not that the tutor directly pointed it out, but you kind of decided it by yourself. Did you consider other various opinions even though she did not directly tell you?]

S11: *Hai*. [Yes.]

Maiko: *Ato koko nan dakedo. Kono* "that" *kara wa kore wa jibun de kangaeta no?* [And also here. How about this part after "that?" Did you think about it by yourself?]

S11: *Tabun sō desu ne. Kanma o tsuketara hiseigen yohō mitai na*. [Yes, probably. I thought adding comma would make it non-restrictive.]

Maiko: *Un. Hiseigen yohō ne*. [Right. Non-restrictive.]

S11: *Kotchi no hō ga, mā tekisetsu. Uehara-san to Sakurai-san no kenkyū no uchi, kore da to sono kenkyū no uchi setchakuzai o tsukatteiru mono mitai na fū ni torawarekanenai kara to omotte.* [I thought this might be more proper. I was afraid that people would take it as the study that uses adhesives out of studies by

Uehara and Sakurai.]

Maiko: *Aā.* [Oh.]

S11: *Kotchi dato Uehara-san tachi no kenkyū wa setchakuzai o tsukatteta n dakedo mitai na*. [If I say it this way, it might imply "although the study byūehara was using adhesives."]

Maiko: *Naruhodo ne. Tashikani. Koremo jā koko kakinaoshiteta toki ni mō ikkai yominaoshite mite hiseigen yohō no hō ga seikaku ni imi ga tsūjiru kana to. De, koko wa? Kore kuwaeta no wa?* [I see. That makes sense. So, when you were rewriting this part, you decided that making it non-restrictive can make sense more accurately when you read this part again. How about this? why did you add it here?]

S11: *Kore wa chokusetsuteki na shiteki wa nakatta n desu kedo, tashika soko dake itta toki ni, onaji koto o nando mo shitsukoku yū no mo tokiniwa itta ho ga ī koto mo aru n de, ronbun no toki niwa tte yū hanashi o ukagatta node, koko mo kotchi de wa koko ni kaiteiru kara*, "Ra" *de ī ka to omotte*. [This was not directly pointed out, but I heard that repeating the same thing may be better in the case of an academic paper, so I made it "Ra" because I wrote it here too.]

Maiko: Naruhodo ne. [I understand.]

S11: "Ra" *ni shita n desu kedo, sore da to chotto are nan de, kotchi mo yappari sō kana to omotte.* [When I only put "Ra," it was not really good and I decided to add an explanation here.]

Maiko: *Sotchi no hō ga dokusha ni totte wa shinsestu kamo shirenai. Naruhodo. Sore de koko ni* "the" *ga haitta no ne.* [It may be reader-friendly. OK, that's why you put "the" here.]

S11: *Sō desu ne*. [Yes.]

Maiko: *Kore oboeteru? Jibun de kakinaoshita toki ni.* [Do you remember this, when you rewrote it by yourself?]

S11: *Sore wa tabun futsu ni yomikaeshiteta toki ni, dokoka ni onaji yona hyogen ga intorodakushon ka dokoka ni atta n desu yo*. [I think it is because I found the similar expression in the introduction when I was casually reading it again.]

Maiko: *Naruhodo*. [I see.]

S11: *Ikegami-san. Koko desu ne*. [Ikegami-san. It is right here.]

Maiko: *Ikegami-san ka.* [Oh, Ikegami-san.]

S11: *Koko de wa* "the" *ga haitte iru*. [There is "the" here.]

Maiko: *Naruhodo ne*. [I see.]

S11: *Sore ni kizuita node toitsu shiyo to omotte.* [I noticed it and decided to make it consistent.]

Maiko: *Naruhodo ne.* OK. *Koko no tokoro de koko ni ** ga koko de wa kuwawatta n dakedo, kore wa oboeteru?* [I understand. OK. How about here, you added "distribution of." Do you remember this?]

S11: *Kore wa shiteki to wa toku ni kankei nakute, futsū ni yomikaeshite ite, kotchi no hō ga chotto nyūansu o umaku tsutaerareru no ka to omotte*. [This is not relating to the suggestion. When I was casually reading it again, I thought it might communicate nuance better.]

Maiko: *Naruhodo ne. Kakinaosu toki tte chūtoriaru o ukete, sono toki wa jibun de nanka ** shiteta?* [Oh, that's what you thought. I see. When you were revising, did you do *** when you took the tutorial, by yourself?]

S11: *Hai. Jibun de wa toku ni*. [Yes, especially in my case, yes.]

Maiko: *Ja chūtā-san ga yatte kureta mono o motte kaerimashita to. Kakinaosu toki tte sa, mazu doyatte kakinaoshita no? Mazu chūtā-san kara iwareta tokoro kara kakinaoshite?* [So, you took home what the tutor did with you. When you rewrote it, how did you do it? Did you start rewriting the parts the tutor pointed out first?]

S11: *Sō desu ne. Tashika chūtā-san kara iwareta koto de kore wa akiraka ni iwareta tōri ni shita hō ga īna to yū tokoro o mazu chachatto naoshite, sono ato de, chotto koko o dō shiyō kana to yū tokoro o ichiō memo shite oite, de saisho kara yonde soko o mō ikkai kangaete mitai na. Ittari kitari de*. [Well, I believe I first fixed the areas where the tutor pointed out and I clearly agreed to, then I fixed areas I was not sure of. I had taken notes on the areas I was not sure of, and read the paper from the beginning and gave more thoughts to it. I went back and forth.]

Maiko: *Sokka sokka. Konkai shitagatta to yūka, sore o sunnari naosanakatta, toriaezu oiteoita tokoro ga yappari koko?* [I see. Do you think this part is what you did not fix quickly but left it for a while?]

S11: *Soko desu ne*. [Yes, that's it.]

Maiko: *Koko ne?* [This part, right?]

S11: *Koko mo tashika ikkai naoshita n desu kedo, yonde miru to oboobo de wakatte inakute.* [I remember I revised this once, but when I read it, it was not so clear and I was not sure.]

Maiko: *Sokka sokka. Hoka ni horyū datta tokoro tte arimasu ka?* [I see. Were there anything else that were pending?]

S11: *Hoka wa toku ni nakatta to omoimasu*. [I don't remember anything else in particular.]

Maiko: *Jā koko dake toriaezu hikkakari nagara mo naoshite ite, mō ikkai yominaoshita toki ni oboobo da na to omotte yatta no ne*. OK. *Wakarimashita. Kono raitingu sentā ni kuru mae wa mō kiku tokoro wa kimeteta?* [So, you mean that only this part was not really clear and you fixed it anyway. Then, when you read it again, you realized that you were not really sure. OK. I got it. Did you know what to ask before you came to the writing center?]

S11: *Sō desu ne. Ichiō bunshō no iro o kaete*. [Yes. I used a different color for those sentences.]

Maiko: *Aa, sō da ne. Nanka kawatteta mon ne. Wakarimashita. Ronbun kaku toki tte kōyū koto ni kiotsukerunda tte hakken toka atta?* [Oh, I see. I remember that something was different. I understand. Did you discover anything you need to be careful about when you write papers after you went?]

S11: *Sō desu ne. Rezaruto to disukasshon no tokoro no hanashi ga atte soko de chotto jibun ga imamade omotteta kōsei no bunshō no haichi no shikata toka chotto chigatta node soko wa kangae ga chotto kawatta to yūka, arimashita. Ato, dōyūfu ni jibun no bunshō o kentō shitari, jibun no bunshō no mondaiten o kaiketsu sureba ī noka to yū koto mo wakarimashita.* [Yes, we talked something about the Results and Discussion sections, and I saw the layout of sentences or something like that was different from what I was thinking, so I was able to gain some new ideas. In addition, through the tutorial session, I learned how to reflect on my writing and solve the problems on my text.]

Maiko: *Sokka, ī ne*. [I see. Great!]

S11: *Ato wa yappari kanshi no tsukekata toka ichiō nanka bunpō de naratta oboe wa atta n desu kedo, soko o iroiro hitotsu hitotsu chotto kakunin suru koto de, sono chishiki ga chotto katamatta to yūka, sō yū no wa atta to omoimasu. Jishin ga moteru to yūka.* [Also, I kind of remembered the way to use articles when I studied grammar, but by confirming those articles one by one, I was able to gain a firm understanding of the usage. I think I have more confidence.]

Maiko: *Naruhodo ne. Kore de daijōbu nanda to yū kakunin ga dekiru*. [You were able to confirm that you were correct.]

S11: *Hai*. [Yes.]

Maiko: *Sokka sokka. Disukasshon o kaku toki toka tte toku ni mayowanakatta?* [I see. Did you have difficulty writing the Discussion section?]

S11: *Sō desu ne. Donna naiyō no bunshō o kaku toka wa toku ni mayowanakatta*. [Yes, it was not very hard for me to decide what to write.]

Maiko: *Jā mō kekkō nanka jikken mo umaku itte kō ronri ga kumitate yasui to yūka, atama no naka de kō kaite kō kaite kakeru na to yū nomo daitai imēji shiyasukatta?* [It looks like the experiment went well, and the logic was easy to build up in your case. Was it easy to imagine the composition of what you were planning to write?]

S11: *Sō desu ne. Hai*. [Yes, I think so.]

Maiko: *Jā, sugoku ī. Nanka yokatta ne. Jikken mo umakuitte*. [That's wonderful. I am glad that the experiment went well too.]

S11: *To yūka, nanka kōkō no toki ni kadai kenkyū tte yū no o risuka data n de yattete, sorede ronbun o, ronbun to yū hodo ja nai n desu kedo, chotto kaiteita node.* [It is just that I took the science and mathematics course at high school and have some experience in researching and writing papers.]

Maiko: *Naruhodo*. [No wonder.]

S11: *Sore ga tashō wa yaku ni tatta men mo atta node.* [I think it was a little bit useful.]

Maiko: *Soka. Ja kekko koyū nagai bun o kaku no wa, sore wa eigo?* [I see, so you had the experience in writing such long sentences. Did you write the paper in English?]

S11: *Sore wa Nihongo desu. Demo kaku naiyō wa…* [It was in Japanese. But the content is…]

Maiko: *Sokka sokka. Naruhodo ne*. [OK, I understand.]

S11: *Hai. Ato wa tada eigo no mondai dake de, sore wa mā jisho o hikinagara*. [So, the problem was just writing English, and I tried it byūsing a dictionary.]

Maiko: *Sokka sokka. Naruhodo. Subarashi desu ne. Wakarimashita. Arigato*. [That's wonderful. Thank you.]

Appendix G

Questionnaire for tutees

For the next eight items, circle the number that best represents what happened in the conference. Circle only ONE number.

1. Who talked the most during the conference?

1	2	3	4	5
Tutor				Me

2. How did you view the tutor?

1	2	3	4	5
As an instructor				As a peer

3. Did the tutor sufficiently answer your questions?

1	2	3	4	5
No				Yes

4. How comfortable were you in the conference?

1	2	3	4	5
Not comfortable				Very comfortable

5. What was the tutor's level of expertise?

1	2	3	4	5
Not very expert				Very Expert

6. Did the tutor give you encouragement or point to the good parts of your draft?

1	2	3	4	5
None				Very Much

7. How successful was the conference?

1	2	3	4	5
Not successful				Very successful

8. To what extent did you incorporate the results of this conference in your writing?

1	2	3	4	5
None				All

Appendix H

Questionnaire for tutors

For the next eight items, circle the number that best represents what happened in the conference. Circle only ONE number.

1. Who talked the most during the conference?

1	2	3	4	5
Student				You

2. Did you believe that you sufficiently addressed the student's questions?

1	2	3	4	5
No				Yes

3. What did you believe the student's comfort level to be?

1	2	3	4	5
Not comfortable				Very comfortable

4. How directive do you think your comments or questions were?

1	2	3	4	5
Not directive				Directive

5. How much positive feedback do you think you gave?

1	2	3	4	5
None				Very much

6. What did you perceive your role to be in the conference?

1	2	3	4	5
Instructor-like				Peer

7. How successful do you think the session was?

1	2	3	4	5
Not successful				Successful

8. To what extent do you think that this conference will influence the student in revising his or her writing?

1	2	3	4	5
Not at all				Very much

Appendix I

Combinations of Tutoring Strategies

Combination of tutoring strategies	Number
Suggestions +negotiations	26
Suggestions +negotiations +explanations	18
Suggestions +negotiations +indication	17
Negotiations +answer	15
Suggestions +indication	12
Negotiations +indication	12
Suggestions +explanations	10
Suggestions +negotiations +indication +explanations	7
Suggestions +negotiations +response	7
Negotiations +answer +explanations	6
Suggestions+negotiations+indication+explanations+response+teacher+readers	5
Negotiations +response	5
Suggestions +negotiations +indication +response	4
Suggestions +negotiations +explanations +responses +teacher	4
Suggestions +answer	4
Negotiations +indication +answer	4
Suggestions +negotiations +indications +paraphrasing	3
Suggestions +negotiations +response +motivational	3
Suggestions +negotiations +paraphrasing	3
Suggestions +indication +explanations	3
Suggestions +indication +response	3
Suggestions +hint	3

Negotiations +indication +response	3
Negotiations +hint	3
Answer +explanation	3
Suggestions +negotiations +indication +explanation +readers	2
Suggestions +negotiations +indication +explanations +response	2
Suggestions +negotiations +indications +motivational	2
Suggestions +negotiations +hint	2
Suggestions +negotiations +response +hint	2
Suggestions +indication +answer	2
Suggestions +answer +explanations	2
Suggestions +explanations +hint +teacher	2
Suggestions +motivational	2
Suggestions +response +hint	2
Indication +answer	2
Suggestions +negotiations +indication +answer +explanation	1
Suggestions +negotiations +indication +answer +response +hint	1
Suggestions +negotiations +indication +explanation +hint	1
Suggestions +negotiations +indication +explanation +hint +motivational +paraphrasing	1
Suggestions +negotiations +indication +explanation +paraphrasing	1
Suggestions +negotiations +indications +hint	1
Suggestions +negotiations +indications +motivational +paraphrasing	1
Suggestions +negotiations +indications +teacher	1
Suggestions +negotiations +indication +response +hint	1
Suggestions +negotiations +indications +response +paraphrasing	1

Suggestions +negotiations +answer	1
Suggestions +negotiations +answer +hint	1
Suggestions +negotiations +answer +response +motivation	1
Suggestions +negotiations +explanations +hint	1
Suggestions +negotiations +explanations +motivational	1
Suggestions +negotiations +explanations +readers	1
Suggestions +negotiations +explanations +teacher	1
Suggestions +negotiations +explanations +responses	1
Suggestions +negotiations +explanations +responses +hint +readers	1
Suggestions +negotiations +explanations +responses +motivational +reader	1
Suggestions +negotiations +explanations +paraphrasing	1
Suggestions +negotiations +motivational	1
Suggestions +negotiations +readers	1
Suggestions +negotiations +teacher	1
Suggestions +indication +answer +readers	1
Suggestions +indication +hint	1
Suggestions +indication +motivational	1
Suggestions +indication +motivational +response	1
Suggestions +answer +indication	1
Suggestions +answer +explanations +paraphrasing	1
Suggestions +explanations +responses +hint	1
Suggestions +explanations +hint	1
Suggestions +explanations +motivation	1
Suggestions +hint +paraphrasing	1
Negotiations +indication +answer +response +hint	1

Negotiations +indication +explanations	1
Negotiations +indication +explanations +hint	1
Negotiations +indication +explanations +response	1
Negotiations +indication +hint	1
Negotiations +indication +motivational	1
Negotiations +indication +response +motivational	1
Negotiations +answer +explanations +response	1
Negotiations +answer +response +hint	1
Negotiations +explanations +response	1
Negotiations +response +hint	1
Indication +answer +motivation	1
Indication +explanation +response	1
Indication +response	1
Indication +motivational	1
Answer +hint	1
Total	381

Note. Indication=Indication of problem, Answer= Giving an answer, Hint= Giving a hint, Teacher=checks for the teacher's instruction, Readers= Interpretation by readers

Appendix J

Students' Pre-Session papers and Revised Papers

S1's Pre-session Paper

Introduction

From ancient times, it is known that several additives affect the term in which food can be eaten safely. Thus, seasonings have been used not only to give flavor to food but also to prevent food from rotting. In modern Europe, L. Pasteur demonstrated the fact that food spoilage is caused by microorganisms such as bacteria and fungi, and it is suggested that the key to preserve food is to suppress the micro-organic multiplication. Seasonings which have used to preserve food traditionally might have anti-microorganic activity. However, the relationship between the kind of seasonings and the term in which food is safe is not clear.

In this report, I did research on the effect of salt, pepper, sugar, vinegar and alcohol on the time for food to be spoiled. I hypothesized that there may be some difference in the time spent before meat is decomposed between seasonings and that one of meat pieces with pepper, salt and vinegar might be longer than one of other meat pieces because they are used as preservative in some culture.

Method

In order to test the hypothesis, an experiment was conducted. In the experiment, pH of the pork was measured because it is well known that when food is spoiled by micro-organic pH of food changes and that meat is easier to become spoiled than vegetables or crops. 5% solutions of salt, pepper, sugar, vinegar and alcohol were used. PH was measured with pH test paper. The experiment was conducted on the floor in my room. Temperature was about 25 ℃ and the humidity was about 65% through the

experiment. Small thin pieces of pork whose size and weight are made same were moistened by solutions in the cups and kept on paper dishes. PH of solutions of pieces was measured at the beginning of the experiment, and at intervals of 1 hour. A piece of pork was also kept without moistened by pure water and measured for comparison.

Result

As shown in Table1, each of the meat pieces did not change significantly in pH within 8 hours. The experiment was suspended after the eighth measuring because samples acquired a foul smell of decomposition. The ninth measuring was done 26 hours after the experiment was started. Samples with no seasonings, with pepper and with alcohol became alkaline and those with sugar and salt became acid. The sample with vinegar once became acid and remained the same pH.

Hour	None	Pepper	Alcohol	Sugar	Salt	Vinegar
0	7	6	6~7	7	7	4
1	7	6~7	6~7	7	7	5
2	6	6~7	7	6	6	5
3	6	7	7	6	6	5
4	7	7	7	6	6	5
5	7	7	6	6	6	5
6	6	7	8	6	6	5
7	6~7	7	8	5	6	5
8	6	6~7	6~7	5~6	6	5
...						
26	7~8	7~8	7~8	5	5	5

Table1: PH of samples with various seasonings at every hour.

Discussion and Conclusion

Against my hypothesis, the kind of seasonings did not seem to affect the speed of spoilage significantly. All samples decomposed within 8hours.

A possible explanation for this result may be that immersion of samples in seasonings was too short, or the amount of seasonings was too small. Another explanation for this result is that the temperature or the humidity might have been so high that samples become spoiled too rapidly to observe the decomposition speed difference.

However, the last pH of meat pieces varied between seasonings. Some of the samples became alkaline. This result indicates that the cause of spoilage varies according to seasonings added: samples with sugar and with salt were spoiled by bacteria and samples with no seasonings, with pepper and with alcohol were spoiled by fungi (John I. Pitt, Ailsa D. Hocking, 2009, p.5). Sample with vinegar once become pH 4 when the experiment was started, and become pH 5 before long. This increase in pH might be because of the evaporation of vinegar. Whether vinegar prevented or delayed the spoilage of the sample was not made clear in this study.

References

John I Pitt, Ailsa D. Hocking (2009) Fungi and Food Spoilage p.5

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I would like to thank all my classmates at ALT for working with me and giving me useful advices. I would like to thank for lending me a spring balance for the experiment. I am also grateful to for teaching me.

S1's Revised Paper

Introduction

From ancient times, it is known that several additives affect the term in which food can be eaten safely. Thus, seasonings have been used not only to give flavor to food but also to prevent food from decomposition. In modern Europe, L. Pasteur demonstrated the fact that food spoilage is caused by microorganisms such as bacteria and fungi, and it has been suggested that the key to preserve food is to suppress the micro-organic multiplication (Jay, Loessner, & Gelden, 2005, p. 6). Seasonings which have been used traditionally to preserve food might have anti-microorganic activity. However, the relationship between the kind of seasonings and the term in which food is safe is not clear.

In this report, I conducted a research on the effect of salt, pepper, sugar, vinegar and alcohol on the time for food to be spoiled. The hypothesis was that there might be some relationship between the time spent before meat is decomposed and seasonings, and that meat pieces with pepper, salt and vinegar might be safe longer than the other meat pieces because they have been used as preservative in some cultures.

Method

In order to test the hypothesis, an experiment was conducted. In the experiment, pork meat was used as material because meat is easier to become spoiled than vegetables or other crops. When food is decomposed by microorganism, several substances such as putrescine, cadaverine, histamine, spermine, and spermidine are generated (Slemr, J., Beyermann, K., 1985). In this experiment, the pH of meat was

measured as indices because it is available as a supplementary indices. 5% solutions of salt, pepper, sugar, vinegar and alcohol were used. The pH was measured with pH test paper. The experiment was conducted in a room. Temperature was about 25 ℃ and the humidity was about 65% throughout the experiment. Small thin pieces of pork of the same size and weight (5g) were moistened by solutions (100g) in the cups for five minutes and kept on paper dishes. The pH of solutions of pieces was measured at the beginning of the experiment, and at intervals of one hour. A piece of pork moistened by pure water was also kept and measured for comparison.

Result

As shown in Table 1 and Figure 1, each of the meat pieces did not change significantly in terms of pH within eight hours. The experiment was suspended after the eighth measuring because samples acquired a foul smell of decomposition. The ninth measuring was conducted 26 hours after the experiment was started. Samples with no seasonings, with pepper and with alcohol became alkaline and those with sugar and salt became acid. The sample with vinegar once became acid and their pH remained unchanged.

Table1. The pH of samples with various seasonings at every hour.

Hour	None	Pepper	Alcohol	Sugar	Salt	Vineg
0	7	6	6.5	7	7	4
1	7	6.5	6.5	7	7	5
2	6	6.5	7	6	6	5
3	6	7	7	6	6	5
4	7	7	7	6	6	5
5	7	7	6	6	6	5
6	6	7	8	6	6	5
7	6.5	7	8	5	6	5
8	6	6.5	6.5	5.5	6	5
…						
26	7.5	7.5	7.5	5	5.5	5

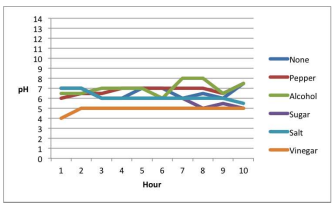

Figure1

Discussion and Conclusion

Against the hypothesis, the kind of seasonings did not seem to affect the speed of spoilage significantly. All samples decomposed within eight hours.

A possible explanation for this result is that eight hours was too short to observe the change of the pH. The suspending of the measuring might have been inappropriate because a foul smell of decomposition is not objective. I could not take longer time due to the limitation of time. Another explanation is that the change of the pH was too small to observe by pH test paper. I could not use pH meters due to the limitation of equipment. To obtain more meaningful result, using pH meters and taking sufficiently longer time will be good in future research.

The last pH of meat pieces varied between seasonings. The pH of some samples became basic and that of others became acid. This result indicates that the cause of spoilage varies according to seasonings added. The phenomena that occurred in the two

kinds of the changes are not made clear in this research. It should be also focused on in future research.

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The Superiority of Visual Memory over Auditory Memory in Memorizing Japanese Words

Abstract

In order to show that visual memory is superior to auditory memory when Japanese college students memorize Japanese words, subjects were asked to memorize Japanese words only by seeing or by listening. Then the number of words correctly memorized was compared in the two situations. The result showed that there was little difference between visual memory and auditory memory. However, it was shown that visual memory was superior to auditory memory in memorizing random numbers with short-term memory in the previous research. Through these results, the following suggestion is considered. In this experiment, visual memory could not perform well because the method of this experiment did not meet the conditions of short-term memory storing. Therefore, if another experiment was done in a way that met conditions required for short-term memory storing, visual memory would perform better than auditory memory.

Introduction

Various methods are used to memorize words. Some pronounce words again and again, and others look at words carefully. However, it has not been clearly proved yet which method is more superior to memorizing words between listening and seeing. There was a research about the superiority of visual memory to auditory memory (Amano, 2006). Amano conducted the experiment in order to affirm the superiority of vision. He prepared memory task with 5 categories (numbers, vegetables, alphabets, animals and symbols) and each categories was made up with 9 digits or words. Then, he checked the number of memorized numbers, words or symbols out of 9 in each category. However, he only found that visual memory is likely to be used when Japanese college students try to memorize alphabets. Furthermore, he could not find any superiority of visual memory with Japanese characters and symbols. However, the alphabet is not so familiar to the subjects because the mother tongue for them is Japanese. Therefore, this article did not really show that Japanese students use visual memory when they memorize words, especially Japanese words (hiragana, katakana and kanji).

Through this background, current research is needed. An experiment was conducted in which Japanese college students were asked to memorize Japanese words both only by sight and only by listening. Then the number of words correctly memorized was compared. In the current experiment, any categories were not set up in fear that categories made any effects on memorizing Japanese words. Hypothesis is that visual memory also performs well with Japanese words just like the alphabet because both of them are characters and the types of characters seem to have little influence. If this is true, a more effective way to remember words with emphasis on vision will be found and studying style will change dramatically.

Method

In order to show that visual memory is superior to auditory memory for Japanese college students when they memorize Japanese words, 50 college students were chosen as subjects. They were 25 men and 25 women, and they were aged between19 and 21. In fear of the sequence of auditory and visual memory experiment disturbing the result, half of the subjects were tested the visual memory experiment first and the other half of them were tested the auditory one first. In this way, more precise data was obtained from a statistical point of view.

Before the experiments, subjects were only informed that they would have an experiment about memory. In the experiment of visual memory, subjects were randomly showed 15 palm-sized cards on which were written easy Japanese words with 2 or 3 characters. Of the 15 cards, five cards were written in hiragana, five in katakana and five in kanji to test all the Japanese characters. 15 words used in the experiment were following.

Hiragana	Katakana	Kanji
じてんしゃ	ロウソク	談話
はしら	マウス	読書
さんま	ピストル	科学
なげる	アコギ	変態
うわさ	メガネ	提出

Subjects were showed one card after another at the speed of one card per 3 seconds. They were asked to memorize all the words without saying any words out loud in order to measure only the visual memory. After this, subjects were asked to count numbers from 1 to 100 in 50 seconds. This was done to prevent their faint memories from influencing the result. Finally, subjects were asked to say the words they memorized and the numbers of words that were correctly memorized were counted.

In the experiment of the auditory memory, subjects were told 15 Japanese words that were similar to, but different from the words of the visual experiment. 15 words used in the experiment were following.

Hiragana	Katakana	Kanji
あい	サイコロ	混乱
ごうかく	センス	破壊
けっさく	エネルギー	妄想
しょくばん	コピー	運転
うちゅう	サイト	交互

Other factors (kinds of characters, speed, not saying words and counting numbers) were all the same with the visual experiment.

Finally, the numbers of memorized words in the two experiments were compared.

Result

Table 1 shows the results of the experiment.

Table 1

the average number of memorized words in each situation

	Total	Hiragana	Katakana	Kanji
Eyes	10.48	3.28	3.56	3.64
Ears	10.74	3.52	3.88	3.34

In Table 1, the figures show the average number of memorized words in each situation. Eyes show words memorized by visual memory and ears show words memorized by auditory memory. Table 1 shows that subjects memorized 10.48 words on average out of 15 words by visual memory and 10.74 words by auditory memory. Table 1 also shows that the subjects memorized 3.28 words in hiragana on average out of 5 words by visual memory and 3.52 words by auditory memory. In the same way, it is shown that subjects memorized 3.56 words in katakana on average by visual memory and 3.88 words by auditory memory, and 3.64 words in kanji by visual memory and 3.34 words by auditory memory.

According to the number of words in each three characters memorized by both of the two memories, there is little difference between visual memory and auditory memory.

Discussion

The experiment was conducted in order to prove that visual memory was superior to auditory memory. However, the result showed little difference between auditory memory and visual memory. This result was the same with the previous research of Amano's. The experiment might have been flawed. For example, the prepared words were so simple that the endeavor needed to memorize words was almost the same. Subjects might have repeated the words in heart when they saw words and picture the figures in their minds when they heard them in the experiment. Therefore, visual memory and auditory memory may have been mixed up. Furthermore, the few differences of the places and the surroundings in the experiment may have affected the result.

However, there was past research affirming the superiority of visual memory in memorizing numbers. Hamada conducted the following experiment. Random 10-digit numbers were visually and auditory presented at a 1.6 sec. rate, and the subjects wrote out as many words as they could at a pace of 1.2 sec per a word. Under the recall conditions, performance for the visual presentation was superior to that for the auditory one. Hamada concluded that visual memory was superior to auditory memory when numbers were memorized in short-term memory (Hamada, 1987). From this fact, two suggestions are considered for the reasons for the result of this current experiment.

The first, if Hamada's result is true and it can be applied to any kind of letters: both Amano's research and the result of current experiment would not be acceptable. Therefore, it should mean that visual memory performs well only at memorizing numbers.

The second, this experiment was not done with short-term memory so the results cannot be compared. Short-term memory is a small amount of information in mind in an active, readily available state for a short period of time (Atkinson & Shiffrin, 1966). Furthermore, the short-term memory only stays in the mind for about 20 seconds (Craik, & Lockhart,

1972), and it was proven that the short-term memory could only include about 7 words or numbers (Millera,1994). The current experiment was done over 50 seconds and with 15 words, so the subjects in the current experiment can be determined to have not used their short-term memory. According to another research of Hamada (Hamada, 1990), the auditory memory of numbers causes a nuisance for visual memory during the stage of memorization in the short-term memory. On the ground of this research, visual memory might have faded as time passed and that might have caused the result to show little difference between visual memory and auditory memory.

In order to make it clear which of those two suggestions are true, another experiment is needed. In the future experiment, 7 Japanese words will be prepared and subjects will be asked to tell the memorized words in 20 seconds. This will meet the condition of short-term memory. Through this experiment, it will be made clear whether or not visual memory is superior to auditory memory when Japanese college students memorize Japanese words in the true sense. If it is found that visual memory is superior to auditory memory in short-term memory, it can be said that students should look at words carefully instead of reading the words loud out at the last minute of exam of words.

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In order to show that visual memory is superior to auditory memory when Japanese college students memorize Japanese words, subjects were asked to memorize Japanese words only by seeing or by listening. Then the number of words correctly memorized was compared in the two situations. The result showed that there was little difference between visual memory and auditory memory. However, it was shown that visual memory was superior to auditory memory in memorizing random numbers with short-term memory in the previous research. Through these results, the following suggestion is considered. In this experiment, visual memory could not perform well because the method of this experiment did not meet the conditions of short-term memory storing. Therefore, if another experiment was done in a way that met conditions required for short-term memory storing, visual memory would perform better than auditory memory..

Keywords: visual memory, auditory memory, short-term memory

Introduction

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Through this background, current experiment is needed. An experiment was conducted in which Japanese college students were asked to memorize Japanese words both only by sight and only by listening. Then the number of words correctly memorized was compared. The current experiment was conducted in order to show the superiority of visual memory in memorizing Japanese words, so categories were not set up in fear that categories made any effects on memorizing Japanese words. Hypothesis is that visual memory also performs well with Japanese words just like the alphabet because both of them are characters and the types of characters seem to have little influence. If this is true, a more effective way to remember words with emphasis on vision will be found and studying style will change dramatically.

Method

In order to show that visual memory is superior to auditory memory for Japanese college students when they memorize Japanese words, 50 college students were chosen as subjects. They were 25 men and 25 women, and they were aged between19 and 21. In fear of the sequence of auditory and visual memory experiment disturbing the results, half of the subjects were tested the visual memory experiment first and the other half of them were tested the auditory one first. In this way, more precise data was obtained from a statistical point of view.

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Result

Table 1 and 2 show the results of the experiment.

Table 1
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According to the number of words in each three characters memorized by both of the two memories, there is little difference between visual memory and auditory memory.

Table 2
the standard deviate of memorized words in each situation

	Total	Hiragana	Katakana	Kanji
Eyes	0.295	0.146	0.148	0.158
Ears	0.284	0.145	0.154	0.149

In Table 2, the figures show the standard deviation in memorizing words in each situation. Standard deviates are the figures that show how much dispersion there is from the average. According to Table 2, the standard deviate in memorizing words by visual memory was 0.295 and that by auditory memory was 0.284. In the same way, it is shown that the standard deviate in memorizing hiragana by visual memory was 0.146 and that by auditory memory was 0.145, and that in memorizing katakana by visual memory was 0.148 and that by auditory memory was 0.154, and that in memorizing kanji by visual memory was 0.158 and that by auditory memory was 0.149.

Judging from Table 2, the dispersion of the subjects was almost the same between the visual experiment and the auditory experiment, because the standard deviates were almost the same in each situation.

According to Table 1 and 2, there is little difference between visual memory and auditory memory in memorizing Japanese words.

Discussion

The experiment was conducted in order to prove that visual memory was superior to auditory memory. However, the result showed little difference between auditory memory and visual memory. This result was the same with the previous research of Amano's. The experiment might have been flawed. For example, the few differences of the places and the surroundings in the experiment may have affected the result. Of prepared two sets of 15 cards, one might have been much easier to memorize than the other. Furthermore, subjects might have repeated the words in heart when they saw words and picture the figures in their minds when they heard them in the experiment. Therefore, visual memory and auditory memory may have been mixed up and the two memories could not have been tested separately.

However, there was past research affirming the superiority of visual memory in memorizing numbers. Hamada conducted the experiment with Random 10-digit numbers. Hamada concluded that visual memory was superior to auditory memory when numbers were memorized in short-term memory (Hamada, 1987).

From this fact, three suggestions are considered for the reasons for the result of this current experiment.

The first, if Hamada's result is true and it can be applied to any kind of letters; both Amano's research and the result of current experiment would not be acceptable. Therefore, it should mean that visual memory performs well only at memorizing numbers.

The second, prior conditions of the experiment of Hamada's were different from those of the current experiment. Two different conditions are considered. The first, the amount of additional images of numbers is lower than that of the easy Japanese words prepared in the current experiment. When subjects saw or heard 10-digit numbers, most of them could not have obtained any images but the 10-digit numbers themselves. In contrast, when subjects saw or heard an easy Japanese word, they could have obtained a certain image of the word easily. In the current experiment, the prepared words were so simple that the amount of images obtained through seeing or hearing might have been the same. The second, in the Hamada's experiment, subjects were asked to memorize 10-digit numbers so the subjects must have memorized the sequence of 10 numbers in addition to the 10 numbers. In contrast, in the current experiment, the sequence of the 15 words was not considered under the recall conditions. Both in the two different conditions, subjects seemed to memorize words much easier in the current experiment than in Hamada's experiment. This is why, the endeavors needed to memorize words were almost the same in the two current experiments and there was little difference between visual memory and auditory memory.

The third, this experiment was not done with short-term memory so the results cannot be compared. Short-term memory is a small amount of information in mind in an active, readily available state for a short period of time (Atkinson & Shiffrin, 1966). Furthermore, the short-term memory only stays in the mind for about 20 seconds (Craik, & Lockhart, 1972), and it was proven that the short-term memory could only include about 7 words or numbers (Millera, 1994). The current experiment was done over 50 seconds and with 15 words, so the subjects in the current experiment can be determined to have not used their short-term memory. According to another research of Hamada (Hamada, 1990), the auditory memory of numbers causes a nuisance for visual memory during the stage of memorization in the short-term memory. On the ground of this research, visual memory might have faded as time passed and that might have caused the result to show little difference between visual memory and auditory memory.

In order to make it clear which of those three suggestions are true, another experiment is needed. In the future experiment, 7 Japanese words will be prepared and subjects will be asked to tell the memorized words in 20 seconds. This will meet the condition of short-term memory. In addition that the prepared Japanese words are unfamiliar with subjects and subjects are asked to memorize the sequence of the words. This will meet Hamada's experiment with 10-digit numbers. Through this experiment, it will be made clear whether or not visual memory is superior to auditory memory when Japanese college students memorize Japanese words in the true sense. If it is found that visual memory is superior to auditory memory in short-term memory, students should look at words carefully instead of reading the words loud out at the last minute of exam of words. Furthermore, it can be said that notice board is more effective than voice warning in order to inform passengers of urgent and crucial information in the mass transit system.

The Superiority of Visual Memory to Auditory Memory
in Memorizing Japanese Words

In order to show that visual memory is superior to auditory memory when Japanese college students memorize Japanese words, subjects were asked to memorize Japanese words only by seeing or by listening. The number of words correctly memorized was compared in the two situations. The result showed that there was little difference between visual memory and auditory memory. However, it was shown that visual memory was superior to auditory memory in memorizing random numbers with short-term memory in the previous research. Through these results, another experiment under other conditions is needed in order to affirm the superiority of visual memory.

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Difference in arrival distance between pure water and muddy water

Introduction

When water falls on ground, it does not accumulate but spreads over the ground. Because of this property, tsunami makes hard damage in a town. Therefore, there are many developing systems to simulate how tsunami moves (Yasuda, Hiraishi, Nagase & Kumita, 2004) (Figure 1), and also Japanese people who experienced the huge earthquake in eastern Japan must expect them to be more precise in order not to lose their lives. In these systems, how far tsunami reaches can be simulated when height and configuration of the ground are decided. However, in those studies, tsunami ~~is thought to consist of~~ modeled by pure water though tsunami consists of at least seawaters and often debris.

To investigate ~~that problem~~ this question, I conducted a research that used both pure water and muddy water. A possible result is that there is some difference between pure and muddy water, I hypothesize.

Method

Materials

To simulate a property of tsunami by testing whether muddy water moves further than pure water or not, I conducted an experiment which needed water. When acting the experiment, I prepared a wood board which was set to be inclined in order to pour water smoothly, pure water and two kinds of sand to compound with water. Those sands are prepared to compare results of water containing coarse sand and results of water containing fine sand. Coarse sand whose central size was about 0.1-1mm was collected in a sandbox in a public park near my house, and fine sand whose central size was about 0.01-0.1mm at riverside of the lower Tama-river. Other materials used in this experiment were a funnel to pour water at the same speed at first and beakers to check whether volume of water of every test was same.

Experiment design

In this experiment, I manipulated inclination of the board, volume of water, weight of sand to compound with water, a force of poured water at first and a condition of the board. The inclination was established to 2 degrees, volume of water to 25mL, weight of sand to 0, 5, 10 and 15g/25mL, a force of poured water was kept to be same by pouring 25mL-water equally in 3 seconds to the funnel which was held on the board vertically and board was kept wet by wiping with a wet towel. (Figure 3)

When practicing the experiment, the general procedure was as follows: First, I poured water (25mL, pure or muddy) with the funnel (contacting with the board, vertical) from the top of the board (2° -inclined). After that, water stopped at a line of the board. Finally, I took photos and recorded the line. (Figure 4) How to decide distance between the pouring point and the line water stopped is as follows: First, I measured three distances (parallel) as Figure 1 shows. Second, I calculated an average of those three values. Then, I use the average as a distance.

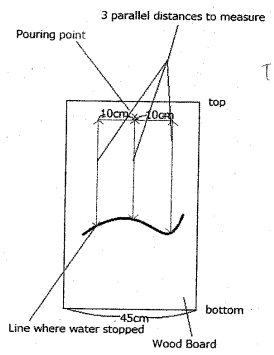


Figure 2: Three parallel distances to measure (red lines in this diagram)

and ~~muddy water reaches~~ that the latter spreads further place. According to physics, strength of friction is proportional to weight (Hyoudou, Hukuoka&Takagi, 2007). ~~In other words, if water just becomes heavier, the result of how far water reaches is that there is no difference between~~ it is the ~~normal water and the heavier water.~~ Consequently, friction itself ~~is thought to be changed.~~ which influences the becomes the According to some data (from Kousyougiken), a coefficient of rolling friction is so low that we can almost ignore. Hence, if water moves on rolling sand or debris, water can move smoothly and advance far away. This may be a real mechanism of tsunami, and, if so, previous simulations are not precise enough to follow when the government plans how to escape from tsunami.

In this present study, I compared pure water and muddy water. Also, I assessed their weights and distance they reached to check a relationship of result and coefficients of friction to find a difference between tsunami of pure water and of muddy water.

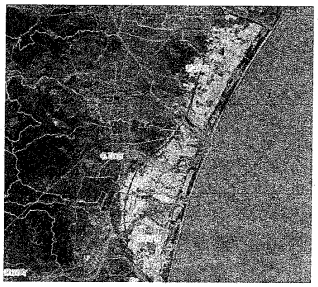
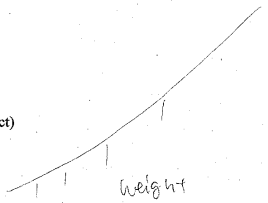


Figure 1: An estimate of area by tsunami (In Touhoku District)



Here are diagrams of the design of this experiment. As you can see, data of how far water reached can be acquired.

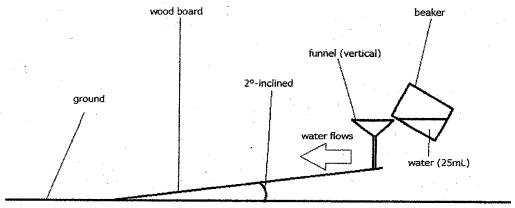


Figure 3: Diagram of equipment for the experiment

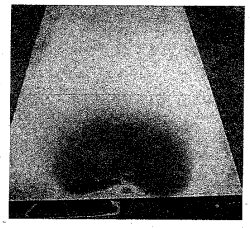


Figure 4: Picture of the board that was used for the experiment

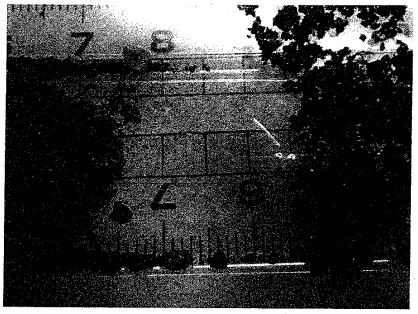


Figure 5: Fine (left side) and coarse (right side) sand on a ruler

Data-analyses

After the experiment, 7 data was collected. Those were data of distance how far water reached of pure water, water containing coarse or fine sand (5, 10, 15g/25mL, i.e. 200, 400, 600g/L). These data showed relationship between the distance that water flowed for and two factors. One factor was mass of sand, and another was size of sand. Also, there were 3 theories involving this test. One was "kinetic friction", another was "rolling friction" and the other was "viscosity resistance". Consequently, data was analyzed by using these theories.

Results

All tests which were presented in the section of method were completed under same condition. In this experiment, all of 7 tests were practiced in a sunny day. Data showed that water containing certain amount of sand could flow furthest.

Amount of sand and size of sand

How far water with each amount and size of sand flowed is shown in Table 1 and Figure 5. Seen from Figure 5, both coarse sand and fine sand have bigger data than data of 0g/25mL, and results of both decrease after those peaks. Therefore, results show that water containing certain amount of sand flows furthest. Those peaks of the two kinds of sand are a datum of 5g/25mL coarse sand and a datum of 10g/25mL fine sand. However, a datum of 5g/25mL fine sand is particularly low (Table 1). Additionally, two data of fine sand are bigger than data of coarse sand and one datum of fine sand is smaller (Figure 5). Also, Weight of fine sand whose datum is the biggest is heavier than that of coarse sand (Figure 5).

Table 1: Relationship between distance and amount of sand (coarse/fine) in water

Kind＼Amount	0g/25mL	5g/25mL	10g/25mL	15g/25mL
coarse sand	32.4	33.6	30.9	27.4
fine sand	32.4	26.5	39.2	37.9

Difference in arrival distance between pure water and muddy water

Introduction

When water falls on ground, it does not accumulate but spreads over the ground. Because of this property, tsunami makes hard damage in a town. Therefore, there are many developing systems to simulate how tsunami moves (Yasuda, Hiraishi, Nagase & Kumita, 2004) (Figure 1). Also Japanese people who experienced the huge earthquake in eastern Japan must expect them to be more precise in order not to lose their lives. In these systems, how far tsunami reaches can be simulated when height and configuration of the ground are decided. However, in those studies, tsunami is modeled by pure water though tsunami consists of at least seawaters and often debris.

To investigate this question, I conducted a research that used both pure water and muddy water. I hypothesized that there is some difference between pure and muddy water, and that the latter spreads further place. According to physics, strength of friction is proportional to weight (Hyoudou, Hukuoka&Takagi, 2007). Therefore, there is no difference in the traveled distance according to weight. Consequently, it is the friction which becomes the influence. According to some data (from Kousyougiken), a coefficient of rolling friction is so low that we can almost ignore it. Hence, if water moves on rolling sand or debris, water can move smoothly and advance far away. This may be a real mechanism of tsunami, and, if so, previous simulations are not precise enough to follow when the government plans how to escape from tsunami.

In this present study, I compared pure water and muddy water. Also, I assessed their weights and distance they reached to check a relationship of traveled distance and coefficients of friction to find a difference between tsunami of pure water and of muddy water.

Figure 1: An estimate of area by tsunami (In Touhoku District)

Method

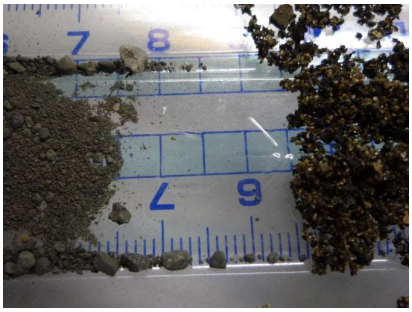
Materials

To simulate a property of tsunami by testing whether muddy water moves further than pure water or not, I conducted an experiment which used tap water as pure water. When acting the experiment, I prepared a wood board which was set to be inclined in order to pour water smoothly, pure tap water and two kinds of sand to compound with water. Those sands are prepared to compare results of water containing coarse sand and results of water containing fine sand. Coarse sand whose central size was about 0.1-1mm was collected in a sandbox in a public park near my house, and fine sand whose central size was about 0.01-0.1mm at riverside of the lower Tama-river (Figure 2). Other materials used in this experiment were a funnel to pour water at the same speed at first and beakers to check whether volume of water of every test was same.

Experiment design

In this experiment, I manipulated inclination of the board, volume of water, weight of sand to compound with water, a force of poured water at first and a condition of the board. The inclination was established to 2 degrees, volume of water to 25mL, weight of sand to 0, 5, 10 and 15g/25mL, a force of poured water was kept to be same by pouring 25mL-water equally in 3 seconds to the funnel which was held on the board vertically and board was kept wet by wiping with a wet towel (Figure 3).

When practicing the experiment, the general procedure was as follows: First, water was poured (25mL, pure or muddy) with the funnel (contacting with the board, vertical) from the top of the board (2° -inclined). After that, water stopped at a line of the board. Finally, Photographs were taken and the line was recorded (Figure 4). The traveled distance was measured in the following manner. First, I measured three distances (parallel) to millimeters as Figure 1 shows. Second, an average of those three values was calculated to two decimals. Then, the average was used as a distance (Figure 5).



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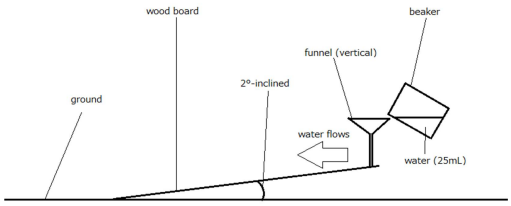

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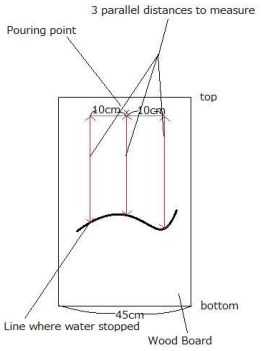

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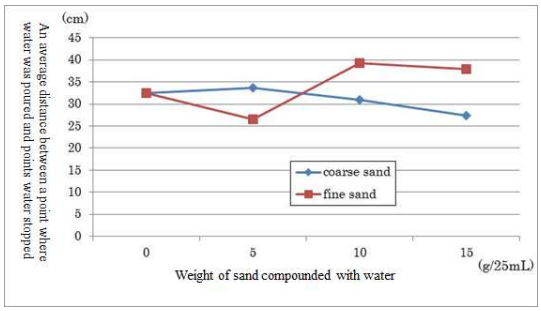

Figure 6: Comparison of results of coarse sand in water and fine sand in water

Discussion and Conclusion

Discussion

The present simulation of tsunami dealt with water as pure water not as water containing debris. However, when studying floods of rivers, scientists consider sediments as the most important factor. It is not only because rivers exist on accumulation of sand and rocks, but also because sand and other particles themselves influence movement of flowing water (Holmquist et al, 1989). In this experiment, difference of data between pure water and water containing about half weight sand is about 15%.

The data discussed above suggest different characteristics of each muddy water are important in thinking about movement of water. Therefore, this is similar to the results of Holmquist et al who found that rivers which had the same grain size distribution in northernmost banks also had the same grain size distribution in southernmost banks.

As anticipated, water containing some amount of sand flowed further than pure water. This showed that sand decreased friction of water, and then water become more difficult to decelerate. It is because friction which was mainly dynamic friction of water itself when pure water poured became smaller friction which was combination of dynamic friction and rolling friction of sand which is far smaller than dynamic friction of water (Kousyougiken). Therefore, water containing some amount of sand could flow further than pure water.

Seen from data, some muddy waters flowed less than pure water. This was mainly because muddy water was heavier, so that friction which was in proportion to weight became larger. Also, it was partly because the part of sand which always accumulated at low speed became an obstacle (Figure 7).

Additionally, water containing fine sand often flowed further than water containing coarse sand. This was because fine sand was more difficult to accumulate at law speed than coarse sand and was deposited more slowly than coarse sand (Figure 7&8). Accumulation of large quantity and fast accumulation do not only help decreasing friction but also obstruct the movement of water, so that coarse sand was easier to decrease power of water at low speed.

Finally, the weight of coarse sand whose datum was peak of data was smaller than weight of fine sand whose datum also was peak. It was also attributed to same factors of other difference of two kinds of sand showed the former paragraph. In other words, coarse sand is easier to become obstacles than fine sand, so peak amount of coarse sand was lighter than fine sand.

Conclusion

The present study of estimating tsunami concentrates on geographical features of land and ocean. However, this experiment showed that debris in water was also important factor. Therefore, considering buildings and soil is important for future work in this area.

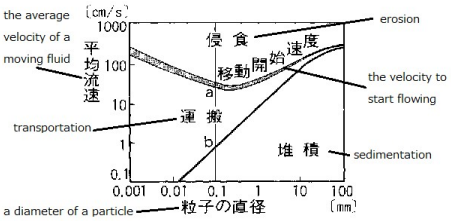

Figure 7: Relationship between movement and velocity of flowing particle (Hagiya, 2001 (translated by a writer of this thesis))

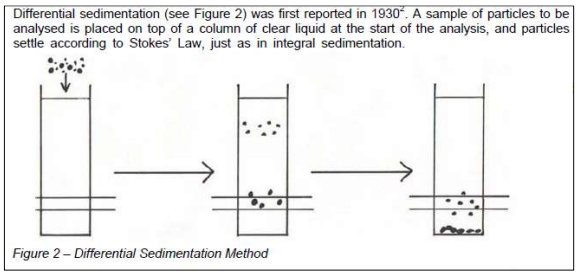

Figure 8: Relationship between size and sedimentary speed of particles

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・Figure 1: PASCO, (2011.3.26) “Estimated change of the flooded range extracted from Synthetic Aperture Radar satellite (TerraSAR-X) updated by PASCO #3” (http://www.pasco.co.jp/disaster_info/110311/images/map_49b.pdf)

・Figure 7: Hagiya, H. [萩谷 宏], (2001.5.21), “A secret of sand [砂の秘密]” from “Science of the earth [砂つぶの地球科学]” (http://homepage2.nifty.com/hagiya/expl0.htm)

・Figure 8: CPS Instruments Europe, (2007.9.04), “Introduction to Differential Sedimentation” (http://www.cpsinstruments.eu/pdf/Introduction%20Differential%20Sedimentation.pdf)

THE COEFFICIENT OF RESTITUTION

Introduction

In 2011, the standard of balls used by Japanese professional baseball players was changed. In Japanese media's sports news, it was said that the baseballs tended to fly less far than before. One of the reasons for this is the decrease of the coefficient of restitution (COR).

COR is a fractional value to know the ratio of speeds (or height) after and before an impact. Generally, COR is between0 to 1. An object with a COR of 1 collides elastically, or bounces to the original height, while an object with a COR of less than 1 collides inelastically. For a COR of 0, the object effectively stops at the surface with which it collides. (cited from Wikipedia :Coefficient of restitution)

In practical batting, a lot of other elements, such as the speed of ball and bat, the point of collision, and wind, make the condition highly complicated. So, to make the situation more simply, an experiment to investigate only COR was conducted. In this experiment, eight varieties of balls were dropped on five varieties of boards. The final purpose of this research is to know the best kind of combination of ball and board. I hypothesize that the best combination is golf ball and metal board.

References

-Wikipedia (Coefficient of restitution)

Method

In order to investigate COR, eight varieties of balls were bounced on five varieties of boards. All balls and boards were chosen as experimental devices because they were obtainable. Balls used were a ping-pong ball (diameter of 4.2cm, weight of 2.5g and density of 0.064g/cm^3), a golf ball (diameter of 4.2cm, weight of 45.6g and density of 1.176g/cm^3), a soft tennis ball (diameter of 6.1cm, weight of 29.5g and density of 0.248g/cm^3), a regulation tennis ball (diameter of 6.6cm, weight of 60.0g and density of 0.399g/cm^3) a rubber ball (diameter of 7.0cm, weight of 33.1g and density of 0.184g/cm^3), a sponge ball (diameter of 7.9cm, weight of 21.0g and density of 0.081g/cm^3) and a hard rubber baseball (diameter of 7.2cm, weight of 134.9g and 0.691g/cm^3) and a regulation baseball (diameter of 7.0cm, weight of 145.7g and density of 0.812g/cm^3). Boards were made of either wood, plastic, metal, ethylene-vinyl acetate (EVA) and tennis racket and were 1.2 centimeters in height. Wood was 15 centimeters in width, 30 centimeters in length. Plastic was 21 centimeters in width, 35 centimeters in length. Metal was 30 centimeters in width, 30 centimeters in length. EVA was 25 centimeters in width, 25 centimeters in length. Tennis racket was 21 centimeters in width, 34 centimeters in length. Each ball was dropped on each board in order from a height of 81 centimeters. Then, the peak height of bouncing ball (=x centimeters) was measured. Finally, COR was determined as the value $\sqrt{x/81}$.

In this experiment, independent variables were kinds of balls and boards. Dependent variables were heights of bouncing balls.

Results

Table1 shows CORs calculated by $\sqrt{x/81}$. Ping-pong ball's CORs with wood, plastic, metal and EVA were in order 0.80, 0.81, 0.79 and 0.64. Golf ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.29, 0.53, 0.38, 0.72 and 0.95. Soft tennis ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.82, 0.82, 0.83, 0.82 and 0.86. Regulation tennis ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.81, 0.79, 0.80, 0.77 and 0.94. Rubber ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.88, 0.79, 0.80, 0.77 and 0.94. Sponge ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.82, 0.81, 0.80, 0.84 and 0.85. Rubber baseball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.81, 0.81, 0.80, 0.77 and 0.92. Regulation baseball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.53, 0.46, 0.56, 0.70 and 0.82.

	Wood	Plastic	Metal	EVA	Tennis racket
Ping-pong	0.80	0.81	0.79	**0.64**	※No data
Golf ball	**0.29**	0.53	0.38	0.72	**0.95**
Soft tennis	0.82	0.82	0.83	0.82	**0.86**
Regulation tennis	0.81	0.79	0.80	0.77	**0.94**
Rubber	0.88	0.87	0.87	0.87	0.92
Sponge	0.82	0.81	0.80	0.84	0.85
Rubber baseball	0.81	0.81	0.80	0.77	**0.92**
Regulation baseball	0.53	0.46	0.56	**0.70**	**0.82**

Table1: COR calculated by $\sqrt{x/81}$.

※It was impossible for ping-pong ball to bound correctly on tennis racket because tennis racket's apertures are too large for ping-pong ball.

Discussion

The results didn't support the hypothesis that the best combination was golf ball and metal board. Table1 suggests that the best combination is golf ball and tennis racket (COR=0.95). However, golf ball also has the lowest COR with wood (COR=0.29). That is, golf ball's COR gap is the biggest. And other balls' CORs are almost equal apart from ping-pong ball and EVA's COR, ~~tennis regulation~~ tennis ball's and tennis-racket's CORs, baseballs and tennis-racket's CORs, baseball regulation and EVA's COR.

To think about these ~~five~~ six CORs, each ball's mass were considered. The results indicate that the larger the ball's mass ~~is~~ was, the bigger the COR of its ball on tennis racket ~~is~~ was. Furthermore, ping-pong ball's CORs (with wood, plastic and metal), tennis ball's CORs(with wood, plastic, metal and EVA), rubber ball's CORs (with wood, plastic, metal and EVA), sponge ball's CORs (with wood, plastic, metal, EVA) and rubber baseball's CORs (with wood, plastic, metal and EVA) were considerably equal. These six balls' densities are lower than golf ball's density and regulation baseball's density.

In conclusion, high-density ball's CORs were dependent on kinds of boards and low-density ball's CORs were resistant to change by kinds of boards. And large-mass ball's COR with tennis racket tended to be large.

In this experiment, air resistance wasn't considered. Therefore, further research should be done to calculate the effects of air resistance. Also, the sizes of boards used in this experiment were not the same, so there was a possibility of this difference having affected the results.

The Relationship Between Ball's Density And The Coefficient Of Restitution

The coefficient of restitution (= COR) is a fractional value to know the ratio of speeds (or height) after and before an impact of balls. Other researches have shown that COR is dependent on kinds of balls. This study examined the features of COR by dropping eight kinds of balls on five kinds of boards. The results suggested that the higher the ball's density is, the greater its COR depends on kinds of boards.

Keywords: COR, density, mechanical energy

Introduction

In 2011, the standard of balls used by Japanese professional baseball players was changed. Japanese sports media reported that the baseballs tended to fly less far than before. One of the reasons for this is the decrease of the coefficient of restitution (COR).

COR is a fractional value to know the ratio of speeds (or height) after and before an impact of balls. Generally, COR is between0 to 1. An object with a COR of 1 collides elastically, or bounces to the original height, while an object with a COR of less than 1 collides inelastically. For a COR of 0, the object effectively stops at the surface with which it collides.

In practical batting, a lot of other elements, such as the speed of ball and bat, the point of collision, and wind, make the condition highly complicated. So, to make the situation more simply, an experiment to investigate only COR was conducted. In this experiment, eight kinds of balls were dropped on five kinds of boards. The final purpose of this research is to know whether there are any features of COR or not.

Method

In order to investigate COR, eight kinds of balls were bounced on five kinds of boards. All balls and boards were chosen as experimental devices because they were obtainable. Balls used were a ping-pong ball (diameter of 4.2cm, weight of 2.5g and density of 0.064g/cm^3), a golf ball (diameter of 4.2cm, weight of 45.6g and density of 1.176g/cm^3), a soft tennis ball (diameter of 6.1cm, weight of 29.5g, and density of 0.248g/cm^3), a regulation tennis ball (diameter of 6.6cm, weight of 60.0g, and density of 0.399g/cm^3), a rubber ball (diameter of 7.0cm, weight of 33.1g, and density of 0.184g/cm^3), a sponge ball (diameter of 7.9cm, weight of 21.0g, and density of 0.081g/cm^3), a hard rubber baseball (diameter of 7.2cm, weight of 134.9g, and 0.691g/cm^3), and a regulation baseball (diameter of 7.0cm, weight of 145.7g, and density of 0.812g/cm^3). Boards were made of either wood, plastic, metal (iron), ethylene-vinyl acetate (EVA), and tennis racket and were all 1.2 centimeters in height. Wood was 15 centimeters in width, 30 centimeters in length. Plastic was 21 centimeters in width, 35 centimeters in length. Metal was 30 centimeters in width, 30 centimeters in length. EVA was 25 centimeters in width, 25 centimeters in length. Tennis racket was 21 centimeters in width, 34 centimeters in length. Each ball was dropped on each board in order from a height of 81 centimeters. Then, the peak height of bouncing ball (=x centimeters) was measured. Finally, COR was determined as the value $\sqrt{x/81}$.

In this experiment, independent variables were kinds of balls and boards. Dependent variables were heights of bouncing balls.

Results

Table1 shows CORs calculated by $\sqrt{x/81}$. Ping-pong ball's CORs with wood, plastic, metal and EVA were in order 0.80, 0.81, 0.79, and 0.64. Golf ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.29, 0.53, 0.38, 0.72, and 0.95. Soft tennis ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.82, 0.82, 0.83, 0.82, and 0.86. Regulation tennis ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.81, 0.79, 0.80, 0.77, and 0.94. Rubber ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.88, 0.79, 0.80, 0.77, and 0.94. Sponge ball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.82, 0.81, 0.80, 0.84, and 0.85. Rubber baseball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.81, 0.81, 0.80, 0.77, and 0.92. Regulation baseball's CORs with wood, plastic, metal, EVA and tennis racket were in order 0.53, 0.46, 0.56, 0.70, and 0.82. The highest COR was golf ball and tennis racket's COR of 0.95 and the lowest COR was golf ball and wood's COR of 0.29.

	Wood	Plastic	Metal (iron)	EVA	Tennis racket
Ping-pong	0.80	0.81	0.79	**0.64**	※No data
Golf ball	**0.29**	0.53	0.38	0.72	**0.95**
Soft tennis	0.82	0.82	0.83	0.82	0.86
Regulation tennis	0.81	0.79	0.80	0.77	**0.94**
Rubber	0.88	0.87	0.87	0.87	0.92
Sponge	0.82	0.81	0.80	0.84	0.85
Rubber baseball	0.81	0.81	0.80	0.77	**0.92**
Regulation baseball	0.53	0.46	0.56	0.70	**0.82**

Table 1: COR calculated by $\sqrt{x/81}$.

※It was impossible for ping-pong ball to bound correctly on tennis racket because tennis racket's apertures are too large for ping-pong ball.

Discussion

As table1 shows, golf ball's COR gap is the biggest. And other balls' CORs are almost equal apart from ping-pong ball and EVA's COR, tennis-regulation and tennis-racket's COR, baseballs and tennis-racket's CORs, baseball regulation and EVA's COR. These six CORs are in boldface type in table 1.

The trends of these six CORs and the other CORs were considered with each ball's mass. The results indicated that the larger the ball's mass is, the bigger the COR of its ball on tennis racket is. Furthermore, ping-pong ball's CORs (with wood, plastic and metal), tennis ball's CORs (with wood, plastic, metal, and EVA), rubber ball's CORs (with wood, plastic, metal and EVA), sponge ball's CORs (with wood, plastic, metal, EVA) and rubber baseball's CORs (with wood, plastic, metal, and EVA) were considerably equal. These six balls' densities are lower than golf ball's density and regulation baseball's density.

In conclusion, high-density ball's CORs were dependent on kinds of boards and low-density ball's CORs were resistant to change by kinds of boards. And large-mass ball's COR with tennis racket tended to be large.

In terms of dynamics, the quantity of mechanical energy which dropped ball loses is inverse proportion to COR. Logically speaking, therefore, the quantity of mechanical energy which dropped ball loses depends on kinds of boards if the ball's density is high.

In this experiment, air resistance wasn't considered. Therefore, further research is needed to calculate the effects of air resistance. Also, the sizes of boards used in this experiment were not the same, so there was a possibility of this difference having affected the results.

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Report

Introduction

Erasing carbon is an essential part of our study if you use a pencil or something to write. Today, in most cases, we use a plastic eraser to erase carbon and we can easily erase carbon with one. Probably, most people can't imagine studying with pencils without plastic erasers. But, before the plastic eraser was invented, how people erased carbon? ...Surprisingly, people used bread to erase carbon in the past. I happened to know that on the Internet and also happened to know the history and the types of erasers. First, I introduce the history and types of erasers.

The history of erasers: In 16th century, the pencil with carbon was invented. In those days, people used bread as an eraser. In 1770, Joseph Priestley, a British scientist happened to know that people can erase written text by using a natural rubber. In 1772, an eraser was invented and sold for the first time. After that, varieties of erasers were invented, such as a plastic eraser and today we mostly use a plastic eraser.

The types of erasers: Mainly, 4 types of erasers exist today (a plastic eraser, a kneaded eraser, a rubber eraser and an abrasive eraser).

Now, we know the history and types of erasers. Then do you want to know exactly how erasers advanced historically and the differences of their performances? So, I will study witch erasers can erase carbon the best. It was hypothesized that a plastic eraser can erase carbon better of all and bread worse of all because a plastic eraser is the newest and bread are the oldest.

Method

To investigate the performance of "erasers", bread (A), a kneaded eraser (B), a rubber eraser (C), an abrasive eraser (D) , a plastic eraser (E) and carbon paper were collected.

The study was done on the desk at the second refectory at University of Tokyo. The date was June 11,2010.

The experimental design and the protocol for collecting date: First, A was set up on a spring balance and A was held at the same power on the carbon paper (2Newton). Subsequently, A was rotated for 5 times (the same power, 2N). This experience was done for each "erasers". Afterwards, the carbon paper was cut and put on a black paper. To clearly see the results, a carbon which was not erased was also put on a black paper (picture 1). Subsequently, the carbon paper was taken photo of and the quantities of Carbon in the lines were investigated. To investigate the quantities, the software called "image J" was used. A rectangle was drawn on the picture and the quantities in the rectangle were investigated (picture2,3). The quantities ware investigated in terms of square measure. Subsequently, the square measures were compared on the basis of a carbon which was not erased. The smaller square measure was, the better "eraser" can erase carbon.

Result

Table 1: The square measures

Erasers	Not erased	bread	abrasive	kneaded	rubber	Plastic
1st	28650.116	25241.049	19009.108	19002.200	20817.170	16348.915
2nd	34887.309	27277.543	24083.631	18528.492	9157.271	9270.146
3rd	28925.401	25074.078	21119.095	16490.430	17513.919	15708.637

The square measures become larger as the quantities of carbon become larger. The square measures of 5 pieces of carbon papers, which were erased with "erasers" are showed on table 1. The square measures are relative value, which means figures on Table 1 have no units. Therefore, the square measure of the not erased carbon paper was used as the base square measure in which the figure is reckoned at 100 and that for erased ones are showed on Table 2. The value is correct to 5 significant figures.

In general, the square measures of pieces of carbon paper which were erased with bread are largest, those with an abrasive eraser are second largest, those with a kneaded eraser and a rubber eraser are almost the same (third largest) except 2nd experiment and those with a plastic eraser are smallest except 2nd experiment.

Table 2

erasers	bread	abrasive	kneaded	rubber	plastic
1st	88.101	66.349	66.325	72.660	57.061
2nd	78.187	69.031	53.109	26.248	26.572
3rd	86.686	78.013	57.010	60.546	54.306
An average	84.991	71.131	58.815	53.151	45.980

Discussion

The result of my study shows that in average, the best performance was, in order, a plastic eraser, a rubber one, a kneaded eraser, an abrasive one and bread. Therefore, my hypothesis is supported. However, the second experiment was against my hypothesis. I think the cause of that is it was difficult to control the power precisely. Thus, to control the power more precisely, we should come up with another experiment and do it.

The conclusion of my study is that if we erase carbon, the newer "erasers" become, the better their performances are. Therefore, if you want to erase carbon easily, you should use a plastic eraser.

References

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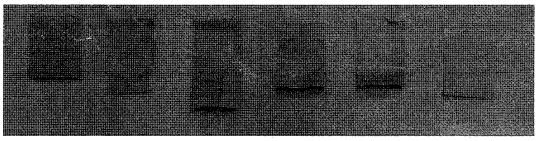

Figure 1: the picture of 6 sheets of carbon papers, which was erased

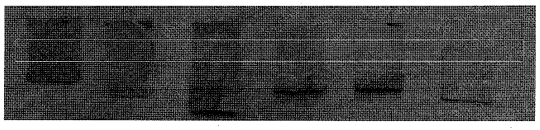

Figure 2: the part, which was erased

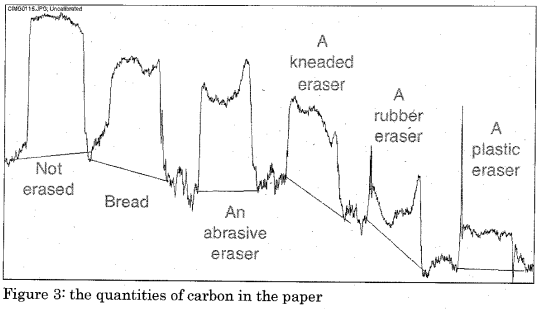

Figure 3: the quantities of carbon in the paper

Abstract

The eraser is advancing as time passes. First, bread was used as a eraser. Now, the types of erasers are aplastic eraser, a kneaded eraser, a rubber eraser and an abrasive eraser. I investigated the performance of those "erasers"(including bread). Keeping the same power and the same times, we erased carbon paper by using those "erasers". The conclusion is that the best performance was, in order, a plastic eraser, a rubber one, a kneaded eraser, an abrasive one and bread.

Report

Introduction

Erasing carbon is an essential part of our study if you use a pencil or something to write. Today, in most cases, we use a plastic eraser to erase carbon and we can easily erase carbon with one. Probably, most people cannot imagine studying with pencils without plastic erasers. Then, before the plastic eraser was invented, how people erased carbon? …Surprisingly, people used bread to erase carbon in the past. I happened to know that on the Internet and also know the history and the types of erasers. First, I introduce the history and types of erasers.

The history of erasers: In 16th century, the pencil with carbon was invented. In those days, people used bread as an eraser. In 1770, Joseph Priestley, a British scientist have the fortune and know that people can erase written text by using a natural rubber. In 1772, an eraser was invented and sold for the first time. After that, varieties of erasers were invented, such as a plastic eraser and today we mostly use a plastic eraser.

The types of erasers: Mainly, 4 types of erasers exist today (a plastic eraser, a kneaded eraser, a rubber eraser and an abrasive eraser).

Now, we know the history and types of erasers. Then I came to want to know exactly how erasers advanced historically and the differences of their performances. With reference to eraser, it has been found that when people clean paper by using dry methods, kneaded eraser is the most gentle and vinyl erasers are extremely gentle. (Paul N. Banks, 1970). Other than this, it has been found that regarding the effect of dry cleaning products on cotton canvas, vinyl eraser are the most abrasive of seven dry cleaning products (Pink Pearl, Kneaded Rubber, Vinyl-based erasers, Absorene, and so on…) (Elizabeth Estabrook, 1989). These 2 study focus on the last condition. So, I focus on the performance of erasers when we erase carbon and will study witch erasers can erase carbon the best. It was hypothesized that a plastic eraser can erase carbon better of all and bread worse of all. That is because a plastic eraser is made especially to erase carbon, an abrasive eraser is made especially to erase characters and the like written on a paper with ball-point pen, fountain pen or the like, a kneaded eraser is made especially to erase cleanly, and bread is not made to erase things. A rubber eraser is also made especially to erase carbon, but it is used only to avoid fusion bond (there is a danger of fusion bond if we do not use a plastic eraser correctly) and probably performance of a rubber eraser is not as good as that of a plastic eraser.

Method

To investigate the performance of “erasers”, bread (A), a kneaded eraser (B), a rubber eraser (C), an abrasive eraser (D) , a plastic eraser (E) and carbon paper were collected.

The study was done on the desk at the second refectory at University of Tokyo. The date was June 11,2010.

The experimental design and the protocol for collecting date: First, A was set up on a spring balance and A was held at the same power on the carbon paper (2Newton). Subsequently, A was rotated for 5 times (the same power, 2N). This experience was done for each “erasers”. Afterwards, the carbon paper was cut and put on a black paper. To clearly see the results, a carbon which was not erased was also put on a black paper (picture 1). Subsequently, the carbon paper was taken photo of and the quantities of Carbon in the lines were investigated. To investigate the quantities, the software called “image J” was used. A rectangle was drawn on the picture and the quantities in the rectangle were investigated (picture2,3). The quantities ware investigated in terms of square measure. Subsequently, the square measures were compared on the basis of a carbon which was not erased. The smaller square measure was, the better “eraser” can erase carbon.

Result

The square measures become larger as the quantities of carbon in the paper become larger. The square measures of 5 pieces of carbon papers, which were erased with “erasers” (“”are used because I include bread in erasers) are showed on table 1. The square measures are relative value (relative to the not erased paper), which means figures on Table 1 have no units. Therefore, the square measure of the not erased carbon paper was used as the base square measure in which the figure is reckoned at 100 and that for erased ones are showed on Table 2. The value is correct to 5 significant figures.

In general, the square measures of pieces of carbon paper which were erased with bread are largest, those with an abrasive eraser are second largest, those with a kneaded eraser and a rubber eraser are almost the same (third largest) except 2nd experiment and those with a plastic eraser are smallest except 2nd experiment.

Table 1: The square measures

Erasers	Not erased	bread	abrasive	kneaded	rubber	Plastic
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Discussion

The result of my study shows that in average, the best performance was, in order, a plastic eraser, a rubber one, a kneaded eraser, an abrasive one and bread. Therefore, my hypothesis that the performance of a plastic eraser is the best of those materials is supported. However, the second experiment was against my hypothesis. The cause of that disagreement is probably that it was difficult to control the power precisely. On top of that, 3 times is too small a number to investigate exactly. This was shown because the figure of the square measure of the 3 experiments is very different. Thus, in the next experiment, we should do the same thing more times and to control the power more exactly, we should do another experiment. For example: First, an eraser is held tightly, looking upwards. Second, a carbon paper fit on an apparatus is held on the eraser and the apparatus is moved at the same power and for the same second. I am not familiar with scientific apparatuses, so I cannot come up with a specific apparatus to do so. Third, investigate the quantities of carbon in a same manner as this experiments.

The conclusion of my study is that if we erase carbon, the newer “erasers” become, the better their performances are. Therefore, if you want to erase carbon easily, you should use a plastic eraser. My study only shows the performance of erasers. However, if we do another experiment that focus on the efficiency, that is, if we investigate which eraser (the same volume) can erase the largest square measures of carbon written by the same pencil, we will see which eraser should be used in terms of economy, in the examination where people must use the same pencil in terms of economy.

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Elizabeth Estabrook (1989). Considerations of the Effect of Erasers on Cotton Fabric. Journal of the American Institute for Conservation, Vol. 28, No. 2, pp. 79-96

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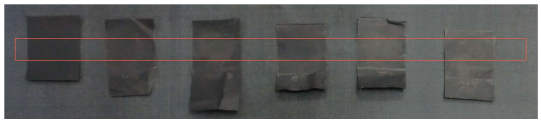

Figure 2: the part, which was erased

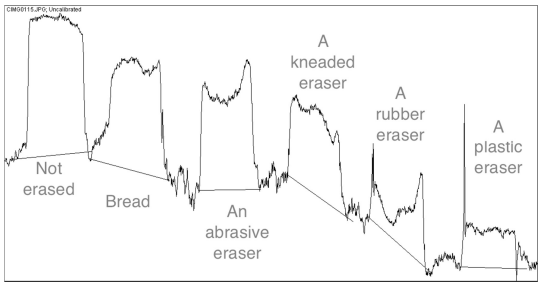

Figure 3: the quantities of carbon in the paper

The Strength of Cardboard due to Height of Waves

Introduction

The reason why cardboards are used in order to transport objects is thought that cardboards are strong. And why are cardboards made of papers strong? We think it is because cardboards have the waves which normal papers do not have and there is relationship between the height of waves and the strength.

It has been thought the many reasons why the cardboards are strong, for example material, ,and so on (Nakagawa and Niwa, 2005). Among such things we choose the height of waves because it was published that if the crease is too shallow, the board breaks easily, but if the crease is too deep, it breaks easily, too(B. K. Thakkar, 2008). But it is seemed that the strength of the paper is in proportion to the thickness.

We experimented to identify that the strength of cardboard is in proportion to the height of waves.

Method

To test relationship between the strength of cardboard and the height of waves, the nine cardboards varying the height of waves were made of thick papers (186.7 g/m^2) (2 mm, 5 mm, 7.5 mm, 10 mm, 15 mm, 20 mm, 30 mm, 40 mm, 50 mm). The other sizes of the cardboards were same. The length was 300 mm, the width was 300 mm and the wavelength was 5 mm. This time a wave's shape is a triangle.

The cardboard was put on stands. Changing the weight of the plastic bottle with water poured into the bottle, the bottle was fallen down from 1000 mm to the cardboard.

When the cardboard was snapped, the weight of the bottle was measured.

Result

The cardboard with the height of waves 2 mm is most fragile and that with the height of waves 50 mm is strongest. The others are interval data (see Figure 1).

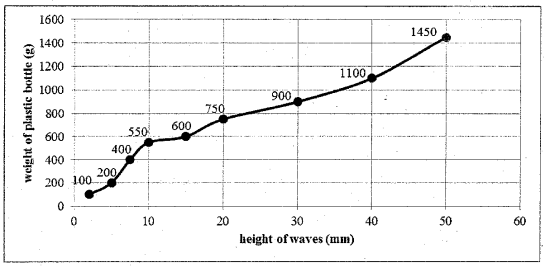

Fig. 1 The relationship between height of waves and weight of plastic bottle.

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Discussion

Figure 1 has the great inclination before 10 mm, so when the height of waves is extremely low, the strength is extremely low.

Considering the result made by the group of B. K. Thakkar suggests that if the crease is too shallow, the board breaks easily, but if the crease is too deep, it breaks easily, too and that figure 1 has the slight inclination after 10 mm, there seems to be the critical point of the strength, but we cannot find it.

Why we cannot find it? I think there are two main reasons. First, what they mean "too deep"? There is a possibility that they mean over 50 mm. Second, we judged from my sense of values of snapping. So there is a possibility of a little margin of error.

But in our experiment, the hypothesis is supported until the height of waves is 50 mm.

Reference

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(JOURNAL OF PACKAGING SCIENCE & TECHNOLOGY, JAPAN, Volume 14, No.5, 2005, Yukiomi Nakagawa; Kazukuni Niwa)

Experimental and numerical investigation of creasing in corrugated paperboard
(Philosophical Magazine, Volume 88, Issue 28 & 29, 2008 ,B. K. Thakkar; L. G. J. Gooren; R. H. J. Peerlings; M. G. D. Geers)

The Strength of Cardboard due to Height of Waves

Introduction

The reason why cardboards are used in order to transport objects is thought that cardboards are strong. Why are cardboards made of papers strong? It has been thought that many factors contribute to the strength of cardboards such as material, adhesive strength and humidity (1). Among such factors the most important factor is the height of waves because the group of B. K. Thakker suggested that if the crease is too shallow, the board breaks easily, but if the crease is too deep, it breaks easily, too (2). However, it is generally said that the strength of paper is proportional to the thickness.

We experimented in order to identify that the strength of cardboard is proportional to the height of waves.

Method

To test relationship between the strength of cardboard and the height of waves, nine cardboards varying the height of waves were made of thick papers (186.7 g/㎡) (2 mm, 5 mm, 7.5 mm, 10 mm, 15 mm, 20 mm, 30 mm, 40 mm, 50 mm). The other sizes of the

cardboards were same. The length was 300 mm, the width was 300 mm and the wavelength was 5 mm. This time a wave's shape is a triangle.

The cardboard was put on stands. Changing the weight of the plastic bottle with water poured into the bottle, the bottle was fallen down from 1000 mm above the cardboard to it. When the cardboard snapped, the weight of the bottle was measured.

Results

The cardboard with the height of waves 2 mm is most fragile and that with the height of waves 50 mm is strongest. The others are interval data (see Figure 1).

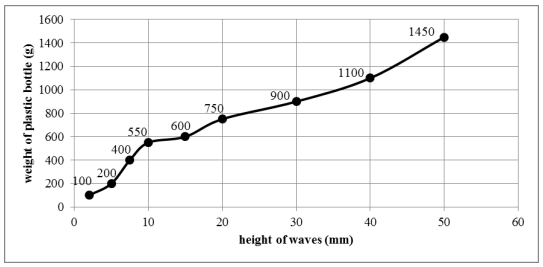

Fig. 1 The relationship between height of waves and weight of plastic bottle.

Discussion

The difference between our hypothesis and the result is whether the relationship between the strength and the height of waves is completely proportional or not. Figure 1 has the great inclination before 10 mm and has the slight inclination after 10 mm.

Why the result is different from B. K. Thakkar's. There are three reasons. First, what the group of B. K. Thakkar means "too deep"? There is a possibility that they mean over 50 mm, so we have chance that there is the critical point of the strength over 50 mm. Second, because snapping was not perfectly defined, there is a chance of a little margin of error. Third, each trial was only once. We wanted to try more, but we judged that if we did so, we could not finish the experiment. So other people might judge that Figure 1 has straight inclination. We should utilize these elements for further experiments.

However, the hypothesis is supported until the height of waves is 50 mm in our experiment.

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(2) B. K. Thakkar; L. G. J. Gooren; R. H. J. Peerlings; M. G. D. Geers 'Experimental and numerical investigation of creasing in corrugated paperboard'
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The Effect of Stirring Times on Sugar Content in Natto

Introduction

It is well known that there are a variety of factors that affect sugar content in foods. A study ([1]) shows that the factors were divided into two groups, pre-harvest and post-harvest factors. The study also reports that the major pre-harvest factors were crop maturity, temperature during growth, mineral nutrition and irrigation, and post-harvest ones are mechanical stresses and storage conditions.

However, the relationship between mechanical force that is one of the most familiar one and sugar content in foods is not clear, and stirring is one of the mechanical forces. There is a report ([2], [3]) that shows that stirring increased viscidity and this influenced greatly on glutamic acid, tastes, scent, and so on, but the report do not refer sugar content. This paper investigated the relation between mechanical force, especially stirring and sugar content in natto, fermented soybeans. Considering the report ([2], [3]) there may be one hypothesis: Much times stirring natto, sugar content will be higher because of the mechanical shearing of carbohydrate.

On the experiment, sugar content in natto was measured for 8 different times. The result of this experiment will contribute to having people able to eat natto deliciously by stirring adequate times.

Method

For this experiment, natto(the size is about 4mm-diameter, and it is before the shelf life date), soy sauce(the sugar content is 36.8%), distilled water(the sugar content is 0.0%), chopsticks(disposable wooden ones), 8 cups(a 5cm-diameter), a pipette(2mL) and a brix meter, which measures sugar contents was needed.

1. Natto was bought at a supermarket, and stored in refrigerator(4□). Take out the natto from the refrigerator and put it at room temperature for the time being. The reason why this process was needed was that all samples should be maintained the same state. The two trays of natto was divided into 4 parts each and each part were removed into a cup respectively and stirred with soy sauce or water for 10 times, 50 times, 100 times, 200 times, 300 times, 400 times and 500 times. One part was maintained without being stirred (figure 1-A).

2. Water solution (figure 1-B) was 15ml-distilled water (sugar content:0.00%), and soy sauce one (figure1-C) was 13ml-distilled water + 2ml-soy sauce(sugar content: $36.8 \times \frac{2}{15} =$ 4.91%). The reason why the distilled water was needed was viscidity hindered measuring the sugar content accurately. These solutions were added into the samples, which were divided at the 1st step. There were two solutions (water or soy sauce), and each solution has 8 samples, so there were 16 samples as a total (figure 1-B C). The reason why these solutions were added before stirring was that when measured every part of cup should have the same sugar content.

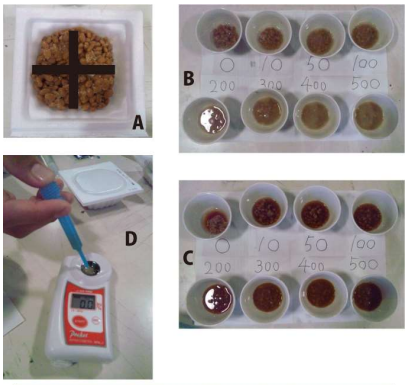


figure 1 pictures of experiments
A : Natto divided into 4 sections.
B : water solution (the number means stirring times)
C : soy sauce & water solution D : pipet and brix meter

3. These samples were stirred for each stirring times (0, 50, 100, 200, 300, 400, and 500) by using chopsticks. Even 0 times, the cup itself was waved to be kept homogeneous solution. The reason why this process was needed was that if not, the solution would be still beginning state. These samples were stirred by the same person and the same rotation direction.

4. Three different part of solution were abstracted by a pipette and measured the sugar content by a brix meter, the temperature was measured at the same time. (figure 1-D) The reason why three part not just one part of solution were abstracted was that preliminary experiments showed that different part of solution had different sugar content even if stirred enough, so it is possible that the solution did not become completely homogeneous solution. The brix meter was zero-point adjusted by distilled water. The raw soy sauce's sugar content was also measured. The measurements were conducted from 0 times, it is because if not, there was a possibility of contamination. The person who used the pipette was the same person during the experiment.

5. The above experiment was repeated two times for each stirring times (0, 50, 100, 200, 300, 400, and 500), and the average of sugar content was plotted on a graph sheet. So, 6 data were gained each stirring time and each solution. Natto could not be divided into 4 equal parts precisely, and that might result into a margin error. Repeating 2 times were needed in order to minimize such a margin error.

An analysis was made for correlation between the number of stirring times and sugar content.

Every step of this experiment, distilled water picked up by the pipette was measured and the sugar content was 0.0%.

Results

Figure 3 shows that the relation between stirring times and sugar content, and "water (1)" shows 1st measurement of water solution, "water (2)" shows 2nd one "soy sauce (1)" shows 1st measurement of soy sauce solution, "soy sauce (2)" shows 2nd one. The all cases show the more number of times the sample is stirred, the more sugar content is increasing, but the rate of increase decreases.

Figure 4 and figure 5 show that the average of 6 samples of water and soy sauce solutions every stirring times. 3 times are from one batch of natto, the other 3 times are from another natto. These two graphs show that the effect of stirring times of natto diminishes after 50times and there is little difference between solution contains soy sauce or not.

During the experiments, the temperature changed little by little from 20□(fig.2).

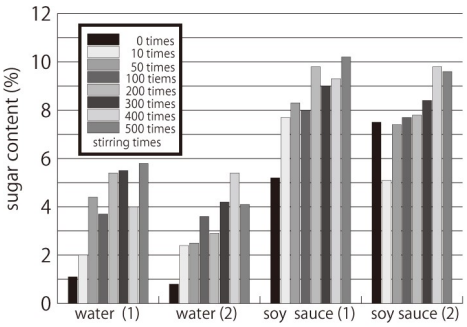
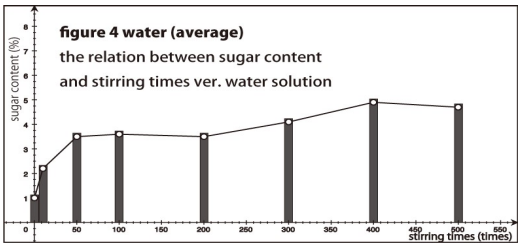
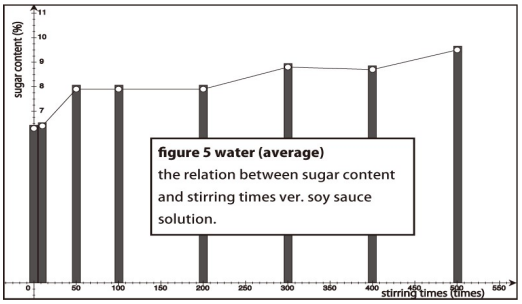
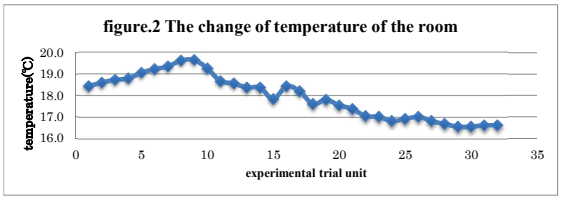


figure 3 the relationship between sugar content and stirring times







Discussion

The results of the present experiments suggest that generally more times natto was stirred, the more sugar content increased within 500 times (figure 3). However, the following two questions remains. One is whether the increase was because of the mechanical shearing of carbohydrate or not. Two is whether or not sugar contents' increasing is limited. According to the results it can be said that within 50 times of stirring, natto's sugar content did not dissolve into solution enough, and in more than 50 times the sugar content dissolve to some extent, so the rate of increase became slower (figure 4 and figure 5).

Furthermore, from these two figures it can be said that whether or not the solution contains soy sauce made only a little difference between the two experiments about sugar content. As for the way of stirring the effect would be little because the same person stirred samples the same rotation and the same power.

Rosanjin Kitaohji, one of the most famous cooks in Japan says by experience that the best time of stirring to eat natto is 424 times ([4]). He did not show it scientifically, so the “424” is not convincing number. In addition, considering from the results, the best time is not the “424” but more than 500 times.

These expriments has some limitations, and the following things were not controlled. There is a lag between finishing stirring and measuring sugar content. Also, the temperature of room changes about 3 degrees, so it cannot be said that the effect is subtle. In addition, the heat generated by stirring might have effect on the results. The results depend on kind of sugar. The effect of the damage of natto beans by chopsticks are not considered.

Further study, two points are suggested. One, it cannot be said that the uneven density of sugar content in the sample are perfectly controlled, so more than 3 points should be sampled from the sample. Two, to see further trend, or to know whether or not there are the upper limit of sugar contents' increasing, stirring times should be larger than 500 times.

In conclusion, when eating natto, the stirring times would be as many times as possible within 500 times and to know what the accurate stirring times is further study is needed.

Acknowledgements

I would like to thank for her suggestion about my experiment methods, and Laboratory for lending me a brix meter. Also, I appreciate my coworkers for conducting experiments, and my classmates’ help in improving my paper.

References

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The Effect of Stirring Times on Sugar Content in Natto

Introduction

It is well known that there are a variety of factors that affect sugar content in foods. A study ([1]) shows that the factors were divided into two groups, pre-harvest and post-harvest factors. The study also reports that the major pre-harvest factors were crop maturity, temperature during growth, mineral nutrition and irrigation, and post-harvest ones are mechanical stresses and storage conditions.

However, the relationship between a mechanical force, stirring which is one of the most familiar one and sugar content in foods is not clear. There is a report ([2], [3]) that shows that stirring increased viscidity and this influenced greatly on glutamic acid, tastes and scent, and so forth, but the report do not refer sugar content. This paper investigated the relation between mechanical force, stirring and sugar content in natto, fermented soybeans. Considering these reports ([2], [3]) there may be one hypothesis: more times natto is stirred, the sugar content will be increase because of the mechanical shearing of carbohydrate.

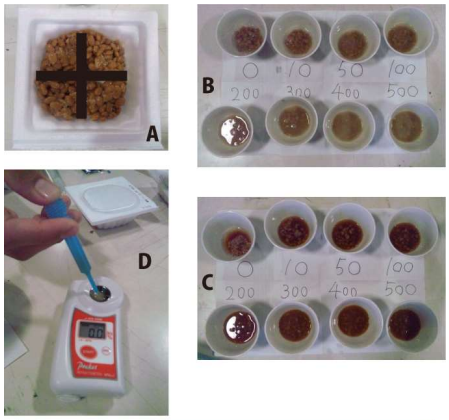
In the experiment, sugar content in natto was measured for 8 different stirring times. The result of this experiment will contribute to having people being able to eat natto deliciously by stirring adequate times.

Method

For this experiment, natto (the size is about 4mm-diameter, and it is before the shelf life date), soy sauce (the sugar content is 36.8%), distilled water (the sugar content is 0.0%), chopsticks (disposable wooden ones), 8 cups (a 5cm-diameter), a pipette (2mL) and a brix meter, which measures sugar contents was needed.

1. Natto was bought at a supermarket, and stored in refrigerator (4□). Take out the natto from the refrigerator and put it at room temperature (20℃) for the time being. The reason why this process was needed was that all samples should be maintained the same state. The two trays of natto was divided into 4 parts each and each part were removed into a cup respectively and stirred with soy sauce or water for 10 times, 50 times, 100 times, 200 times, 300 times, 400 times and 500 times. One part was maintained without being stirred (figure 1-A).

2. Water solution (figure 1-B) was 15ml-distilled water (sugar content:0.00%), and soy sauce one (figure1-C) was 13ml-distilled water + 2ml-soy sauce (sugar content: $36.8 \times \frac{2}{15} = 4.91\%$). The reason why the distilled water was needed was viscidity hindered measuring the sugar content accurately. These solutions were added into the samples, which were divided at the 1st step. There were two solutions (water or soy sauce), and each solution has 8 samples, so there were 16 samples as a total (figure 1-B C). The reason why these solutions were added before stirring was that when measured every part of cup should have the same sugar content.



A : Natto divided into 4 sections.
B : water solution (the number means stirring times)
C : soy sauce & water solution D : pipet and brix meter

Figure 1. Pictures of Experiments

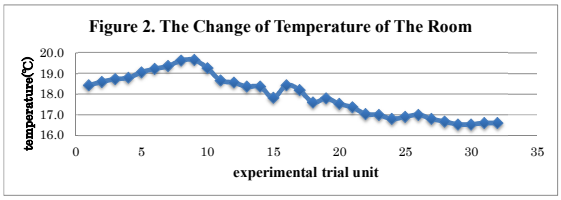
3. These samples were stirred for each stirring times (0, 50, 100, 200, 300, 400, and 500) by using chopsticks. Even 0 times, the cup itself was waved to be kept homogeneous solution. The reason why this process was needed was that if not, the solution would be still beginning state. These samples were stirred by the same person and the same direction of rotation.

4. Three different part of solution were abstracted by a pipette and measured the sugar content by a brix meter, the temperature was measured at the same time (figure 1-D). The reason why three part not just one part of solution were abstracted was that preliminary experiments showed that different part of solution had different sugar content even if stirred enough, so it is possible that the solution did not become completely homogeneous solution. The brix meter was zero-point adjusted by distilled water. The raw soy sauce's sugar content was also measured. The measurements were conducted from 0 times, it is because if not, there was a possibility of contamination. The person who used the pipette was the same person during the experiment.

5. The above experiment was repeated two times for each stirring times (0, 50, 100, 200, 300, 400, and 500), and the average of sugar content was plotted on a graph sheet. So, 6 data were gained each stirring time and each solution. Natto could not be divided into 4 equal parts precisely, and that might result into a margin error. Repeating 2 times were needed in order to minimize such a margin error.

During the experiments, the temperature changed little by little (figure 2). Every step of this experiment, distilled water picked up by the pipette was measured and the sugar content was 0.0%.

An analysis was made for correlation between the number of stirring times and sugar content.



Results

Figure 3 shows that the relation between stirring times and sugar content, and "water (1)" shows 1st measurement of water solution, "water (2)" shows 2nd one "soy sauce (1)" shows 1st measurement of soy sauce solution, "soy sauce (2)" shows 2nd one. The all cases show the more number of times the sample is stirred, the more sugar content is increasing, but the rate of increase decreases.

Figure 4 and figure 5 show that the average of 6 samples of water and soy sauce solutions every stirring times. 3 times are from one batch of natto, the other 3 times are from another natto. These two graphs show that the effect of stirring times of natto diminishes after 50times and there is little difference between solution contains soy sauce or not.

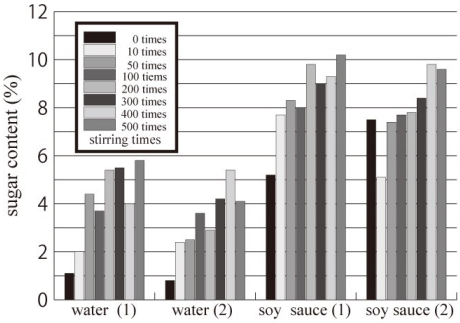


Figure 3. The Relation Between Sugar Content and Stirring Times

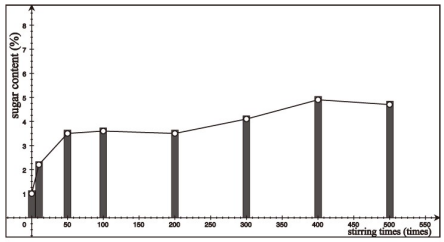


Figure 4. Water (average)

the relation between sugar content and stirring times ver. water solution

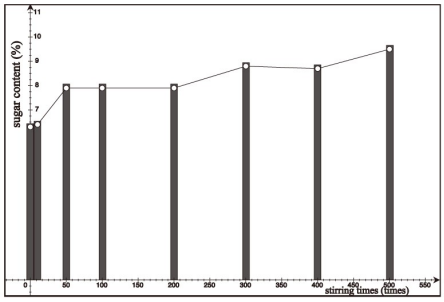


Figure 5. Soy Sauce (average)

the relation between sugar content and stirring times ver. soy sauce solution

Discussion

The results of the present experiments reveal that generally more times natto was stirred, the more sugar content increased within 500 times (figure 3). The results mostly followed the hypothesis. However, the following two questions remains: 1) whether the increase was because of the mechanical shearing of carbohydrate or not, and 2) is whether or not there is a upper limit of sugar contents' increasing. According to the results it could be said that within 50 times of stirring, natto's sugar content did not dissolve into solution enough, and in more than 50 times the sugar content dissolve to some extent, so the rate of increase became slower (figure 4 and figure 5).

Furthermore, from these two figures it could be said that whether or not the solution contains soy sauce made only a little difference between the two experiments about sugar content. As for the way of stirring, the effect of stirring on sugar content would be little because the same person stirred samples in the same direction and with the same power.

Rosanjin Kitaohji, one of the most famous cooks in Japan mentions by experience that the best time of stirring times to eat natto is 424 times ([4]). He did not prove it scientifically, so the number “424” is not convincing. In addition, considering from the results, the best number is not the 424 but more than 500 times.

These expriments has some limitations because the following things were not controlled. There was a time lag between finishing stirring and measuring sugar content. Also, the temperature of room changed about 3 degrees Celsius, so it cannot be said that the effect was subtle. In addition, the heat generated by stirring might have effect on the results. The effects of the damage of natto beans by chopsticks were not considered.

For further study, two points are suggested. One, it cannot be said that the uneven density of sugar content in the sample are perfectly controlled, so more than 3 points should be extracted from the sample. Two, to see further trend, or to know whether or not there are the upper limit of sugar contents' increasing, stirring times should be larger than 500 times.

In conclusion, when eating natto, the stirring times would be as many times as possible within 500 times. To know what the accurate stirring times for eating natto is further study is needed.

Acknowledgements

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References

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Abstract

Some research have shown that the color which is absorbed well by chlorophyll and the color which is good for the growth of land plants are not necessarily the same. I investigated which color of light is good for water plants, which live in the blue environment. Four groups of water plants were placed under each color of light (red, green, blue, and transparent) for three weeks, and then the change of their weight was measured. The better colors are blue and green, which water plants can get much in their wild environment while the worse colors are red, which water plants cannot get much and transparent. However, the difference is slight and the looks of the plants are not different; the red group was as fine as the blue or green group. So, it does not matter much for water plants whether the color of light is red or green or blue. This suggests that the wavelength area which water plants can absorb is wider than that of land plants. To know which color is good for plants and how important it is help cost reduction in factories where vegetables are made.

Introduction

There are many plants not only on land but also in water, and water plants photosynthesize, too.

It is known that chlorophyll absorbs the red and blue lights well. However, the blue light depresses the growth of some land plants (Cosgrove & Green, 1981). The activation of anion channels seems to cause the depression (Parks, Cho & Spalding, 1998). So, the good color for photosynthesis and the good one for the growth of the plant are not necessarily the same. Hogewoning, Douwstra, Trouwborst, Ieperen and Harbinson (2010) say that the complicated interaction of many responses makes it difficult to predict the overall plant renponse.

The water plants are known to use different wavelength area for photosynthesis, but the relationship between the good color of light for photosynthesis and that for the growth is unknown. So I conducted the experiment to research what is the best color for the growth of water plants.

I hypothesized that the blue light is the best and the red one is the worst, and that the plants of red group would die, because the color which water plants can use well in its environment is blue while there is not the red light much.

These days, more and more plants are raised in factories, especially for foods. To know the relationship between the growth and the color of light can promote more effective ways in the industry.

Each of four groups of water plants was placed under each colored light (red, blue, green, and transparent). After three weeks, the change of their weights was measured.

Result

The appearances of four groups were the same; no plant changed its color or, died. However, the change of weight happened slightly. Shown in the Figure 1, in the four colors (red, green, blue, and transparent), the better colors of light for the growth of water plants were blue and green, and the worse colors were red and transparent. As Table 1 shows, the blue and green groups increased their weight by 5% while the red and transparent groups did not change. Blue and green are the colors which can be seen in the sea, and red is the color which is not seen much.

Cosgrove and Green (1981) showed that the blue light depress the growth of some land plants. Compared with their study, our result was different in that the blue light did not depress the growth of water plants.

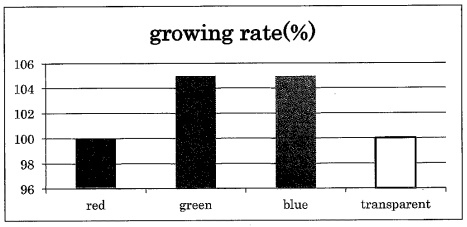

Figure 1:The growing rates of each group.

	before(g)	after(g)	growing rate(%)
red	21	21	100
green	20	21	105
blue	20	21	105
transparent	20	20	100

Table.1: The detailed numeric data of the change of the weigh.

Discussion

Preceding research (Cosgrove & Green, 1981) showed that blue light depresses the growth of some land plants though chlorophyll absorbs the blue light well. This shows that the light absorption is not directly connected with the growth. This experiment was conducted to research what color is the best for the growth of water plants, which are known to absorb different range of wavelength. My hypothesis was that the blue light is the best, and that the red light is the worst and the plants of red group would die, because I guessed that the water plants that live in the environment without red light could not use red light to photosynthesis.

According to the results, the blue and green lights are better for water plants than the red one. This part confirms my hypothesis. However, to the contrary, the fact that the water plants of red light group seem as fine as the others is opposite to the hypothesis. I can conclude that though blue and green light is good for this water plant, the red light is used as well to the degree that there is not a clear difference after the three weeks experiment.

This result that the blue light did not depress the growth of water plants is different from the result that Cosgrove and Green (1981) showed. In addition, this also differs from the common sense that green light is not used well by plants which are green.

I assume the difference between water plants and land plants is caused by the difference of the light environment. The colors which can be seen generally in the sea are blue and green, and red is not seen usually. In the process of evolution, it is natural that what can be used is used. And, the reason why the red group was able to survive was that they could do photosynthesis at least. In water plants, some pigments absorb lights and they hand the energy to chlorophyll which photosynthesizes (Ikeuchi, 2007). It is possible that this chlorophyll directly uses the energy of red light.

In this study, each group had three or four plants. The plants are living things, so they have individual differences, which could make errors. To increase the number of the plants will reduce this effect. To make the environmental conditions more equal, the equipment should be placed in darkness. Though external light was removed as well as possible by using the cardboard boxes, the heat it made may not be removed completely. In future research, the plants should be raised under each color of light from their germination to study the effect of the color of lights in detail.

To understand the practical relation between the color of light and the growth of plant is important, because these days more and more vegetables are made in factories and which color bulb is used decides expense largely; for example, blue LED is more expensive than red or green one. The result that there is not big difference based on the color of light means that the least expensive bulb can be used.

S8's Revised Paper

Abstract

Previous research has shown that the color which is absorbed well by chlorophyll and the color which is effective in the growth of land plants are not necessarily the same. I investigated which color of light is good for water plants, which live in blue environment. Four groups of water plants were placed under each color of light (red, green, blue, and transparent) for three weeks, and then the change of their weight was measured. The more effective colors are blue and green, which are the colors existing much in the environment where the water plants live while the less effective colors are red, which is the color not existing much in the environment and transparent. However, the difference is slight and the appearances of the plants were not different. It does not make a big difference for water plants whether the color of light is red or green or blue. This suggests that the wavelength area of lights which water plants can absorb is wider than that of land plants. Knowing which color is effective in the growth of plants and whether the difference of the color of lights is important for the growth help cost reduction in factories where vegetables are made.

Introduction

There are many plants not only on land but also in water, and water plants also photosynthesize.

It is known that chlorophyll absorbs the red and blue lights well. However, the blue light depresses the growth of some land plants (Cosgrove & Green, 1981). The activation of anion channels seems to cause the depression (Parks, Cho & Spalding, 1998). The color absorbed well during photosynthesis and the effective one in the growth of the plant are not necessarily the same. Hogewoning, Douwstra, Trouwborst, Ieperen and Harbinson (2010) state that the complicated interaction of many responses makes it difficult to predict the overall plant response.

The water plants are known to use different wavelength area for photosynthesis, but the relationship between the color of light absorbed well during photosynthesis and the color effective in the growth is unknown. I conducted the experiment to research what is the most effective color for the growth of water plants.

I hypothesized that the blue light is the best and the red one is the worst, and that the plants of red group would die, because the color which water plants can use well in its environment is blue while there is not the red light much. Four groups of water plants was placed under each colored light (red, blue, green, and transparent). After three weeks, the change of their weights was measured.

These days, more and more plants are raised in factories, especially for foods. To know the relationship between the growth and the color of light can promote more effective ways in the industry.

Result

The appearances of four groups were the same; no plant changed its color or, died. However, the change of weight happened slightly. Shown in the Figure 1, in the four colors (red, green, blue, and transparent), the more effective colors of light in the growth of water plants were blue and green, and the less effective colors were red and transparent. As Table 1 shows, the blue and green groups increased their weight by 5% while the red and transparent groups did not change.

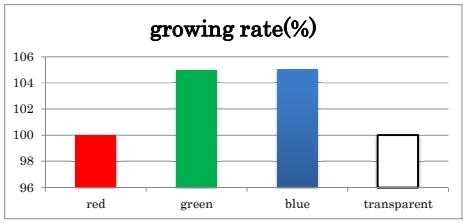

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Table.1: The detailed numeric data of the change of the weigh.

Discussion

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In this experiment, the blue and green groups increased their weight by 5% while the red and transparent groups did not change. According to the results, the blue and green lights are more effective color in the growth of water plants than the red light. This part confirms my hypothesis. However, to the contrary, the fact that the water plants of red light group seem as fine as the others is opposite to the hypothesis. I can conclude that though blue and green lights are more effective in the growth of this water plant, the water plant can absorb red light as well to the degree that there is not a big difference between the conditions of the water plant of each group after the three weeks experiment.

This result that the blue light did not depress the growth of water plants is different from the result that Cosgrove and Green (1981) showed. In addition, this also differs from the common sense that green light is not used well in photosynthesis by plants which are green.

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difference of the light environment. The colors which can be seen generally in the sea are blue and green, and red is not seen usually. In the process of evolution, it is natural that living things use what can be used in the environment. The reason why the red group was able to survive was that they could photosynthesize. In water plants, some pigments absorb lights and they transmit the energy to chlorophyll which photosynthesizes (Ikeuchi, 2007). It is possible that this chlorophyll directly uses the energy of red light.

In this study, each group had three or four plants. The plants are living things, so they have individual differences which could make errors. To increase the number of the plants could reduce this effect. To make the environmental conditions more uniform, the equipment should be placed in darkness. Though external light was removed as much as possible by using cardboard boxes, the heat it made may not be removed completely. This time The plants were already matured and did not grow much. In future research, the plants should be raised under each color of light from their germination to study the effect of the color of lights in detail.

Understanding the practical relation between the color of light and the growth of plant is important because these days more and more vegetables are made in factories and which color bulb is used determines expense largely. For example, blue LED is more expensive than red or green one. The result that there is not big difference based on the color of light means that the least expensive bulb can be used.

The practical value of threshold in spatial vision

Introduction

Eyesight has it's limits. Generally it is said that people whose visual acuity is over 1.0 can live without difficulty. In the case where the distance between a person and objects is 43 cm and his visual acuity is 1.0, he cannot distinguish differences under 0.12mm (Me no kaizoudo, para.8). Thus, people whose visual acuity is 1.0 can distinguish differences about 0.12mm.

However, the question about whether people can distinguish differences in practice remains. There is the optical illusion of concentric circles which could be useful to answer this question. For example, regarding Figure 1, though the diameter of the outer circle of the left concentric circle is equal to that of the inner circle of the one, it seems that the left outer circle is smaller than the right inner circle (this optical illusion is called "Delboeuf circle illusion", and this type illusion was studied by Cooper & Lynn A. (1970)). Thus, the image which people believe that they are seeing is what is entered from the outer world through and is treated with their brains. So, they mistake the same two circles for the different two circles. In this case, two objects of same size

are perceived as being different. This implies that the same can be said for the opposite case; two objects of different size are perceived as being same.

I hypothesize that the value of threshold in spatial vision in the participants would be larger than 0.1mm for the following reason. The objective of this experiment was to find the limit of differences that people can distinguish. In this present study I compared two objects which are same in color but different in size. It was inspected to what degree participants can distinguish size difference in objects. Considering the above information about eyesight, 0.1mm is about the threshold that one can distinguish two objects. However, in reality there are influences from cerebral process as in the example of the optical illusion of concentric circles.

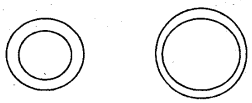

Figure1: The optical illusion of concentric circles. It seems that the left outer circle is smaller than the right inner circle though two circles are same size.

Method

Volunteers

Volunteers were recruited among students of University Of Tokyo. They were eligible for participation if they were assessed healthy at the annual health check at the university. They should have not suffered from eye disease or disorder such as cataract, colorblindness and so forth. The correct eyesight of the volunteers was over 0.7. It was not questioned whether or not they wore glasses.

Study design

Twelve cards were prepared. One set was consisted of two cards and there are six sets in all. One black circle was drawn in the center of each card. The radiuses of the circles were respectively 2.3 cm (Figure2), 2.3 cm×1.01, 2.3 cm×1.02, 2.3 cm×1.05, 2.3 cm×1.07, and 2.3 cm×1.09. These card sets could not be distinguished from others by the gap and the blank of the cards. Behind each card, a mark was written so that the size of the circles could be checked after the experiment. 23 healthy volunteers (20 males, 3 females, aged 19±21 y) received shuffled cards and selected which two cards are same without seeing behind the cards. No time limit was set. When subjects finished selecting cards, the combination (which cards were seen as set) was recorded.

Statistical analyses

There are three statistical analysis conducted: first was the percentage of the correct answer; second was the range of the size of the errors which subjects mistook; and third was the average of the circle set which subjects mistook.

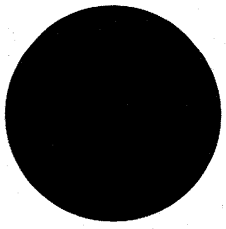

Figure2: this is the model of the circles used in the experiment (the radius is 2.3cm).

Results

Table 1 shows the percentage of the correct answers which people could answer. The largest number of people who could answer correctly is 2.3 cm ×1.09 and the smallest number is 2.3cm as shown in Figure 3. The mode, the median, the average, the maximum, and the minimum of the differences of the errors are displayed in Table 2. Figure 4 shows the aggregate of errors (total number is 138) and the differences of the errors (For example, when people mistake 2.3cm×1.07 for 2.3cm ×1.09, the difference of the errors is 0.02). Figure 5 is the approximate curve of the relation between the differences of errors and aggregate of errors from 0.01 to 0.07. The curve shows that about 0.02 has the maximum.

Table 1: The percentage of the correct answers about the ratio of the size of the circles

The ratio of the size of circles	The percentage of the correct answers (%)
1	34.8
1.01	17.4
1.02	17.4
1.05	17.4
1.07	26.1
1.09	65.2

*These percentages are rounded off to the first decimal places

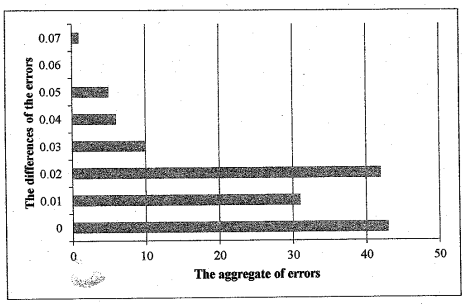

Figure 4: The relation between the differences of the errors and the aggregate of errors

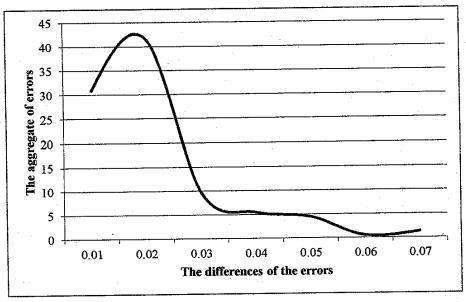

Figure 5: The approximate curve of the relation between the differences of errors and aggregate of errors from 0.01 to 0.07

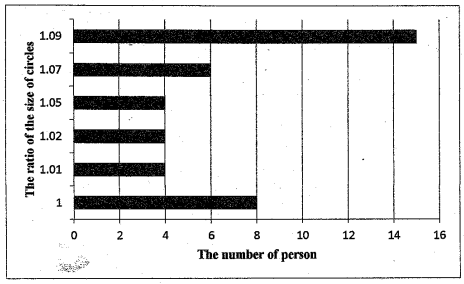

Figure 3: The number of person who answer the correct answer

Table 2: Parameters about the differences of the errors

Parameter	
Mode	0
Median	1
Average (including 0)	0.0146
Average (excluding 0)	0.0211
Maximum	7
Minimum	0

*The average is rounded off to the third decimal places

Discussion and Conclusion

According to the results, about 77% of wrong errors is in the range 0.01 ~ 0.02. This indicates that people cannot distinguish errors by about 0.02 × 2.3cm = 0.46mm. On the other hand, over 0.03 is only 23%. This indicates that people can distinguish errors by about 0.03 × 2.3cm = 0.69mm. Thus, the value of threshold in spatial vision in the participants is in 0.46mm ~ 0.69mm. By these results, my hypothesis that the value of threshold in spatial vision in the participants is over 0.1mm is correct. In fact, these values (0.46mm ~ 0.69mm) are largely different from the theoretical one (0.12mm). If outer factors are not considered, factors which can be considered are inner factors (outer factors cannot be considered in this experiment). Objects which we see are the vision that is treated by a brain through eyes. Thus, this may suggest that the large difference between practice and theory is caused by the treatment of the brain (David & Torsten, 1979). The reason why people cannot distinguish tiny difference may be that the brain regards the tiny difference as a trifle (It is difficult to consider other possibilities in this experiment).

On the other hand, Figure 3 suggests that this experiment has margin. As shown in Figure 3, 1.09 and 1.00 occupy largely the correct answers (almost 56%). This indicates that largest or smallest object may be more recognizable than other objects. In this experiment, this possibility cannot be denied. If the divisions are calibrated finely, the new data which can solve this problem are gained.

Although this experiment has some limit, this experiment is useful in that the new fact and possibility which is not gained or emerge come into being.

References

- Me no kaizoudo [目の解像度] (n.d.) from http://homepage2.nifty.com/ttoyoshima/Digicam/EyeRes.htm
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The practical value of threshold in spatial vision

Introduction

Eyesight has it's limits. Generally it is said that people whose visual acuity is over 1.0 can live without difficulty. Visual acuity is measured by Landolt ring (Figure 1) (Siryoku 1.0 no kijyunn ha nani?). In the case where the distance between a person and objects is 43 cm and his visual acuity is 1.0, he cannot distinguish differences under 0.12mm (Me no kaizoudo, para.8). Thus, people whose visual acuity is 1.0 can distinguish differences about 0.12mm.

However, the question about whether people can distinguish differences in practice remains. There is the optical illusion of concentric circles which could be useful to answer this question. For example, regarding Figure 2, though the diameter of the outer circle of the left concentric circle is equal to that of the inner circle of the one, it seems that the left outer circle is smaller than the right inner circle (this optical illusion is called "Delboeuf circle illusion", and this type illusion was studied by Cooper & Lynn A. (1970)). Thus, the image which people believe that they are seeing is what is entered from the physical world through and is treated with their brains. So, they mistake the same two circles for the different two circles. In this case, two objects of

same size are perceived as being different. This implies that the same can be said for the opposite case; two objects of different size are perceived as being same.

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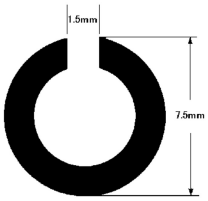

Figure 1: The Landolt ring. This is used in visual acuity test.

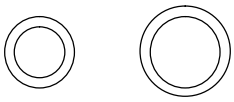

Figure 2: The optical illusion of concentric circles. It seems that the left outer circle is smaller than the right inner circle though two circles are same size.

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Volunteers

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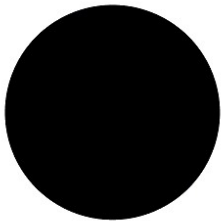

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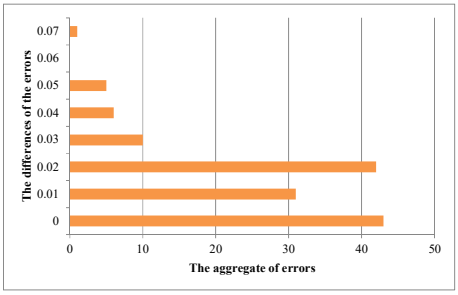

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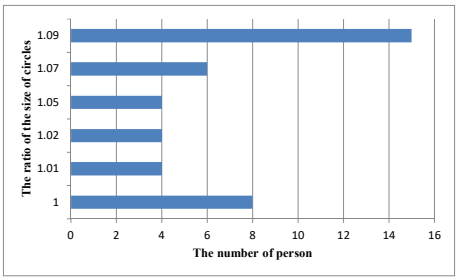

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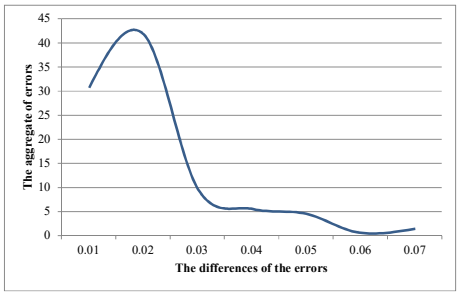

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According to the results, about 77% of wrong errors is in the range 0.01 ~ 0.02. This indicates that people cannot distinguish errors by about 0.02 × 2.3cm = 0.46mm. On the other hand, over 0.03 is only 23%. This indicates that people can distinguish errors by about 0.03 × 2.3cm = 0.69mm. Thus, the value of threshold in spatial vision in the participants is in 0.46mm ~ 0.69mm. By these results, my hypothesis that the value of threshold in spatial vision in the participants is over 0.1mm is correct. In fact, these values (0.46mm ~ 0.69mm) are largely different from the

theoretical one (0.12mm). Thus, this may suggest that the large difference between practice and theory is caused by the treatment of the brain (David & Torsten, 1979). Objects which we see are the vision that is treated by a brain through eyes. The reason why people cannot distinguish tiny difference may be that the brain regards the tiny difference as a trifle (It is difficult to consider other possibilities in this experiment).

On the other hand, Figure 4 suggests that this experiment has three margins. Firstly, as shown in Figure 3, 1.09 and 1.00 occupy largely the correct answers (almost 56%). This indicates that largest or smallest object may be more recognizable than other objects. If the divisions are calibrated finely, the new data which can solve this problem are gained. Secondly, the generation and the sexes of the volunteers are unbalanced. Volunteers are consists of 20 males and 3 females. Also, their age is around twenty. It is possible that the generation and the sexes are largely influential in this experiment. Finally, the color of the circles may be influential in this experiment. The color-caused optical illusion is studied by Cleveland & McGill (1983). In Figure 7, it seems that the left circle is smaller than the right circle though two circles are same size. Thus, if the color of the circles is changed, the results may be different.

Although this experiment has some limit, this experiment is useful in that the new fact and possibility which is not gained or emerge come into being. If this study is more advanced, the new standard of visual acuity may be established.

In summary, it can be concluded that the value of threshold in spatial vision is 0.46mm ~ 0.69mm.

Figure 7: The color-caused optical illusion. It seems that the left circle is smaller than the right circle though two circles are same size.

References

・Me no kaizoudo [目の解像度] (n.d.) from http://homepage2.nifty.com/ttoyoshima/Digicam/EyeRes.htm

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・Cooper & Lynn A. (1970). Delboeuf-type circle illusions: Interactions among luminance, temporal characteristics, and inducing-figure variations.

・David H. Hubel & Torsten N. Wiesel (1979). Brain Mechanisms of Vision.

・Cleveland & McGill (1983). A color-caused optical illusion on a statistical graph.

Efficiency of Wind Turbines

Introduction

Renewable energy is required emergently due to Fukushima nuclear accident and wind energy is the most promising energy of all the renewable energy. However, there is no record of the efficiency of wind turbines. I made two types of wind turbines and measured the correlation between the wind speed and the generated power using these two turbines. Through the experiment, I found that lift-type turbines are more efficient than drag-type ones and also found a mathematical correlation between the wind speed and the generated power. Although further research is needed, this conclusion will contribute to making electricity at home.

Background

As is mentioned in ~~[1] [2]~~, lift-type turbines generally have higher performance than drag type turbines. Drag-type turbines only use pushing force of the wind, so the speed of their blades cannot exceed the wind speed. On the other hand, lift-type turbines use fluid mechanics (Bernoulli's theorem) to create rotation energy, so the speed of their blades can exceed the wind speed. It is possible to derive the wind power of more energy by using fluid mechanics. Therefore, lift-type turbines are more powerful than drag-type ones.

In fluid mechanics, it is known that the pressure of fluid decreases when the flow speed of fluid increases (Bernoulli's theorem). Therefore, when the wind speed above the wind blade exceeds the speed below it, there appears force to lift the blade, and this force is called "lift". The blade is formed ideally in order to create powerful force. As for wind turbines, the lift appears perpendicular to the relative velocity of wind and the vertical component of "lift" drives the blade to rotate continuously (see Fig.1.).

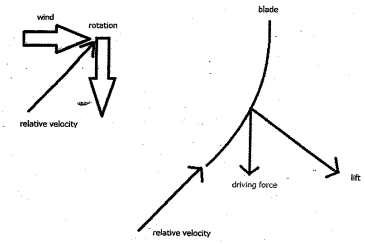

Fig.1. mechanism of lift

In addition, students in Kushiro National College of Technology did research to make a better wind turbine in [3]. Students had done trials and errors and improve their own hand-made wind turbine and they finally got a result of their analysis. Though the purpose of this research is to improve students' problem-solving abilities, this research can be regarded as research similar to mine. There is no information about the specific results (such as figures of performance), but there are many indication of the results of this research. ~~Kazunori C.~~ et al said that the superiority of lift-type turbines was limited but that it was easier to get the better results by using lift-type turbines than by using drag-type ones.

Method

To test the correlation between the wind speed and generated power, I did research using wind turbines. First, I made two wind turbines – a Savonius vertical-axis wind turbine (drag-type) and a horizontal-axis wind turbine (lift-type). The former was made of plastic board. Plastic board (0.3 mm thickness) was cut into two circles (radius 3cm) and two rectangular blades (5x5cm). These components were attached with cellulose tape as Fig.2. On the other hand, the later was made of plastic board and plastic flames. Plastic board was cut into five rectangular blades (2x5cm). These blades and plastic flames (taken from other wind turbines) were attached with cellulose tape (Fig.3.).

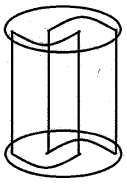

Fig.2. Savonius wind turbine

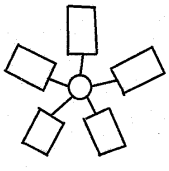

Fig.3. Horizontal-axis wind turbine

Second, I attached these wind turbines to an electric generator. The electric generator consisted of a long shaft and a motor (XGM-RA). Each wind turbine was attached to the shaft and this was rotated by the wind created by a dryer (Panasonic EH-NA92). This dryer had three speed modes so I used it three times for each mode.

Third, the power generated by this electric generator was detected by a tester (SANWA PM3) and a resistance (10Ω). At the same time, I measured the wind speed by a wind speed detector (CUSTOM CW-10). I would find the correlation between the wind speed and the generated power.

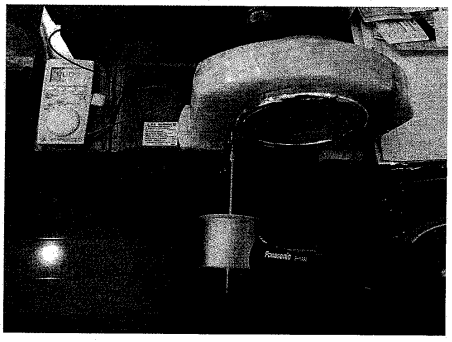

Fig.4. rotating Savonius turbine 2010/12/12

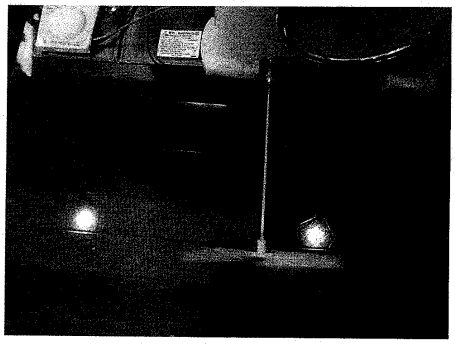

Fig.5. rotating horizontal-axis turbine 2010/12/12

Results

wind speed[m/s](cubed)	Drag-type turbine power[mW]	Lift-type turbine power[mW]
17(4913)	1.75	2.13
15(3375)	1.06	1.46
9.4(830)	0	0.0807

The results were shown in the table above. I calculated the generated power using Joule's laws ($P = \frac{V^2}{R}$; when V is detected voltage and R is resistance (10Ω), P is generated power.). The drag-type turbine did not move when I used the slow wind (9.4m/s), so I put 0 in the cell.

I plotted two graphs. One used wind speed (m/s) and generated power to show the results (Fig.6.). The other used cubed wind speed (m^3/s^3) and generated power to clarify the correlation between the two (Fig.7.).

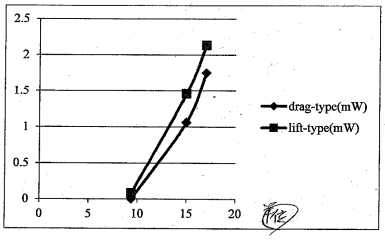

Fig.6. wind speed and generated power

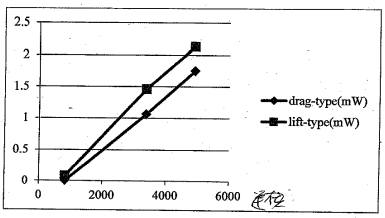

Fig.7. cubed wind speed and generated power

Discussion

Fig.7. shows that the lift-type turbine is superior to the drag-type one with any wind speed, but the difference is slight. The turbines have the blades with the same sum of areas (2x5x5=5x5x2), so it can be stated that lift-type one is superior to drag-type one when they have blades with the same size and that lift-type one is more efficient when the same cost is spent. However, the difference is so slight that this superiority might easily be reversed by the more optimization.

Theoretically, the wind has kinetic energy in proportion to the cubed wind speed. The kinetic energy is calculated by the sum of the kinetic energy of the gas molecule. If all molecules have the same speed equal to the wind speed, the kinetic energy can be calculated as follows.

$$E = \frac{1}{2}Mv^2$$

(M is the sum of all the masses of molecules, and v is the wind speed)

When the wind blows across the area A, the masses of molecules which strike A is calculated as follows.

$$M = \rho Av\Delta t$$

(ρ is the density of the air, and Δt is the timespan)

Therefore, the kinetic energy is proportional to the cubed wind speed as follows.

$$E = \frac{1}{2}\rho Av^3\Delta t$$

Fig.7. actually shows that the generated power is almost linearly dependent on the cubed wind speed, while Fig.6. shows that the generated power is not proportional to the original wind speed.

On the other hand, the generated power is almost (or exactly) zero when the wind speed is low. This can easily be explained supposing that the wind turbine begins to rotate at a certain wind speed (a threshold). This hypothesis is consistent with the theory. As for the lift-type turbine, the lift force will not appear when the rotation speed is not enough because the relative velocity of wind cannot be parallel to the wind (see Fig.1.). Therefore, the positive feedback which accelerates the blades will not occur and the generated power will be almost zero. On the other hand, as for the drag-type turbine, especially the Savonius turbine, there is a moment when the wind does not give work to the blades (see Fig.8.). Therefore, constant rotation requires enough wind speed to move the blades by inertia when the wind does not give work and the generated power will be zero when the blades cannot rotate constantly.

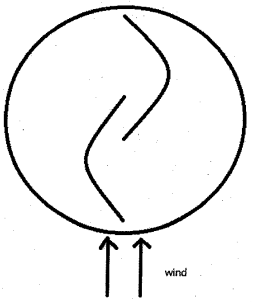

Fig.8. problem of Savonius turbine

Conclusion

Lift-type turbines are the most popular in the world, but it is not known which are more efficient, lift-type turbines or drag-type turbines. Through the experiment, the hypothesis that lift-type turbines are more efficient than drag-type ones has been proved, but the difference between the two is slight. Further research has to be done to detect the clear superiority. In addition, the theory of the kinetic energy of the wind has also been observed in the research. This conclusion will contribute to making another wind turbine to make electricity at home.

References

1. Kosaku T. et al; "Optimum pitch control for variable-pitch vertical-axis wind turbines by a single stage model on the momentum theory," Systems, Man and

Cybernetics, 2002 IEEE International Conference on , vol.5, no., pp. 6 pp. vol.5, 6-9 Oct. 2002

2. G. James et al. "Design and resource requirements for successful wing energy production on Mars", ETM Inc/NASA Jonson Space Center/Barrios Technology, 1999

3. Kazunori CHIDA et al, "Relation Between Design Specification and Student's Products in Trial and Error Engineering Experiments Based on Design of Blade for Wind Turbine," Journal of JSEE, 56, 5, 5_103-5_110, 2008

Efficiency of Wind Turbines

Abstract

Renewable energy is required emergently due to Fukushima nuclear accident and wind energy is the most promising energy of all the renewable energy. However, there is no record of the experiment about efficiency of wind turbines. I made two types of wind turbines and measured the correlation between the wind speed and the generated power using these two turbines. Through the experiment, I found that lift-type turbines are more efficient than drag-type ones and also found a mathematical correlation between the wind speed and the generated power. Although further research is needed, this conclusion will contribute to making electricity at home.

In addition, students in Kushiro National College of Technology did research to make a better wind turbine (Chida et al., 2008). Students had done trials and errors to improve their own hand-made wind turbine and they finally got results of their analysis. Although the purpose of their research is to improve students' problem-solving abilities, their research can be regarded as research similar to my research. There is no information about the specific results (such as figures of performance), but there are many indications of results of my research. Chida et al. have mentioned that the superiority of lift-type turbines was limited but that it was easier to get the better results by using lift-type turbines than by using drag-type ones. Therefore, it is necessary to check this superiority with detailed and clear results.

Method

To test the correlation between the wind speed and generated power, I did research using wind turbines. First, I made two wind turbines – a Savonius vertical-axis wind turbine (drag-type) and a horizontal-axis wind turbine (lift-type). The former was made of plastic board. Plastic board (0.3 mm thickness) was cut into two circles (radius 3cm) and two rectangular blades (5x5cm). These components were attached with cellulose tape as Fig.2. On the other hand, the latter was made of plastic board and plastic flames. Plastic board was cut into five rectangular blades (2x5cm) and these blades were bent at an angle of 10 degrees. These blades and plastic flames (taken from other wind turbines) were attached with cellulose tape as Fig.3.

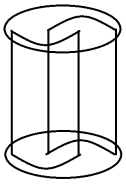

Fig.2. Savonius wind turbine

Background

There is no record of the detailed experiment, but Kosaku, Sano and Nakatani (2002) have indicated that lift-type turbines theoretically have higher performance than drag type ones. James, Chamitoff and Barker (1999) have also mentioned this theory. Drag-type turbines only use pushing force of the wind, so the speed of their blades cannot exceed the wind speed. On the other hand, lift-type turbines use fluid mechanics (Bernoulli's theorem) to create rotation energy, so the speed of their blades can exceed the wind speed. It is possible to derive the wind power of more energy by using fluid mechanics. Therefore, lift-type turbines are more powerful than drag-type ones.

In fluid mechanics, it is known that the pressure of fluid decreases when the flow speed of fluid increases (Bernoulli's theorem). Therefore, when the wind speed above the wind blade exceeds the speed below it, there appears force to lift the blade, and this force is called "lift". The blade is formed ideally in order to create powerful force. As for wind turbines, the lift appears perpendicular to the relative velocity of wind and the vertical component of "lift" drives the blade to rotate continuously (see Fig.1.).

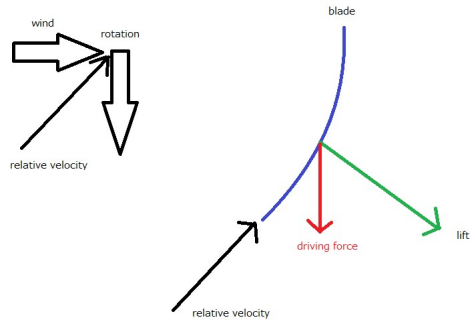

Fig.1. Mechanism of lift

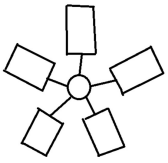

Fig.3. Horizontal-axis wind turbine

Second, I attached these wind turbines to an electric generator. The electric generator consisted of a long shaft and a motor (XGM-RA). Each wind turbine was attached to the shaft and this turbine was rotated by the wind created by a dryer (Panasonic EH-NA92). The distance between the turbine and the dryer was kept 10cm. This dryer had three speed modes so I changed its speed mode each time.

Third, the power generated by this electric generator was detected by a tester (SANWA PM3) and a resistance (10Ω). At the same time, I measured the wind speed by a wind speed detector (CUSTOM CW-10). I would find the correlation between the wind speed and the generated power.

Fig.4. Rotating Savonius turbine (December 12, 2011)

Fig.5. Rotating horizontal-axis turbine (December 12, 2011)

Results

wind speed [m/s](cubed [m^3/s^3])	Drag-type turbine power [mW]	Lift-type turbine power [mW]
17(4913)	1.75	2.13
15(3375)	1.06	1.46
9.4(830)	0	0.0807

Table 1. Wind speed and generated power

The results were shown in Table 1. I calculated the generated power using Joule's laws ($P = \frac{V^2}{R}$; when V is detected voltage and R is resistance (10 Ω), P is generated power.). The drag-type turbine did not move when I used the slow wind (9.4m/s), so I put 0 in the cell.

I plotted two graphs. One used wind speed (m/s) and generated power to show the results (Fig.6.). The other used cubed wind speed (m^3/s^3) and generated power to clarify the correlation between the two (Fig.7.).

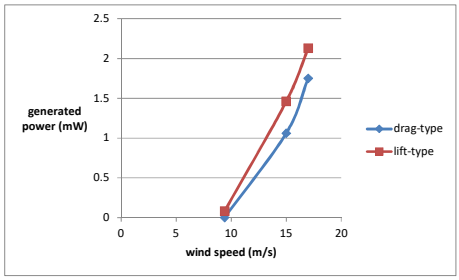

Fig.6. Wind speed and generated power

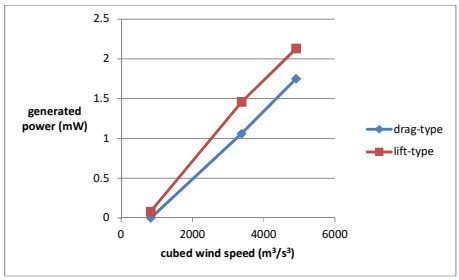

Fig.7. Cubed wind speed and generated power

Discussion

Fig.6. shows that the lift-type turbine is superior to the drag-type one with any wind speed, but the difference is slight. The turbines have the blades with the same sum of areas (2x5x5=5x5x2), so it can be stated that lift-type one is superior to drag-type one when they have blades with the same size and that lift-type one is more efficient when the same amount of plastic is used as material. However, the difference is so slight that this superiority must be observed in further research. The graph shows that the generated power grows rapidly according to the wind speed, so the superiority might clearly be checked by an experiment with faster wind and larger wind turbines.

Theoretically, the wind has kinetic energy in proportion to the cubed wind speed. The kinetic energy is calculated by the sum of the kinetic energy of the gas molecule. If all molecules have the same speed equal to the wind speed, the kinetic energy can be calculated as follows.

$$E = \frac{1}{2}Mv^2$$

(M is the sum of all the masses of molecules, and v is the wind speed)

When the wind blows across the area A, the masses of molecules which strike A is calculated as follows.

$$M = \rho A v \Delta t$$

(ρ is the density of the air, and Δt is the timespan)

Therefore, the kinetic energy is proportional to the cubed wind speed as follows.

$$E = \frac{1}{2}\rho A v^3 \Delta t$$

Fig.7. actually shows that the generated power is almost linearly dependent on the cubed wind speed, while Fig.6. shows that the generated power is not proportional to the original wind speed.

On the other hand, the generated power is almost (or exactly) zero when the wind speed is low. This can easily be explained supposing that the wind turbine begins to rotate at a certain wind speed (a threshold). This hypothesis is consistent with the following theory. As for the lift-type turbine, the lift force will not appear when the rotation speed is not enough because the relative velocity of wind cannot be parallel to the wind (see Fig.1.). Therefore, the positive feedback which accelerates the blades will not occur and the generated power will be almost zero. On the other hand, as for the drag-type turbine, especially the Savonius turbine, there is a moment when the wind does not give work to the blades (see Fig.8.). Therefore, constant rotation requires enough wind speed to move the blades by inertia when the wind does not give work and the generated power will be zero when the blades cannot rotate constantly.

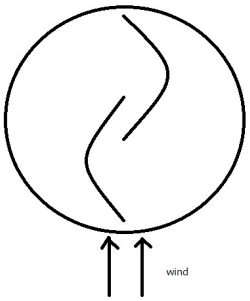

Fig.8. Problem of Savonius turbine

Conclusion

Lift-type turbines are the most popular in the world, but it is not known which are more efficient, lift-type turbines or drag-type turbines. Through the experiment, the hypothesis that lift-type turbines are more efficient than drag-type ones has been proved, but the difference between the two is slight. Further research has to be done to detect the clear superiority. In addition, the theory of the kinetic energy of the wind has also been observed in the research, but more samples are needed to check this correlation because the number of plotted points in my research is too small. This conclusion will contribute to making another wind turbine to make electricity at home.

References

Kosaku, T., Sano, M., & Nakatani, K. (2002). Optimum pitch control for variable-pitch vertical-axis wind turbines by a single stage model on the momentum theory. *Systems,*

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The Effect of Surface Roughness on Bonding Strength of Double-sided Tape.

Although it is known that bonding strength of adhesives depends on surface roughness, the effect of surface roughness on bonding strength of double-sided tape has not been clarified. In order to examine the effect, experiments on tensile, shear, and peel strength were conducted with sandpaper and double-sided tape. The results showed that adhesion became stronger as the surface of sandpaper became finer within #180-#800. Further research is needed to expand this result, which may be applied to better use and development of double-sided tape.

Keywords: Bonding strength, surface roughness, double-sided tape

Introduction

It has been pointed out that bonding strength of adhesives is influenced by surface finish, according to Jennings (as cited in Uehara & Sakurai, 2002, p. 178). Seeking the optimum value of surface roughness, Uehara and Sakurai (2002) conducted three kinds of experiments: tensile, shear, and peel test. In those experiments, they tested the effect of surface roughness on bonding strength. The results showed that optimum surface roughness exists with particular adhesives. Uehara and Sakurai (2002) argued that the difference of the roughness dependency could be attributed to a combination of three factors: the adhesion theory by Nihon Secchaku Kyokai (1986), the area effect and notch effect suggested by Ikegami (as cited in Uehara & Sakurai, 2002, p. 180).

In the experiments by Uehara and Sakurai (2002), five types of adhesives were tested. However, their experiment has no information about double-sided tape. Although the adhesion theory (Nihon Secchaku Kyokai, 1986) shows a theoretical value of bonding strength, the theory may be inapplicable to double-sided tape.

Since double-sided tape consists of a carrier material (nonwoven fabric) between adhesive layers, the present study hypothesized that bonding strength of double-sided tape is influenced by surface roughness. If the influence exists, it can be confirmed that both adhesives and double-sided tape have dependence on surface roughness. This study tested the tensile, shear, and peel strength of two joined objects that are covered with different roughnesses of sandpapers and adhered with double-sided tape.

Method

In order to verify that bonding strength of double-sided tape depends on surface roughness, three experiments were conducted in this research: (1) an experiment on tensile strength, (2) an experiment on shear strength, and (3) an experiment on peel strength. Surface roughness of specimens was controlled by using sandpapers. They had different roughnesses of #180, #400 and #800 according

to JIS, which is the Japanese standard.

In each experiment, two objects covered with sandpaper were joined with a piece of double-sided tape, which was five millimeters square. Then increasing force measured with a spring scale was applied to the objects (Figure 1) until they peeled off. The way force was applied to each specimen was as follows:

(1)Tensile strength test. In this test, the force perpendicular to the bonded surface was applied (Figure 2).

(2)Shear strength test. In this test, the force parallel to the bonded surface was applied (Figure 3).

(3)Peel strength test. In this test, the force perpendicular to the bonded surface was applied from an edge (Figure 4).

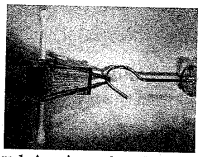

Figure 1. A spring scale and a specimen.

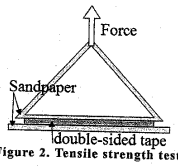

Figure 2. Tensile strength test.

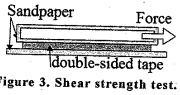

Figure 3. Shear strength test.

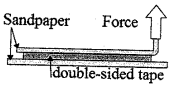

Figure 4. Peel strength test.

The double-sided tape used in these experiments consists of nonwoven fabric and acrylic adhesives. The tests were repeated three times for each experiment, and the mean value of strength was calculated.

Results

Figure 5 shows the relationship between tensile strength and surface roughness. The error bar stands for standard deviation. The clearest increase in strength was observed.

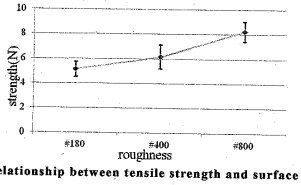

Figure 5. Relationship between tensile strength and surface roughness.

Figure 6 shows the relationship between shear strength and surface roughness. An increase in strength was observed.

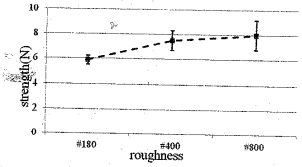

Figure 6. Relationship between shear strength and surface roughness.

Figure 7 shows the relationship between peel strength and surface roughness. An increase in strength was observed.

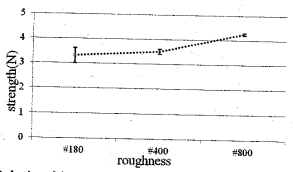

Figure 7. Relationship between peel strength and surface roughness.

On the whole, adhesion became stronger as its surface became finer. Comparing the three types of tests, peel strength was weaker than tensile and shear strength in respective roughness.

During the experiments, detaching of acrylic adhesives from nonwoven fabric was not observed on the double-sided tape. Tearing of specimen was also not observed.

Discussion

As expected, the results indicate that tensile, shear, and peel strength depend on surface roughness. Adhesion of double-sided tape seems to become stronger as the surface becomes finer within #180-#800. The results also indicate that peel strength is weaker than tensile and shear strength. These results may be explained by simplifying the surface of sandpaper.

Figure 8 is a low-dimensional model of the surface of sandpaper. Assuming that the surface of sandpaper is as shown in Figure 8, width and height of projections on surface are represented by x. Width of hollows are also represented by x. Based on this model, it is calculated that surface roughness (Ra) of #180-#800 sandpapers used in this study is larger than 15μm.

Figure 8. Simplified model of the surface of sandpaper.

The results cannot be compared with the results of previous research by Uehara and Sakurai (2002) that used adhesives, because Ra was smaller than 16 μm in their research. However, the results in this paper seem to follow the schematic illustration of bonding strength by Uehara and Sakurai (2002), in which three factors are combined: the adhesion theory by Nihon Secchaku Kyokai (1986), area effect and notch effect by Ikegami (as cited in Uehara & Sakurai, 2002, p. 180). In the schematic illustration, they expected that adhesion would become stronger as the surface becomes finer in the range of relatively large roughness.

Although Uehara and Sakurai (2002) explained the general reason why bonding strength depends on surface roughness, there seem to be another reason peculiar to double-sided tape. Figure 9 and Figure 10 is the models of finer surface and rougher surface. These figures describe only one side of double-sided tape. When bonding finer surfaces, it is likely that the acrylic adhesive of double-sided tape reaches bottoms of hollows since x is smaller (i.e. hollows are shallower) on finer surface. When bonding rougher surfaces, however, it is less likely that the acrylic adhesive reaches bottoms of hollows since x is larger (i.e.

hollows are deeper) on rougher surface. This tendency is probably more notable with double-side tape than with adhesives, since the adhesive on double-sided tape is not liquid and has high viscosity in order not to separate from the nonwoven fabric. In this way, rougher surfaces have smaller bonding plane, resulting in weaker adhesion. That may be the reason why adhesion became stronger when the surface became finer, especially with double-sided tape. If this explanation is true, it is expected that adhesion of double-sided tape using adhesive with lower viscosity is stronger. Further research is needed to confirm this explanation.

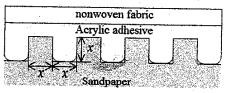

Figure 9. Finer surface.

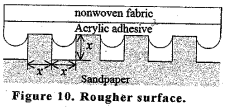

Figure 10. Rougher surface.

Figures 11-13 illustrate the force applied in each experiment. In the peel strength test, the force is concentrated on one side compared with the other tests since peel force was applied from an edge. That may be the reason why peel strength was weaker than tensile and shear strength.

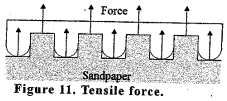

Figure 11. Tensile force.

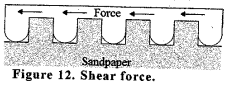

Figure 12. Shear force.

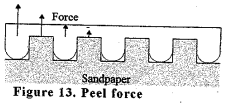

Figure 13. Peel force

The results of this study may be limited by the fact that small numbers of experiments were conducted with only one kind of double-sided tape, within narrow range of roughness. Further research needs to be conducted to test the dependence of bonding strength on wider range of roughness, using various kinds of double-sided tapes. That kind of research may contribute to better use and development of double-sided tape.

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Method

In order to verify that bonding strength of double-sided tape depends on surface roughness, three experiments were conducted in this research: (1) an experiment on tensile strength, (2) an experiment on shear strength, and (3) an experiment on peel strength. Surface roughness of specimens was controlled by using sandpapers. They had different roughnesses of #180, #400 and #800 according

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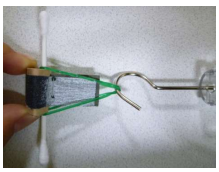
In each experiment, two objects covered with sandpaper were joined with a piece of double-sided tape, which was five millimeters square. Then increasing force measured with a spring scale was applied to the objects (Figure 1) until they peeled off. The way force was applied to each specimen was as follows:

(1)Tensile strength test. In this test, the force perpendicular to the bonded surface was applied (Figure 2).
(2)Shear strength test. In this test, the force parallel to the bonded surface was applied (Figure 3).
(3)Peel strength test. In this test, the force perpendicular to the bonded surface was applied from an end (Figure 4).

The double-sided tape used in these experiments consisted of nonwoven fabric and acrylic adhesives. The tests were repeated three times for each experiment, and the mean value of strength was calculated.



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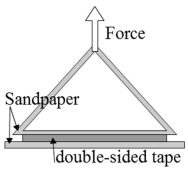


Figure 2. Tensile strength test.

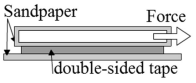


Figure 3. Shear strength test.

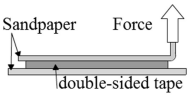


Figure 4. Peel strength test.

Results

Figure 5 shows the relationship between tensile strength and surface roughness. The length of error bar stands for standard deviation. The largest increase in strength was observed as the surface became finer from #180 to #800.

Figure 6 shows the relationship between shear strength and surface roughness. An increase in strength was observed.

Figure 7 shows the relationship between peel strength and surface roughness. An increase in strength was observed.

On the whole, adhesion became stronger as its surface became finer. Comparing the three types of tests, peel strength was weaker than tensile and shear strength in respective roughness.

During the experiments, detaching of acrylic adhesives from nonwoven fabric was not observed on the double-sided tape. Tearing of specimen was also not observed.

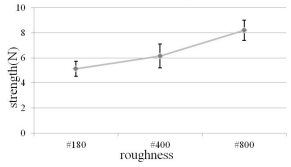


Figure 5. Relationship between tensile strength and surface roughness.

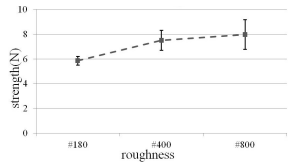


Figure 6. Relationship between shear strength and surface roughness.

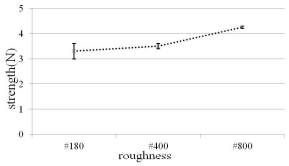


Figure 7. Relationship between peel strength and surface roughness.

Discussion

The results showed that adhesion of double-sided tape became stronger as the surface became finer within #180-#800. This supports the hypothesis that tensile, shear, and peel strength depend on surface roughness. The results also showed that peel strength was weaker than tensile and shear strength. These results may be explained by simplifying the surface of sandpaper.

Figure 8 is a low-dimensional model of the surface of sandpaper. Assuming that the surface of sandpaper is as shown in Figure 8, width and height of projections on the surface are represented by *x*. Width of hollows are also represented by *x*. Based on this model, it is calculated that surface roughness (Ra) of #180-#800 sandpapers used in this study is larger than 15μm.

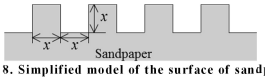


Figure 8. Simplified model of the surface of sandpaper.

The results cannot be compared with the results of previous research by Uehara and Sakurai (2002), which used adhesives, because surface roughness (Ra) was smaller than 16 μm in their research. However, the results in this paper seem to follow the schematic illustration of bonding strength by Uehara and Sakurai (2002), in which three factors are combined: the adhesion theory by Nihon Secchaku Kyokai (1986), the area effect and notch effect by Ikegami (as cited in Uehara & Sakurai, 2002, p. 180). In the schematic illustration, they expected that adhesion would become stronger as the surface becomes finer in the range of relatively large roughness.

Although Uehara and Sakurai (2002) explained the general reason why bonding strength depends on surface roughness, there seems to be another reason peculiar to double-sided tape. Figure 9 and Figure 10 present the models of finer surface and rougher surface. These figures describe only one side of double-sided tape. When bonding finer surfaces, it is likely that the acrylic adhesive of double-sided tape reaches bottoms of the hollows since *x* is smaller (i.e. hollows are shallower) on finer surface. When bonding rougher surfaces, however, it is less likely that the acrylic adhesive reaches bottoms of the hollows since *x* is larger (i.e. hollows are deeper) on rougher surface. This tendency is probably more notable in double-side tape than in adhesives, since the adhesive on double-sided tape is not liquid and has high viscosity in order not to separate from the nonwoven fabric. In this way, rougher surfaces have smaller bonding plane, resulting in weaker adhesion. That may be the reason why adhesion became stronger when the surface became finer, especially with double-sided tape. If this explanation is true, it is expected that adhesion of double-sided tape using adhesive with lower viscosity is stronger. Further research is needed to confirm this explanation.

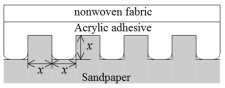


Figure 9. Finer surface.

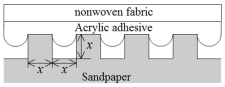


Figure 10. Rougher surface.

Figures 11-13 illustrate the distribution of force applied in each experiment. In the peel strength test, the force is concentrated on one side compared with the other tests since peel force was applied from an end. That may be the reason why peel strength was weaker than tensile and shear strength.

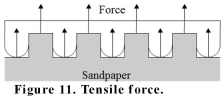


Figure 11. Tensile force.

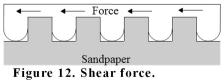


Figure 12. Shear force.

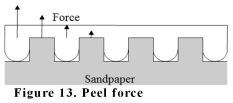


Figure 13. Peel force

The results of this study may be limited by the fact that small numbers of experiments were conducted with only one kind of double-sided tape, within narrow range of roughness. Further research needs to be conducted to test the dependence of bonding strength on wider range of roughness, using various kinds of double-sided tapes. That kind of research may contribute to better use and development of double-sided tape.

References

Uehara, K., & Sakurai, M. (2002). Bonding strength of adhesives and surface roughness of joined parts. *Journal of Material Processing Technology, 127,* 178-181.

Nihon Secchaku Kyokai, (1986). *Secchaku Handbook [Adhesion Handbook]* (2nd ed.). Japan: Nikkan Kogyo Shinbun.

Shape and air resistance

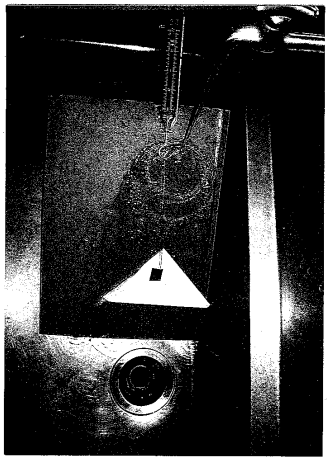
Introduction

The shape of objects is important to decide how much they are influenced by air resistance. The shape of bullet trains and that of airplanes are determined after wind-tunnel tests to decrease air resistance [1]. The vehicle which is less influenced by air resistance needs less energy. Therefore, it is necessary to research what shape is least influenced by air resistance. In the experiment which I conducted, only triangle was researched and objects which have other shape were not included, but this experiment provides some information to know what shape is least influenced by air resistance. I hypothesized that sharp triangle was least influenced by air resistance because bullet trains have sharp front shape. Bullet trains must have shape which is little influenced by air resistance. Ogawa, S. and I conducted an experiment to determine what shape of triangle is least influenced by air resistance by changing the height and fixing the base of triangle.

Method

In order to investigate what shape is least influenced by air resistance, we used three kinds of triangle (to simplify the experiment, only triangle was researched). The shape of triangles were as follows: The base was all the same and the vertical angle was

120° , 90° , and 60° . We put one triangle on a slope whose angle of inclination was about 20° and kept pouring water from the top of the slope caring that the vertical angle faced exactly to pouring water. The speed of flow of water was fixed and a triangle was connected to a spring balance. We knew the pressure of water from the value of it. Subsequently, we mixed a little colored water with a syringe and observed the speed and the way water flowed by paying attention to it. After the flow of water hitting against three kinds of triangle was observed, we regarded the flow of water as the flow of air. Finally, we considered what shape of object was least influenced by air resistance and its reason.



Results

When we measured the pressure of water, a spring balance showed the biggest value when the vertical angle was 120° and the smallest when it was 90° (Table 1). It follows that the triangle whose vertical angle is 120° is most influenced and 90° is least influenced of the three by air resistance. The way of flow of water is shown in Figure 1. It shows that the water hit against the line is least flowed on it when the triangle's vertical angle is 120° and most when it is 90° .

Table 1: Measured values

vertical angle	only object	object+water	only water
120°	0.84N	1.76N	0.92N
90°	0.96N	1.62N	0.66N
60°	1.14N	1.98N	0.84N

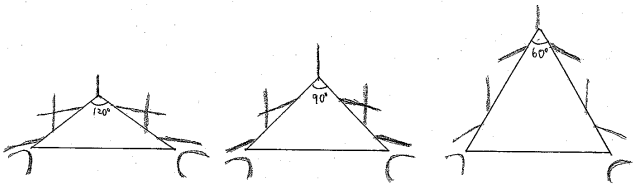


Figure 1: Flow of water

Discussion

The result of this experiment indicates that sharp objects are not necessarily least influenced by air resistance. If the length of a base is the same of all triangles, the length of line influenced by air resistance is different according to its vertical angle. As the angle is bigger, so the length of line influenced by it is shorter. However, if the vertical angle is big, triangle is more directly influenced by air because it is similar to being exposed to air from the front. Therefore, it became clear that the balance of these was important to decide the shape of object least influenced by air resistance, but more detailed experiment is needed to determine it.

The reason why bullet trains have sharp front shape is not only to decrease air resistance, but also the noise which happen when they enter a tunnel [2]. Consequently, it does not follow that bullet trains' shape is least influenced by air resistance.

References

[1] Komine, T. (2006). *Yokuwakaru saisin ryuutaikougaku no kiso* [The basis of Fluid Engineering]. Tokyo: Syuuwa system.

[2] Ozawa, S. (2002). Aerodynamic problems of high-speed trains. *Nagare Dai21kan. 346-353.*

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Introduction

In the place where people live, if doors or windows are closed, the air current gets worse. So in such place, ventilation becomes to be necessary. By doing this, people living there can feel comfortable.

However, it is not known how the ventilation has an effect on the condition of room, for example, on temperature or humidity. Then, this experiment is necessary.

The aim of this research is to observe the way temperature and humidity change with ventilation, and find the effect of this routine work.

It is generally known that ventilation is supplying with the fresh air, and it is good for elimination or prevention of dissemination of noxious gases or pathogen, dilution of stink, and emission of humidity and heat. In fact, for example, S. Murakami et. al. (1987) showed that as the effect of ventilation, they got a decline of sensible temperature was gotten to some extent .

It is also known that when two different systems (for example, pressure, temperature, volume) contact, an exchange of heat is done, and they are close to "thermal equilibrium state." It is the condition that they are balanced thermally, and they do not change. In this case, the outside system is much larger than that in the room.

So the hypothesis of this research that thermal equilibrium state is close to the state of outside, and it means that system in the room will be close to that of outside.

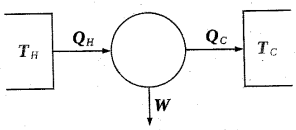

Fig1: The exchanging of heat

(From: http://en.wikipedia.org/wiki/Thermodynamic_equilibrium)

Abstract

Ventilation is known to be good for supplying for the fresh air, emission gases and heat, and so on. The research of the real effect of it is necessary. This research was aimed at observing the way temperature and humidity in the room changed with ventilation, and finding the effect of ventilation on temperature and humidity.

In this experiment, a multifunctional environmental instrument was used to measure temperature and humidity in the room while ventilation being done by opening the window every ten minutes six times. And graphs which show the way parameters change were made.

As a result, temperature became lower than before ventilation was and often lower than that of outside. On the other hand, humidity became higher than before ventilation was done and the way it changed was unstable.

This result suggests that temperature and humidity are close to that of outside. And considering the result, it can be concluded that the lower outside humidity is, the faster temperature changes.

In order to improve the conclusion, further research will be needed.

Keywords: ventilation, temperature, humidity

References

Yosuke Iida

[1]Murakami, S. [村上周三], Kobayashi, N. [小林信介], Kato, S. [加藤信行], Akabayashi, S. [赤林伸一] (1987). Experimental study on natural ventilation of dwellings (part1): Field experiment with full-scale house model and wind tunnel experiment with 1/40 model [住宅の自然通風に関する実験的研究 (その1) : 実測と風洞模型実験による天窓の通風効果を中心にして]. In *Nihonkenchikugakkai keikakukeironbun houkokusyu*[日本建築学会計画系論文報告集]. Retrieved December 13, 2011, from http://ci.nii.ac.jp/naid/110004072129/

[2]Miyake, S. [三宅哲] (1989). *Netsurikigaku*[熱力学](21th ed). Tokyo: Syokabo[裳華房].

[3]Thermodynamic equilibrium－Wikipedia, the free encyclopedia(n.d.). Retrieved December 15, 2011, from http://en.wikipedia.org/wiki/Thermodynamic_equilibrium

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S14's Pre-session Paper

The affects of twisting and widening: strengthened fibers

Introduction

Many people seem to know based on their experiences that fibrous materials such as tissues increase their strength when they are twisted. The main reason is that when fibrous materials are twisted, their density rise, which creates frictions among fibers which are touching. Typically disintegration of the fiber occurs stepwise; the point which receives the largest burden in the fiber breaks and as the strain becomes larger, broken portion of the fiber increases. However, when the frictional force is large enough, one area of fiber prevents ~~other~~ part of area which is around, from breaking. So disintegration occurs simultaneously, which requires a large force to tear. This theory is applied when yarn is spun. Fragile threads such as silkworm silk are bundled and twisted to become a strong yarn [1][2].

Therefore, it appears to be ~~collect~~ that the twisted fabrics such as ropes and yarns bring many benefits to people's lives. ~~And~~ many organizations have been making much effort to improve their twisted fiber products in terms of strength or hand feelings. Consequently, when focused on commonplace fiber, it is important to measure the relation between the number of twist and change in the strength of the fiber. Generally, as the number of twist rises, ~~the~~ higher density of fiber becomes and stronger friction becomes. But all materials have their own limit such as tensile strength. Tensile strength is the maximum amount of tensile stress that it can be subjected to before failure. [3]. Therefore, probably to a certain number of twists, the more tissues twisted, the stronger it becomes. ~~As one expectation,~~ the relation between the number of twists and the strength of tissue may show a linear function approximation. However when the number is too many, the tissue of the fiber may begin to collapse, ~~And~~ the strength may decrease.

Methods

The tissues used in this experiment were "High Quality Soft Tissues" (produced by Crecia japan Ltd). I prepared pieces of tissues with several types of width (0.5cm, 1.0cm, 1.5cm, 2.0cm), and the length was more than 4.0cm. Generally, the fibers of tissues have a certain direction that is easy to tear. In this experiment, the pieces of tissues were cut off to make the length to be along the direction. Humidity in the room was kept at 40% during this experiment. As scale weights, a lot of pebbles were used. Experimental procedure is shown below. Firstly, the tissue's width was folded and its edge except for the central 2.0 cm in length was fixed by glue. Secondly the central part that was not fixed was twisted several times rotations. During this process, the length that was not fixed by glue was kept 2.0cm. Afterwards the part that was twisted was also fixed by glue except for the central 1.0cm in length. This was done in order to prevent the boundary point between twisted area and the area that was fixed for the first time, from breaking earlier than twisted area. Subsequently the fixed area was attached to a stand by a scotch tape. After the experimental preparation was completed, pressure was applied to twisted area that was not fixed by glue in an area with 1 mm width by dangling the weights. As weights, pebbles were added one by one every 4seconds until the tissue was torn. The weights of the pebbles in this experiment were between 4g and 10g. I examined maximum pressure each tissue could withstand. The number of rotation was set to (0times/cm, 1times/cm, 2times/cm, 3times/cm 4times/cm), and the width had 4 previously mentioned patterns. Therefore 20 patterns were obtained. Each pattern was examined two times and the experimental result was defined as the average of the two results.

In this study I investigated the relations between the weight the twisted tissue can tolerate and the number of twist, and the relations between the width of the tissue and the weight.

Results

Experiments were carried out without any critical problem, and the maximum pressures each pattern could tolerate were recorded and are shown in Table 1. Overall Figure 1 shows that there were significant margins between results of 2times/cm and that of 3times/cm. Furthermore, wider tissue could tolerate heavier weight. In other points, looking at the two adjacent widths, according to Figure 3, the wider tissues were, the slightly heavier the margin of maximum pressures became. From another perspective, as the number of twists increases, the twisted tissue could support heavier pressure. The trend that more number of twists made the tissue stronger remained the same during this experiment. For consideration, I performed the same examination at ~~the~~ 15times/cm of twists. The results were 355g(0.5cm), 800g(1.0cm), 1550g(1.5cm). Results of 2.0cm were not able to be measured because the point that was fixed by glue broke before the twisted point.

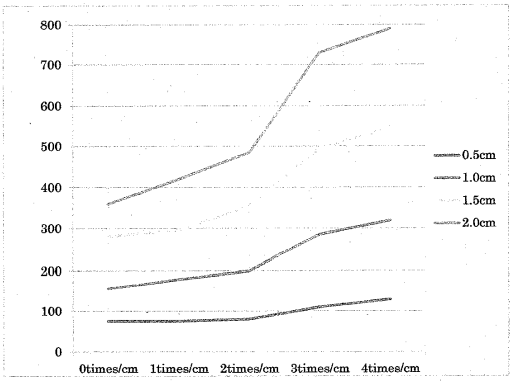

Figure 1: The relations between maximum pressures[g] and number of twists

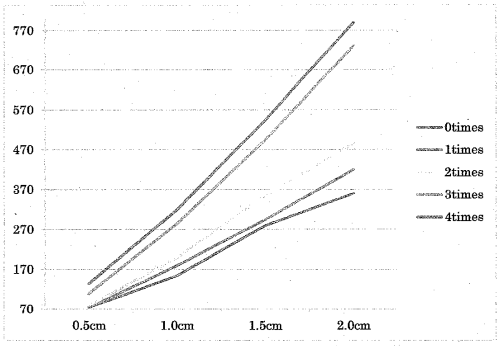

Figure 2: The relations between maximum pressures[g] and widths

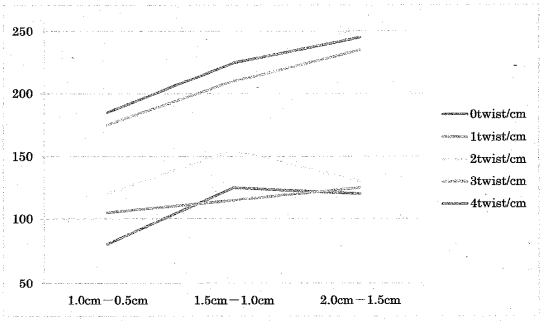

Figure 3: The margin of maximum pressures[g]

Conclusion

As is shown in Figure 1, significant margins between results of 2times/cm and that of 3times/cm exist. This suggests that the frictional force begins to soar between 2times/cm and 3times/cm. Generally, when fibrous materials are subjected the burden that is large enough, the deflection of fibers arise that is not reversible, and the fibers becomes weaker. This was also the case with tissues; when the tissues were twisted, many folds and deflections that were not able to remove arouse. This must have made the tissues weaker. However, when the results of this experiment are considered, this effect seems much smaller than the increase in frictional force unless the number of twists is extremely large.

In addition, as mentioned previously, the rate of increase in the maximum pressure associated with widening the tissue became slightly higher when the original width was wilder. This suggests that the relationship between width and its maximum pressure is like a curved line function, and I think the maximum pressure may be able to be approximated to the equation of the width. The frictional force of one area would become higher when the area gets more distance from the surface, and at the surface of a twisted tissue the frictional force may not work to the fiber. When the tissue's width is defined as [a (cm)]. The radius of the twisted tissue would be approximated as [$\beta\sqrt{a}$](β is a fixed number). When the distance from the center of the cross section of twisted tissue to one area is defined as [x(cm)], the frictional force may be approximated as [$\alpha(\beta\sqrt{a}-x)$] (α is a fixed number). Then if f(x) is defined as [$2\pi \times \alpha(\beta\sqrt{a}-x)$], the amount of frictional force would be

$$\int f(x)\,dx \quad (x:0\sim\beta\sqrt{a})$$

The result of this formula is $\gamma \times \sqrt{x}$ ($\gamma = 1/3\,\pi\,\alpha\,\beta^3$).

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Introduction

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Therefore, it appears to be correct that the twisted fabrics such as ropes and yarns bring many benefits to people's lives. In addition many organizations have been making much effort to improve their twisted fiber products in terms of strength or smoothness. Consequently, when focused on commonplace fiber, it is important to measure the relation between the number of twists, and change in the strength of the fiber. Generally, as the number of twist rises, the density of fiber becomes higher and friction becomes stronger. But all materials have their own limit such as tensile strength. Tensile strength is the maximum amount of tensile stress (a power that stretches something) that it can be subjected to before failure. [3]. Therefore, probably to a certain number of twists, the more tissues twisted, the stronger it becomes. This paper expects that the relation between the number of twists and the strength of tissue may show a linear function approximation. However, when the number is too many, the tissue of the fiber may begin to collapse and the strength may decrease.

Methods

The tissues used in this experiment were “High Quality Soft Tissues” (produced by Crecia japan Ltd). I prepared pieces of tissues with several types of width (0.5cm, 1.0cm, 1.5cm, 2.0cm), and the length was more than 4.0cm. Generally, the fibers of tissues have a certain direction that is easy to tear. In this experiment, the pieces of tissues were cut off to make the length to be along the direction. Humidity in the room was kept at 40% during this experiment. As scale weights, a lot of pebbles were used. Experimental procedure is shown below. Firstly, the tissue’s width was folded and its edge except for the central 2.0 cm in length was fixed by glue (pic 1). Secondly the central part that was not fixed was twisted several times rotations. During this process, the length that was not fixed by glue was kept 2.0cm. Afterwards the part that was twisted was also fixed by glue except for the central 1.0cm in length. This was done in order to prevent the boundary point between twisted area and the area that was fixed for the first time, from breaking earlier than twisted area. Subsequently the fixed area was attached to a stand by a scotch tape. After the experimental preparation was completed, pressure was applied to twisted area that was not fixed by glue in an area with 1 mm width by dangling the weights (pic 2 and pic 3). As weights, pebbles were added one by one every 4seconds until the tissue was torn. The weights of the pebbles in this experiment were between 4g and 10g. I examined maximum pressure each tissue could withstand. The number of rotation was set to (0times/cm, 1times/cm, 2times/cm, 3times/cm 4times/cm), and the width had 4 previously mentioned patterns. Therefore 20 patterns were obtained. Each pattern was examined two times and the experimental result was defined as the average of the two results.

In this study I investigated the relations between the weight the twisted tissue can tolerate and the number of twist, and the relations between the width of the tissue and the weight.

Pic 1

Pic 2

Pic 3

Results

Experiments were carried out without any critical problem, and the maximum pressures each pattern could tolerate were recorded and are shown in Table 1. Overall Figure 1 shows that there were significant margins between results of 2times/cm and that of 3times/cm. Furthermore, wider tissue could tolerate heavier weight. In other points, looking at the two adjacent widths, according to Figure 3, as the tissues become wider, the margin of maximum pressures became slightly heavier. From another perspective, as the number of twists increased, the twisted tissue could support heavier pressure. The trend that more number of twists made the tissue stronger remained the same during this experiment. For consideration, I performed the same experiment at 15times/cm of twists. The results were 355g(0.5cm), 800g(1.0cm), 1550g(1.5cm). Results of 2.0cm were not able to be measured because the point that was fixed by glue broke before the twisted point.

Twists/cm＼width	0.5cm	1.0cm	1.5cm	2.0cm
0 / cm	75	155	280	360
1 / cm	75	180	295	420
2 / cm	80	200	355	485
3 / cm	110	285	495	730
4 / cm	135	320	545	790

Table 1: The results of all pattern [g]

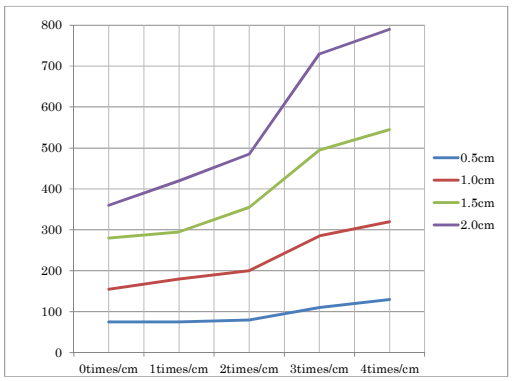


Figure 1: The relations between maximum pressures[g] and number of twists

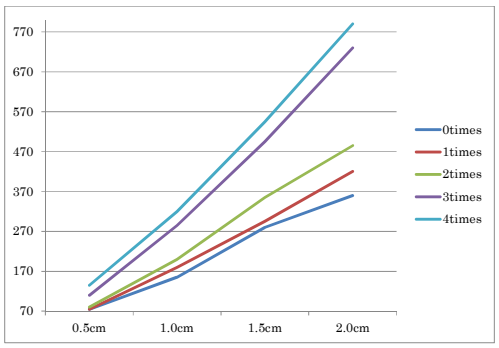


Figure 2: The relations between maximum pressures[g] and widths

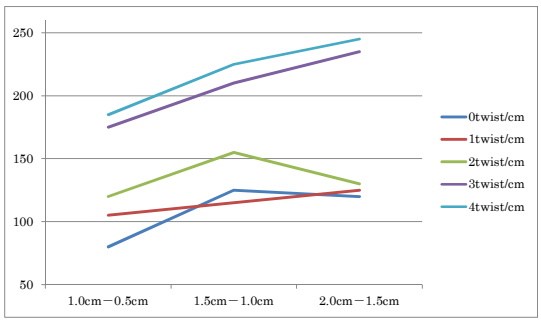


Figure 3: The margin of maximum pressures[g]

Conclusion

As is shown in Figure 1, significant margins between results of 2times/cm and that of 3times/cm exist. This suggests that the frictional force begins to soar between 2times/cm and 3times/cm. Generally, when fibrous materials are subjected the burden that is large enough, the fibers deflect not reversibly, and the fibers become weaker. This must have been also the case with tissues when they were twisted. However, when the results of this experiment are considered, this effect seems much smaller than the increase in frictional force. Indeed this would not be the case when the number of twists is extremely large.

In addition, as mentioned previously, the rate of increase in the maximum

pressure associated with widening the tissue became slightly higher when the original width was wider. This suggests that the relationship between width and its maximum pressure is like a curved line function, and the maximum pressure may be able to be approximated by calculating the equation of the width. When the number of twists is fixed at the certain number, and the tissue's width is defined as [a (cm)], the area of cross section of the twisted tissue would be in proportion to the width. Therefore the area of cross section would be approximated as[α a(cm^2)](α is a fixed number),and the surface area of the twisted tissue would be approximated as [$\beta\sqrt{}$ a(cm)] ($\beta=2\sqrt{\alpha\pi}$). I suppose that there is a constant frictional force at one area except for the surface area, and that at the surface area the frictional force does not exist. Consequently the amount of frictional force would be approximated as[γ (α a- $\beta\sqrt{}$ a)](γ is a fixed number).

Reference

[1] National Silk Twisters Association(日本撚糸工業組合連合会)the meaning of twisting/retrieved October 13 2011 http://www.nenshi.or.jp/about_nenshi.html
[2] Ning Pan 2004, On uniqueness of fibrous materials, C. WIT Press, Boston, 493-504 retrieved October 13 2011http://ningpan.net/Publications/51-100/89.pdf#search='twist fabric friction'
[3] Science Reference/the mean of Tensile strength / retrieved October 13 2011 http://www.sciencedaily.com/articles/t/tensile_strength.htm

S15's Pre-session Paper

Friction on Ice

Introduction

Many people might believe that the friction on ice is small through the experience of ice skating or slipping on the frozen road. However, few people might know what condition of ice is the most slippery. Some facts about this topic are already known. For example, according to THE MECHANISM OF FRICTION ON ICE, the coefficient of friction depends on temperature, velocity and normal load when temperature is under 0℃.(P.,Oksanen, 1982) However there was little research about how friction on ice change when the temperature reaches 0℃ or more and the ice begin to melt. Therefore this research was conducted to find. I researched how the friction between solid water and a small metal ball changes when the ice begins to melt. The hypothesis was that the friction is smallest when ice melt a little and then the friction begin to become big according to the ice melts. It has been anecdotally reported that every ice skating rink has peculiar condition of ice and figure skaters identify the difference. My research might be helpful to keep good condition of ice in ice rinks.

Method

First in order to test the hypothesis, a flat ice was made. I poured tap water into a tray (about15cm*10cm*1cm), and kept cold in freezer for 3days.

Then the following experimental device was constructed. (fig1)

The experiment was conducted as follows:

I examined how long did it take for small metal ball to go through on the solid water. The time required was timed as follows. A small metal ball was on the top of the rail (high speed), or on the bottom of the rail (low speed). The position of the ball should be constant to keep the velocity same when the ball reached the ice. I let the metal small ball go and it went on the solid water.

This experiment was done every 1 minute from just after the solid water was take out of the freezer to 20 minutes later at two different speed(High /Low), in my room (the temperature was kept 20℃ by air conditioner). A video camera was used to time. The movie which records the experiments was separated into 24 frames per second like Figure2, and the time taken for the ball to go thorough on the solid water was recorded. I did same experiment twice.

Figur1:experimental device

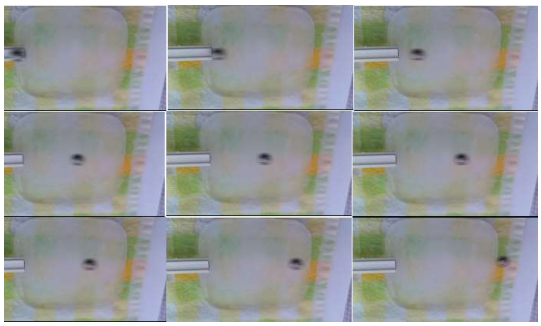


Figure2:the pictures of a trial

Results

I conducted my experiment every minute at two different speeds (high/low). Then the difference between the time at 0[min] and at each experiment was calculated from pictures like Figure2 and the average of two experiments were shown in figure 1. In addition, the standard deviation of high speed was 0.2132[/24*sec] and of low speed was 0.1994[/24*sec].

Figure3 shows that when the speed of the ball was high the ball went slower and then went faster according to melt the ice. On the other hand, when the speed of the ball was low, the ball went faster and then went slower according to the degree of ice melting. The time required was changed specifically during first 10 minutes in High speed and 5 minutes in low speed. In case of high speed it took additional 1.25/24[sec] at 3[min] compared with the time of 0[min].In case of low speed the time at 3 and 4[min] was shorter by 1.5/24[sec] than that at 0[min].The absolute value of Vertical axis at 3[min] was about 3 times as much as that during 10~19[min] in case of high speed. The absolute value of Vertical axis at 3 and 4[min] is almost twice as much as that during 5~19[min]. It seems that for first few minutes, the friction on ice depends not only on the time (horizontal axis of figure3), but also the speed of the ball. After 5 minutes in High speed and 10 minutes in Low speed, however, the value was almost fixed: -0.25/24[sec] or -0.5/24[sec] in High speed and -0.75/24[sec] or -1/24[sec] in low speed. The time required were shorter than that of 0[min] in both speeds,

but the absolute value were small compared with that of first few minutes.

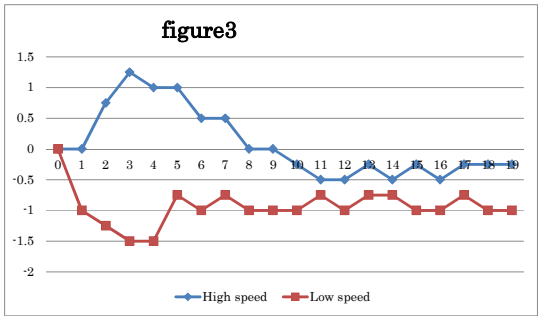


Figure3: The change of the time required to go through on the ice depends on the time when the ice left in the room.

Y label:{ (the time at each time) −(the time at 0[min])}[/24*min]: The average of the difference between the time it took at 0[min] and that at each time[min] [/24*sec]

X label: Time [min](from the time when the ice was taken out of the freezer)

Discussion

The findings from this study suggest that the friction between ice and metal ball changes significantly specifically when the ice begins to melt: in case of high speed the friction at 3[min] might be largest, on the other hand, in case of low speed the friction at 3 and 4[min] was smallest. It seems that for 10 minutes in high speed and for 5 minutes in low speed the values of friction depend on not only the time when the ice was left outside, but also the speed of the ball. After the solid water melts some degree, then the friction becomes little smaller than that of completely solid ice. The possible reasons for the result are as follows: Until all surface of the ice melt the condition of ice is very complex, that means some part of the ice already melts and other is still completely solid. Furthermore a recent study about ice melting in microscopic levels, found the appearance of two types of liquid phases that are both dynamic and spatially inhomogeneous formed by surface melting. They appeared

heterogeneously, moved around, and coalesced dynamically on ice crystal surface (Gen Sazaki, Salvador Zepeda, Shunichi Nakatubo, Makoto Yokomine, and Yoshinori Furukawa, 2012).That is way the friction seems to depend on not only the condition of the ice. After all surface of the ice melts, the results were almost fixed. It might be because once all surface of the ice melts the condition of the ice, solid water covered with liquid water's layer, is kept. Also I can say that the friction on ice with little liquid water is smaller than that of on the solid ice. We can see the same phenomenon: when we do skating, the ice melts a little and becomes liquid because of the pressure, so the friction becomes very small and then we can skate. This experiment shows same result: the ball went faster on the solid water with little liquid water than on the solid water.

However, there are some limitations in this experiment. Firstly, 24 flames per second were too perfunctory for these experiments because the speed is very high: the standard deviation was 0.2132/24[sec] (High speed), 0.1994/24[sec] (Low speed). That means the 2 σ intervals in this experiment are almost as much as the minimum time I could record ,0.5/24[sec], so more frames are needed for more detail results. Secondly, the experiment was conducted only twice. It is not enough to avoid the possibility of various minor human errors. Finally I couldn't have observed the degree of ice melting in good way, because there were only subtle differences in conditions of the ice I could identify visually. In the future experiment, descriptions of the ice might be needed. If these problems were solved, this research may be useful for making good environment for sports such as ice hockey, figure skating, and curling.

References

P.,Oksanen, (1982) THE MECHANISM OF FRICTION ON ICE, Wear,78(1982)315-324

Gen Sazaki, Salvador Zepeda, Shunichi Nakatubo, Makoto Yokomine, and Yoshinori Furukawa, (2012) Quasi-liquid layers on ice crystal surfaces are made up of two different phases, PNAS Early Edition

Acknowledgements

I would like to thank and all my classmates at for giving me good advice.

S15's Revised Paper

Friction on Ice

Introduction

Many people might believe that the friction on ice is small through the experience of ice skating or slipping on the frozen road. However, few people might know what condition of ice is the most slippery. Some facts about this topic are already known. For example, according to previous research, the coefficient of friction depends on temperature, velocity and normal load when temperature is under 0℃.(Oksanen, 1982) However, there was little research about how friction on ice change when the temperature reaches 0℃ or more and the ice begin to melt. Therefore, this research was conducted to find out the friction of ice in such condition. I researched how the friction between solid water and a small metal ball changes when the ice begins to melt. The hypothesis is that the friction is smallest when ice melt a little and afterwards the friction begins to become large according to the ice melts. It has been anecdotally reported that every ice skating rink has peculiar condition of ice and figure skaters identify the difference. My research might be helpful to keep good condition of ice in ice rinks.

Method

First in order to test the hypothesis, a flat ice was made. I poured tap water into a tray (about15cm*10cm*1cm), and kept cold in freezer for 3days.

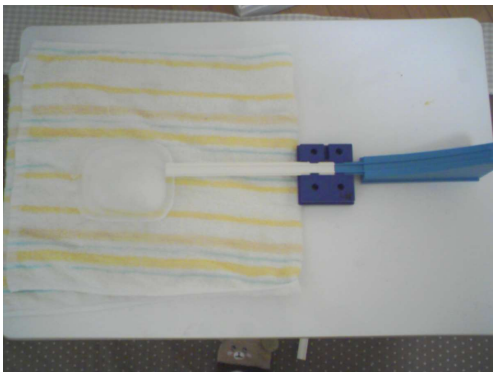
Then the following experimental device was constructed. (fig1)

The experiment was conducted as follows:

I examined how long did it take for small metal ball to go through on the solid water. The time required was timed as follows. A small metal ball was on the top of the rail (high speed), or on the bottom of the rail (low speed). The position of the ball should be constant to keep the velocity same when the ball reached the ice. I let the small metal ball go and it went on

the solid water.

This experiment was done every 1 minute from just after the solid water was take out of the freezer to 20 minutes later at two different speed(High /Low), in my room (the temperature was kept 20℃ by air conditioner). A video camera was used to time. The movie which records the experiments was separated into 24 frames per second like Figure2, and the time taken for the ball to go thorough on the solid water was recorded. I did same experiment twice.



Figur1:experimental device

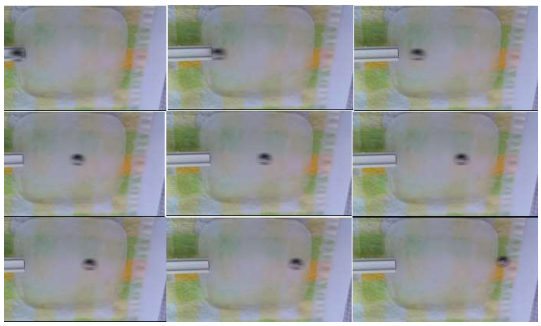


Figure2:the pictures of a trial

Results

I conducted my experiment every minute at two different speeds (high/low). Then the difference between the time at 0[min] and at each experiment was calculated from pictures like Figure2 and the average of two experiments were shown in figure 1. In addition, the standard deviation of high speed was 0.2132[/24*sec] and of low speed was 0.1994[/24*sec].

Figure3 shows that when the speed of the ball was high the ball went slower and then went faster according to melt the ice. On the other hand, when the speed of the ball was low, the ball went faster and then went slower according to the degree of ice melting. The time required was changed specifically during first 10 minutes in High speed and 5 minutes in low speed. In case of high speed it took additional 1.25/24[sec] at 3[min] compared with the time of 0[min].In case of low speed the time at 3 and 4[min] was shorter by 1.5/24[sec] than that at 0[min].The absolute value of Vertical axis at 3[min] was about 3 times as much as that during 10~19[min] in case of high speed. The absolute value of Vertical axis at 3 and 4[min] is almost twice as much as that during 5~19[min]. It seems that for first few minutes, the friction on ice depends not only on the time (horizontal axis of figure3), but also the speed of the ball. After 5 minutes in High speed and 10 minutes in Low speed, however, the value was almost fixed: -0.25/24[sec] or -0.5/24[sec] in High speed and -0.75/24[sec] or -1/24[sec] in low speed. The time required were shorter than that of 0[min] in both speeds,

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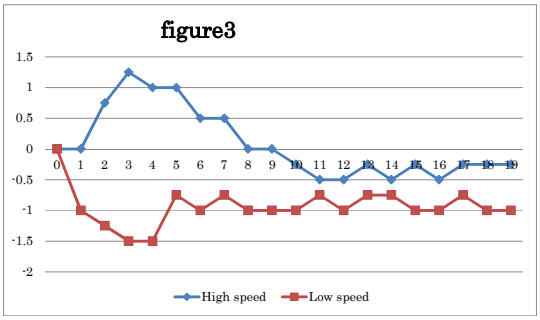

Figure3: The change of the time required to go through on the ice depends on the time when the ice left in the room.

Y label:{ (the time at each time) −(the time at 0[min])}[/24*min]: The average of the difference between the time it took at 0[min] and that at each time[min] [/24*sec]

X label: Time [min](from the time when the ice was taken out of the freezer)

Discussion

My hypothesis for this experiment was that the friction is smallest when ice melts a little and afterwards the friction begins to become large according to the ice melts. However the results were a bit different from that I expected. The findings from this study suggest that the friction between ice and metal ball changes significantly, when the ice begins to melt: in case of high speed the friction at 3[min] might be largest, on the other hand, in case of low speed the friction at 3 and 4[min] was smallest. It seems that for 10 minutes in high speed and for 5 minutes in low speed the values of friction depend on not only the time when the ice was left outside, but also the speed of the ball. After the solid water melts some degree, then the friction becomes little smaller than that of completely solid ice. The possible reasons for the result are as follows: Until all surface of the ice melt the condition of ice is very complex, that means some part of the ice already melts and other is still completely solid.

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References

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Acknowledgements

I would like to thank , and all my classmates at for giving me good advice.

The significance of pressure exchanger in the PRO

Introduction

How much electricity PRO (pressure retarded osmosis), one of the osmotic power generating system like Fig. 1, generates is known by the research by Thor Thorsen and Torleif Holt (2009)[1], but whether a model like Fig. 1 is the best structure of plant is unclear. For example,the ratio of the amount of recycled brackish water to that of brackish water flow into turbine, what will happen? In this study, I made a simple model of PRO and research what influences the flux under several conditions, such as water pressure.

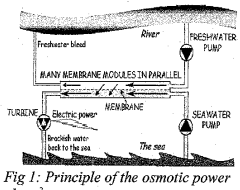


Fig 1: Principle of the osmotic power plant.[2]

Background

When placing a semi-permeable membrane (i.e. a membrane that retains the salt ions but allows water through) between reservoirs containing waters with differences in salt gradients, a net flow of water towards the saltier water side will be observed because of osmosis.[3] In the pressure retarded osmosis (PRO) process, fresh water fed into the plant from a river is transferred by osmosis into brackish water and enhances the pressure of salty water's flow, which makes a turbine revolve and generates electricity.

Method

Before making the model of PRO process, it was required to research how large the cellophane's area must be to generate high osmotic pressure enough to observe the influence of it in this experiment. So, I did a simple research; I made a long and narrow vessel, a straw whose diameter was 6 mm and whose end was covered with a color cellophane. Then water saturated with sugar is poured into the vessel, and put the vessel into the bigger one filled with fresh water. After 20 minute later, the level of solution became 2 cm higher than before.(Fig.2,Fig.3) Therefor, the amount of the fresh water which penetrated through the cellophane was about 377 ml. And in this simple experiment, the area of membrane was about 12.6cm². So, the amount of water which 1-cm² cellophane could allow to penetrate in one hour is about 90 cm². But in the experimental model of PRO like in Fig.1, water flow without any osmotic power in the straw C and D was 0.5L/min. So, the influence of osmosis may be too small to observe by using the model of PRO like in Fig.1. So another method may be required.

Fig 2:Before

Fig 3:After 20 minutes

I reasoned one of the factor which influence the amount of generated electricity is the flux to a turbine. Therefore, the liquid flow in the instrument is seemed to be unnecessary. So, I made the instrument, which is the one to research the amount of penetrating fluid through the cellophane, like in Fig.4. This was made of straw and cellophane. To prevent the water leak, the joints of straw was coated by glue. First of all, I filled the equipment with the water for two days to confirm that water did not leak. The cellophane was put up red part in Fig.5. The instrument was putted on the stand whose shape is like capital "L". On this stand, the membrane part was horizontal, which equalize the pressure on each membrane. And the instrument's part attached equipped with a scale was vertical so as to the surface make

Fig 4 :Instrument in this experiment

1,2,3:Thor Thorsen and Torleif Holt,"The potential for power production from salinity gradients by pressure retarded osmosis",Journal of Membrane Science (2009).

I thought the main factor which influence the amount of generated electricity may be the flux to a turbine. Therefore, the liquid flow in the device is seemed to be unnecessary. So, I made the device, which is the one to research the amount of penetrating fluid through the cellophane, like in Fig.4. This was made of straw and cellophane. To prevent the water leak, the joints of straw was coated by glue. The cellophane was put up red part in Fig.5.

FIG 4:device in this experiment

First, I researched the influence of dense of brackish water. I attached the tip of equipment to a liquid and sucked it up by 0 scale and folded up the tip straw. And, in order to remove the bubbles in membrane part, I held the device and hopped some times. (The device was so fragile one, so if I shook it roughly, the liquid might leak from it. And if I shook it too lightly, the bubble may remain around the membrane.) Then, the level of liquid was dropped to the required level by slightly straightening the tip straw. After that, I read scale on the device by a first place of decimal. I change the concentration of solution from 5wt% to 25wt% (saturated) by 5wt%.

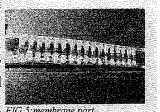


FIG 5:membrane part

Second, the effect of the difference of water pressure added to the membrane was studied. I thought that if the pressure from brackish water is higher than that of fresh water by the osmotic pressure, the flux into the salty water per a minute might decrease. So, I did the same experiment except for the initial level of the solution. I supposed the thicker the solution is, the more rapidly the water move to the solution. So as to make results' differences remarkably, I adopted the saturated brackish water in this experiment. However, considering the possibility that the contradiction to my hypothesis,that is the pressure differences controls the flux from fresh water, I also used the 5wt% salty water.

Finally, the membrane's areas was changed. Setting of the device was the same as first experiment. Then by blowing a breath into the tip straw, I removed the liquid in the membrane part. After that, I read the scale like in the first research. The 25wt% solution was adopted for the same reason in second experiment.

Result

The result was like below. The Fig.6 is the picture of the equipment's stand. The device was almost filled with liquid for two days. The stand wasn't wet, so it might be safe to assume water didn't occur.

The first two tables shows the result of scale reading, the third graph

Scale reading	Percent concentration of mass [wt%]									
	5		10		15		20		25	
Time [min]	Flesh	Solution	Flesh	Solution	Flesh	Solution	Flesh	Solution	Flesh	Solution
0	9.5	8.1	9.2	9.0	10.9	10.6	9.0	10.7	8.7	8.4
5	9.3	8.3	8.9	9.3	9.5	11.3	8.4	11.7	7.4	9.7
10	9.3	8.6	8.6	9.6	8.9	11.7	7.2	12.6	6.1	11.0
15	9.2	8.8	8.2	9.8	8.4	12.4	6.3	13.4	5.0	12.2
20	8.9	9.0	7.9	10.2	7.9	12.8	5.4	14.4	3.8	13.4
25	8.6	9.2	7.6	10.4	7.5	13.5	4.7	15.3	2.6	14.5
30	8.4	9.4	7.5	10.6	7.0	13.7	3.9	16.0	1.6	15.7

Table 1: The result of first experiment

- **The water pressure and the flux**

The result of second experiment was like in the Table 2. The mean of figure and significant figures are the same as in the first experiment.

Scale reading	Percent concentration of mass [wt%]									
	25%						5%			
Time [min]	Flesh	Solution	Flesh	Solution	Flesh	Solution	Flesh	Solution	Flesh	Solution
0	45.7	45.1	2.5	54.2	8.4	8.7	4.5	45.7	9.5	8.1
5	46.7	43.7	3.0	52.0	9.7	7.4	4.2	46.0	9.3	8.3
10	47.8	42.6	4.1	51.8	11.0	6.1	3.7	46.3	9.3	8.6
15	49.0	41.5	5.4	49.8	12.2	5.0	3.5	46.5	9.2	8.8
20	50.0	40.6	6.4	48.6	13.4	3.8	3.4	46.6	8.9	9.0
25	51.1	39.4	7.4	47.6	14.5	2.6	3.3	46.7	8.6	9.2
30	52.0	38.5	8.4	46.4	15.7	1.8	3.2	46.8	8.4	9.4

Table 2:The result of second experiment.

- **The areas of membrane and the flux**

The result of third experiment was like in the Table 3. As the time passed, the level in the membrane part decreased. So I showed how low the level in the cellophane part became in the line of "Number of sheets of the film which is seemed to be in contact with the liquid". The figure in this line does not necessarily reflect the areas of watered membrane.

	Number of sheets of the film which is seemed to be in contact with the liquid		Scale reading	
Time [min]	Solution	Fresh	Solution	Fresh
0	4	2	26.6	24.4
5	5	3	25.6	25.3
10	5	4	25.0	25.8
15	5	4	24.4	26.4
20	6	4	24.0	27.0
25	6	4	23.5	27.7
30	6	5	22.9	28.4

Table 3:The result of third experiment.

Discussion

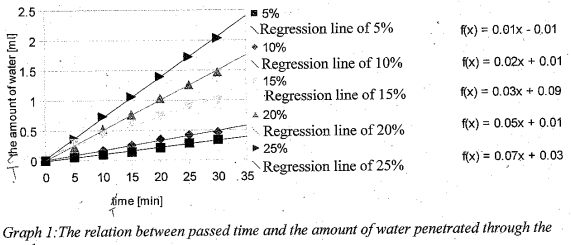
- ***The concentration and flux***

The scale is struck at intervals of 5 mm, the straws' diameter is 6 mm. So the amount of water which penetrated through the membrane in 5 minute (ΔV) is as follows:

$$\Delta V = 45\pi \cdot x \times 10^{-3} [ml/5\min] \quad \cdots(a)$$

As the water penetrate into the brackish water, its concentration became low. We get the following table and graph by using this expression (a).

	Percent concentration of mass [wt%]				
Time [min]	5%	10%	15%	20%	25%
0	0	0	0	0	0
5	0.05655	0.08482	0.29688	0.22619	0.36757
10	0.09896	0.16965	0.43825	0.52308	0.73513
15	0.14137	0.25447	0.6079	0.76341	1.06029
20	0.21206	0.35343	0.73513	1.03201	1.39958
25	0.28274	0.42412	0.89064	1.25821	1.72473
30	0.33929	0.46653	0.9896	1.47027	2.03575

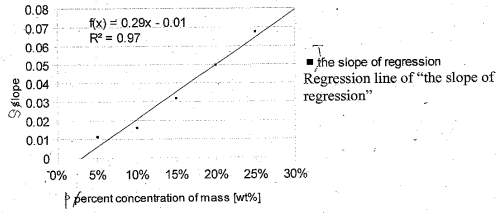


Graph 1:The relation between passed time and the amount of water penetrated through the membrane.

Judging from the graph1, ΔV seems to be proportion to the time. The relation between the solution's percent concentration of mass and the slope of regression is like follow:

percent concentration of mass [wt%]	5%	10%	15%	20%	25%
the slope of regression	0.011	0.016	0.032	0.050	0.068

Table 4:The relation between the solution's percent concentration of mass.



Graph 2:The slope of regression and the concentration

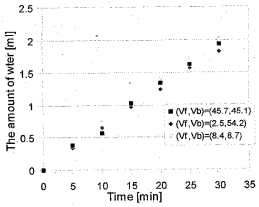
Judging from the above discussion, the flux per minute is expected to be proportion to the percent concentration of mass.

- ***Pressure differences and flux***

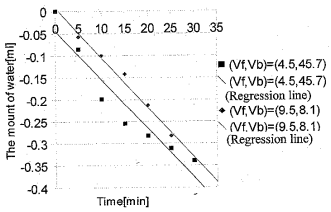
Using the result of the second experiment and the expression(a), we get the following table and the graphs. Vf is the initial value of the fresh water's scale readings, Vb is that of brackish water. Judging from the plot in two graphs and the slope of regression line, there might be two possible conclusion; one is that the liquid's pressure merely influence the flux in a minute, the other is that the water pressure added to cellophane in this experiment was too small, so we couldn't observe the effect of it. After all, in my experiment, the level of liquid is seems not to change the *ΔV*.

ΔV	percent concentration of mass [wt%]				
time [min]			25%		5%
0	0	0	0	0	0
5	0.33929	0.3817	0.36757	-0.08482	-0.05655
10	0.65031	0.56549	0.73513	-0.19792	-0.09896
15	0.97546	1.03201	1.06029	-0.25447	-0.14137
20	1.24407	1.34303	1.39958	-0.28274	-0.21206
25	1.56923	1.62577	1.72473	-0.31102	-0.28274
30	1.82369	1.93679	2.03575	-0.33929	-0.33929

Table 5:The amount of water which penetrated through the membrane in 5 minute (ΔV)



Graph 3:The effect of the pressure differences (at 25wt%)



Graph 4:The effect of the pressure differences (at 5wt %)

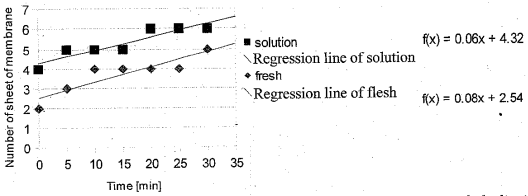
- ***The area of membrane and the flux***

As the result shows, area of the dipped membrane isn't constant in the third experiment. So, for more accuracy, some rectifying may be required. To rectify the scale readings of the level, the decrease of the level in the membrane part is the what I consider first. To make the problem simple, the decreasing speed is assumed to be constant. In the membrane part, the gap of each membrane's center is about 1cm in a straight line. And, the short tubes' length, which have cellophane in its center is about 4 cm. And if the scale readings of fresh water increase, ΔV increase, and if that of brackish water increase, ΔV decrease. So if "the number of sheets of film which is seemed to be in contact with the liquid" of the fresh water increased by F and that of the brackish water increased by B, the number we have to add to the ΔV is;

$$(2+4/2)\times 9\pi\times 10^{-3}\times(B-F)\ [ml]$$

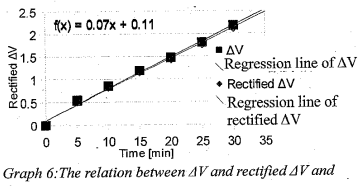
$$B=0.08t$$

$$F=0.06t$$



Graph 5:the number of sheets of the film which is seemed to be in contact with the liquid

Followings are the graph and table showing the relation between ΔV and time. The slope of the regression line is 0.07. It is as large as the result of first experiment at 25wt%. From these, the effect of area of the membrane is seemed to be difficult to observe with this instrument.



Time [min]	ΔV [ml]	Rectified ΔV [ml]
0	0	0
5	0.54	0.53
10	0.85	0.83
15	1.19	1.16
20	1.47	1.44
25	1.81	1.77
30	2.18	2.13

Table 5:ΔV and rectified ΔV

Graph 6:The relation between ΔV and rectified ΔV and time.

Conclusion

In order to simplify the problem, we think about the simple model of PRO like in Fig7. P1 is the water pressure at the point①, and P2, P3, P4, P5, P6 is defined as the same manner. The larger P6 is, the faster the turbine's engine speed might become. And as the water pressure is in proportion to sum of the momentum of water monocular.[2] And, the temperature of liquid is proportional to the kinetic energy of monocular. So if the temperature at any point of the PRO model is the same, the pressure might be in proportion to the number of water monocular in an unit volume. So, if the ratio of the amount of the water to turbine (⑥) to that of to pressure exchanger (⑤) is x to y, the following formula is gained;

$$P5 : P6 = x : y \cdots\cdots (b)$$

Considering the discussion of the first experiment, the flux from the fresh water to solution through the membrane is expected to be in proportion to the solution's percent concentration of mass. And the sea water contains 33~38‰ of salt.[3] So the concentration of brackish water at the place ① is assumed to be 3wt%. Considering the discussion of the first experiment, the flux from the fresh water to solution through the membrane is expected to be in proportion to the solution's percent concentration of mass. So, the concentration might be almost the same in the PRO process. In this approximation, the C1(the concentration at the point①) and C2(that at the point②) and C5(that at the point ⑤) is supposed to be like this;

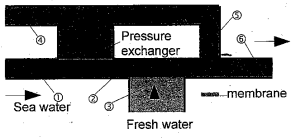


Fig 7:The simple model of PRO

$$C2=\frac{dsvLC1}{dsvL+\alpha(C1-C5)Llv}$$

$$C5=\frac{dsvLC1}{dsvL+\alpha(C1-C5)Llv+\alpha C2L'lv}$$

(d is the dense of liquid, s is a cross area of the model, v is the velocity of brackish water, L is a length of the section of pressure exchanger, L' is that of the the)

2 Wikipedia:http://ja.wikipedia.org/wiki/%E6%B0%B4%E5%9C%A7
3 Wikipedia

The Ideal Geological Condition for the PRO Plant

Introduction

How much electricity PRO (pressure retarded osmosis), one of the osmotic power generating system like Fig. 1a, generates is known by the research by Thor Thorsen and Torleif Holt (2009)[1], but what is the best conditions for the PRO plant is unclear. In this study, I made a simple model of PRO and research what influences the flux under several conditions, such as water pressure. And the result indicated the best geological condition of small sized PRO is seemed to be that the seawater's concentration is high.

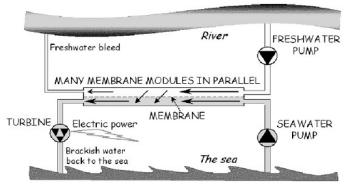


Fig 1: Principle of the osmotic power plant.[2]

Background

When placing a semi-permeable membrane (i.e. a membrane that retains the salt ions but allows water through) between reservoirs containing waters with differences in salt gradients, a net flow of water towards the saltier water side will be observed because of osmosis[3]. In the pressure retarded osmosis (PRO) process, fresh water fed into the plant from a river is transferred by osmosis into brackish water and enhances the pressure of salty water's flow, which makes a turbine revolve and generates electricity.

[1, 2, 3] Thor Thorsen and Torleif Holt,"The potential for power production from salinity gradients by pressure retarded osmosis",Journal of Membrane Science (2009).

-Preliminary experiment-

Method

Before making the model of PRO process, it was required to research how large the cellophane's area must be to generate high osmotic pressure enough to observe the influence of it in this experiment. So, I did a simple research; I made a long and narrow vessel, a straw whose diameter was 6 mm and whose end was covered with color cellophane. Then water saturated with sugar was poured into the vessel, and soaked the vessel in fresh water in the bigger one.

Result

After 20 minute later, the level of solution became 2 cm higher than before. (Fig.2) Therefor, the amount of the fresh water, which penetrated through the cellophane, was about 377 ml. And in this simple experiment, the area of membrane was about 12.6 ㎠. So, the amount of water which 1-㎠ cellophane could allow to penetrate in one hour is about 90 ㎤. But in the experimental model of PRO like in Fig.1, water flow without any osmotic power in the straw C and D was 0.5L/min.

Discussion and conclusion

So, the influence of osmosis may be too small to observe by using the model of PRO like in Fig.1. So another method may be required. I reasoned one of the factors which influence the amount of generated electricity is the flux to a turbine. Therefore, the liquid flow in the instrument is seemed to be unnecessary.

a **b**

Fig.2 The result of preliminary experiment a, This was taken immediately after the vessel was soaked into the water. b, This was taken after 20 minutes later.

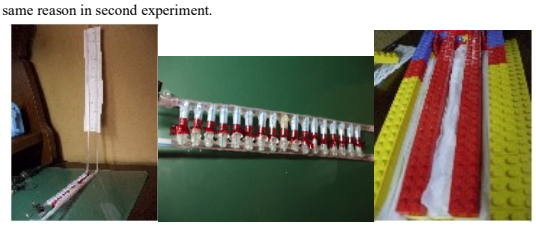
Method

I made the instrument, which is the one to research the amount of penetrating fluid through the cellophane, like in Fig.4. This was made of straws whose diameters were 9mm and color cellophane. The two transparent straws were parallel to each other and each end is connected with the short 17 straws. Each short straw was partitioned off by cellophane, so this instrument has two section across the membrane. Each section has a capacity of 21ml. In this paper, I term the inside of the instrument around the cellophane “membrane part”. In the membrane part, the gap of each membrane's center is about 1cm in a straight line and the short tubes' length is about 4 cm. To prevent the water leak, the joints of straw were coated by glue. The diameter of the straw was 6mm. The other ends of the instrument were attached the paper printed with the scale from 0 to 55. The interval of scales' division was 5mm. The scale reading get low if the level of liquid become high. The instrument was deposited on the stand whose shape was like capital “L”. On this stand, the membrane part was horizontal, which equalize the pressure on each membrane. And the instrument's part attached equipped with a scale was vertical so as to the surface make horizontal, which help us read the scale accurately and easily.

In the first experiment, I researched the influence of brackish water's concentration. I attached the tip of equipment to a liquid and sucked it up until the straw was filled with it and folded up the tip straw. In order to remove the bubbles in membrane part, I held the instrument and hopped few times. The instrument was fragile, so shaking it roughly might cause the liquid to leak but shaking it too lightly might cause bubbles around the membrane remain. Then, the level of liquid was dropped to the required level by slightly straightening the tip straw. After that, I read scale on the instrument by a first place of decimal. I change the concentration of solution from 5wt% to 25wt% (saturated) by 5wt%. As the water penetrate into the brackish water, its concentration is likely to become low. So I gauged the capacity of the instrument in order to use for estimation of the effect of this phenomenon is. Following is the way to gauge it; I poured 100g of water into the vessel putted on the scale, and measured the decrease of weigh when the water was sucked up. In this measurement, the bubble in the equipment was removed in the same way in aforesaid explanation.

Second, the effect of the difference of water pressure added to the membrane was studied. I thought that if the pressure from brackish water is higher than that of fresh water by the osmotic pressure, the flux into the salty water per a minute might decrease. So, I did the same experiment except for the initial level of the solution. I supposed the thicker the solution is, the more rapidly the water move to the solution. So as to make results' differences remarkably, I adopted the saturated brackish water in this experiment. However, considering the possibility that the contradiction to my hypothesis, that is the pressure differences controls the flux from fresh water, I also used the 5wt% salty water.

Final experiment was researching the relation between the liquid flux and the membrane's areas. Setting of the instrument was the same as first experiment. Then by blowing a breath into the tip straw, I removed the liquid in the membrane part. After that, I read the scale like in the first research. The 25wt% solution was adopted for the same reason in second experiment.



a **b** **c**

Fig.3: The instrument in this experiment. a, the whole picture of the instrument. b, The membrane part. c ,The instrument was almost filled with liquid for two days. The stand wasn't wet. so it might be safe to assume water didn't occur.

Result

The scale is struck at intervals of 5 mm, the straws' diameter is 6 mm. So if the scale reading was x, the amount of water which penetrated through the membrane in 5 minute (ΔV) is as follows:

$$\Delta V = 45\pi \cdot x \times 10^{-3}\ [ml] \ldots (a)$$

We get the following table and graph by using this expression (a).

I found that ΔV seems to be proportion to the time. This trend is conspicuous if the solution's concentration is low. (Fig.7) I also found that the slope of regression in Fig.7 is like to be in proportion to initial value of solution's percent concentration of mass.(Fig.8) Judging from the above discussion, the flux per minute is expected to be proportion to the initial percent concentration of mass.

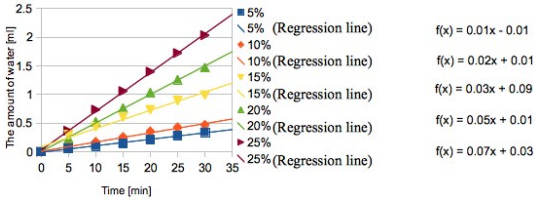


Fig 4:The relation between passed time and the amount of water penetrated through the membrane.

Table 1; The result of third experiment.

	Number of sheets of the film which is seemed to be in contact with the liquid		Scale reading	
Time [min]	Solution	Fresh	Solution	Fresh
0	4	2	26.6	24.4
5	5	3	25.6	25.3
10	5	4	25.0	25.8
15	5	4	24.4	26.4
20	6	4	24.0	27.0
25	6	4	23.5	27.7
30	6	5	22.9	28.4

Because the area of the dipped membrane isn't constant in the third experiment, for more accuracy, some rectifying may be required. To rectify the scale readings of the level, the decrease of the level in the membrane part is what I consider first. To make the problem simple, the decreasing speed is assumed to be constant. (Fig.8) In the membrane part, the gap of each membrane's center is about 1cm in a straight line and the short tubes' length is about 4 cm. So if "the number of sheets of film which is seemed to be in contact with the liquid" of the fresh water increased by F and that of the brackish water increased by B, the number we have to add to the ΔV is;

$$\left(2+\frac{4}{2}\right)\times 9\pi\times 10^{-3}\times(B-F)\ [ml]$$

$$B = 0.08t$$

$$F = 0.06t$$

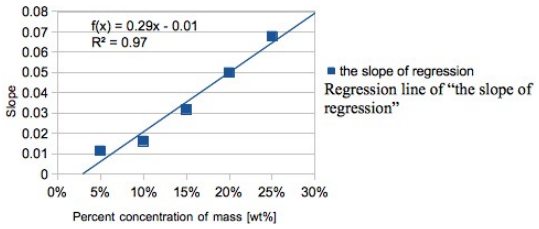


Fig 5:The slope of regression and the concentration

Then, the relation between the liquid pressure and the flux is discussed. In the two graph, Fig.9 and Fig.10, Vf is the initial value of the fresh water's scale readings, Vb is that of brackish water. Judging from the plot in two graphs and the slope of regression line, there might be two possible observation; one is that the liquid's pressure merely influence the flux in a minute, the other is that the water pressure added to cellophane in this experiment was too small, so we couldn't observe the effect of it. After all, in my experiment, the level of liquid is seems not to change the ΔV.

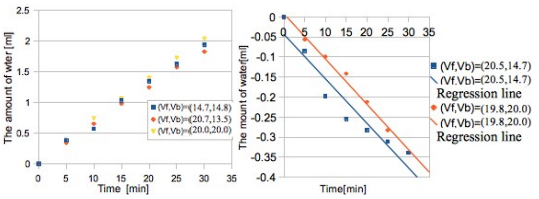


Fig 6:The effect of the pressure differences (left; at 25wt%, right; at 5wt%)

The result of third experiment was like in the Table1. As the time passed, the level in the membrane part decreased. So I showed how low the level in the cellophane part became in the line of "Number of sheets of the film which is seemed to be in contact with the liquid". The figure in this line does not necessarily reflect the areas of watered membrane.

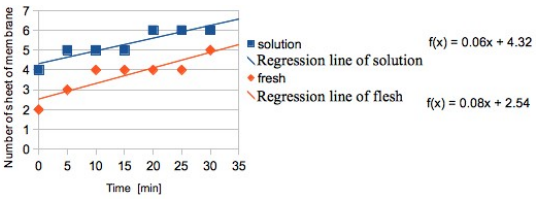


Fig 8:the number of sheets of the film which is seemed to be in contact with the liquid

Followings are the graph and table showing the relation between ΔV and time. The slope of the regression line is 0.07. It is as large as the result of first experiment at 25wt%. From these, the effect of area of the membrane is seemed to be difficult to observe with this instrument.

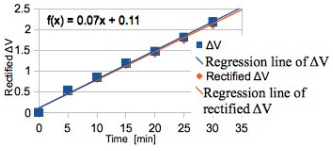


Fig 9:The relation between ΔV and rectified ΔV and time

Table 2:ΔV and rectified ΔV

Time [min]	ΔV [ml]	Rectified ΔV [ml]
0	0	0
5	0.54	0.53
10	0.85	0.83
15	1.19	1.16
20	1.47	1.44
25	1.81	1.77
30	2.18	2.13

Discussion

And the seawater contains 35‰ of salt[4]. So the concentration of brackish water is assumed to be 3.5wt%. Considering the discussion of the first experiment, the flux from the fresh water to solution through the membrane is expected to be in proportion to the solution's percent concentration of mass. And if the concentration is low(5%), this tend is remarkable.

In the discussion about second experiment and third experiment, the effect of pressure and area of the membrane on the flux was not observed. It is partly because the pressure applied to the membrane was too weak, and the area of the membrane was too small, in other words, it might be too small apparatus. So if the PRO plant was small, the effect of pressure on the flux might be small. Therefore, the most influential variable might be, the concentration of seawater in the small- sized PRO plantation. So what is the best geological conditions for PRO plant is seemed to be high concentration of sea water.

Conclusion

In the “small-sized” PRO process, the concentration of the sea water is seemed to be the most important factor. But this conclusion cannot apply if the size of the system is large. So to discuss more general cases, the larger instrument may be required. And the influence of water velocity was not researched, so this variable is supposed to be researched.

References

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[4] Konpakuto-ban Tikyu-kankyo-handobukku,[コンパクト版地球環境工学ハンドブック. The compact handbook of environmental engineer] (1993)tikyukankyohandobukku-hensyuin.[地球環境ハンドブック編集委員. The editorial commit of the handbook of environmental engineer] Japan:Ohmsha Ltd.

Konpakuto-ban Tikyu-kankyo-handobukku,[コンパクト版地球環境工学ハンドブック. The compact handbook of environmental engineer] (1993) tikyukankyohandobukku-hensyuin. [地球環境ハンドブック編集委員. The editorial commit of the handbook of environmental engineer] Japan:Ohmsha Ltd.

S17's Pre-session Paper

The Effect of Positions on Breaking Strings

Introduction

Vibrato is a musical effect consisting of a regular, pulsating change of pitch. It is used to add expression to vocal and instrumental music. Vibrato is also used in playing the guitar. Guitarists produce finger vibrato on a string by cyclic hand movement. The movement requires specialized finger strength and it often cause the string to break. This difficulties annoy guitarists and then they wonder where is apt to break so that they can avoid breaking the strings. However, there is little research which answer their very natural question, "Where is the easiest for us to break strings?"

If you have played with Zip-line (or Flying fox), you might know immediately by intuition that the center of the strings is the easiest to break, because the cable of Zip-line bends the most when we come at the center. Based on this kind of experiences, we formed a hypothesis: The most breakable position on strings is the center of the strings.

In order to confirm this hypothesis, we designed two methods. First, we actually use a guitar and measure quantitatively the maximum weight that each position on the string withstands. Second, we use computer and analyze the result of the first method.

Method

There are various types of guitar and two majorities are acoustic guitars and electric guitars. We prepared an electric guitar because strings of an electric guitar are finer than those of an acoustic guitar and so we can break strings easily. The subject is the finest string, which is 0.009 inch (= 0.23 mm) in diameter, of Fernandes and made of steel.

In order to know the weight when the string breaks, we use plastic bottles. The bottles were fixed to hanger and it was hung on the position we want to measure. The bottles were gradually poured water into. When the string was broken, we weigh the bottles. This procedure was repeated on each position.

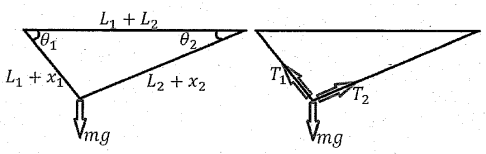
We turn into a quantitative model and calculated the tension and extension of the string. For the quantitative model, we postulated the following abstraction.

The string can be considered as a stiff spring following Hooke's law.

i.e. $\Delta T = k\Delta x$

(ΔT[N]: variation of tension, k[N/m]: spring constant, Δx[m]: extension of string)

A string of which length is $l_1 + l_2$[m] is tightening horizontally with tension T_0[N]. At this point, the string is extending and its length is $L_1 + L_2$[m]. At length L_1 from the left edge, a weight of which mass is m[kg] is hung. Assume the weight does not slide on the string.



Mathematical relations between forces are

$$T_1 \cos\theta_1 = T_2 \cos\theta_2 \quad (1)$$
$$T_1 \sin\theta_1 + T_2 \sin\theta_2 = mg \quad (2)$$

If a spring is cut into halves, these two strings have double the spring constant of the original spring because of Hooke's law. Generally, if a spring cut into r times, the spring constant become $1/r$ times.

$$T_1 = T_0 + \kappa\frac{x_1}{l_1}, T_2 = T_0 + \kappa\frac{x_2}{l_2} \quad (3)$$

(κ[N]: spring constant per unit length of the string)

T_1 or T_2 has only x_1 or x_2 for its variable. So that

$$\Delta T_1 = \kappa\frac{\Delta x_1}{l_1}, \Delta T_2 = \kappa\frac{\Delta x_2}{l_2} \quad (4)$$

When the weight m pull the string and work to the string, the work ΔW done by the weight is not converted to heat or electromagnetic waves, and thus all of the work ΔW conserve and convert to elastic energy.

$$\Delta W = T_1\Delta x_1 + T_2\Delta x_2 \quad (5)$$

According to (1),

$$\Delta T_1 \cos\theta_1 = \Delta T_2 \cos\theta_2 \quad (6)$$

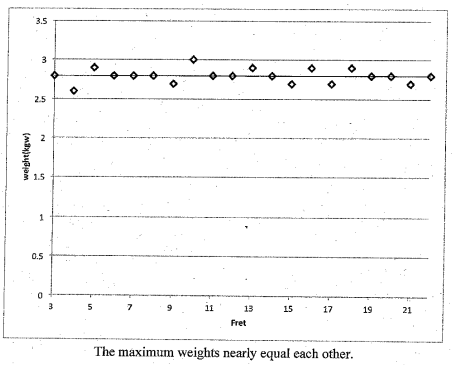
Using (4), (5) and (6),

$$\Delta x_1 = \frac{\Delta W}{T_1 + T_2\frac{l_2\cos\theta_1}{l_1\cos\theta_2}}, \Delta x_2 = \frac{\Delta W}{T_2 + T_1\frac{l_1\cos\theta_2}{l_2\cos\theta_1}} \quad (7)$$

We calculated $(x_1(W+\Delta W), x_2(W+\Delta W), T_1(W+\Delta W), T_2(W+\Delta W))$ from the preceding state $(x_1(W+\Delta W), x_2(W+\Delta W), T_1(W+\Delta W), T_2(W+\Delta W))$.

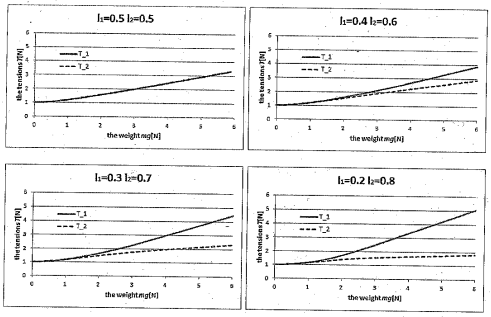
$$x_1(W+\Delta W) = x_1(W) + \Delta x_1, x_2(W+\Delta W) = x_2(W) + \Delta x_2 \quad (8)$$
$$T_1(W+\Delta W) = T_1(W) + \Delta T_1, T_2(W+\Delta W) = T_2(W) + \Delta T_2 \quad (9)$$

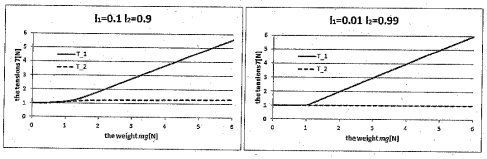
Result



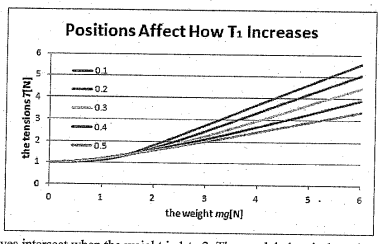
The maximum weights nearly equal each other.

$l_1 + l_2 = 1\text{m}, T_0 = 1\text{N}, \kappa = 1\text{N}, \Delta W = 0.001\text{J}$

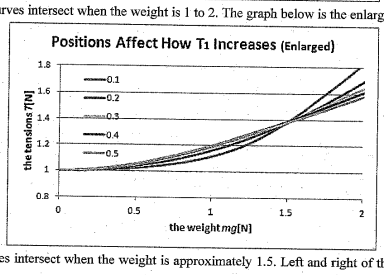




As the weight increase, the tensions increase. The tension of the shorter string, which is T_1 now, is larger than the other tension (T_2).



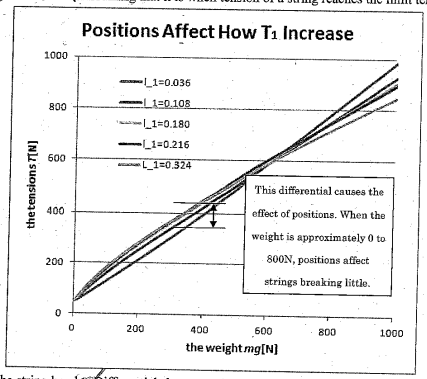
These curves intersect when the weight is 1 to 2. The graph below is the enlarged view.



The curves intersect when the weight is approximately 1.5. Left and right of the curves changed at this point.

not broken on the pressed position.

Another possible explanation we considered for the result is that tension of a string has the limit. Assuming that it is when tension of a string reaches the limit tension



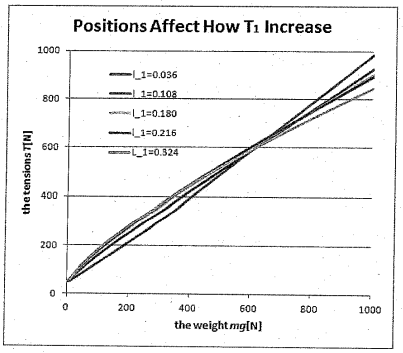
when the string breaks. Differential shown on the graph below causes effect of positions. When the weight is approximately 0 to 800N, positions affect strings breaking little. On the other hand, when the weight is over 800N, position affect strings breaking much.

On this research, we experimented and simulated about the effect of position on breaking strings. The experiment showed us that our hypothesis is wrong, and the simulation gave us the reason why the result is so. Especially the simulation reveals interesting phenomena. For example, as graph2 show, T_1 begin increasing proportionally at $mg = T_0$ when L_1 nearly equal 0. This reason has not been demonstrated yet.

References

Sawa, T. [沢俊行] (2000). Kiso-kouza sai-nyumon zairyou-kagaku (2) [基礎講座 再入門・材料化学(2). Basic Lectures: materials science once again]. *Nikkei mechanical* [日経メカニカル]. Tokyo: Nikkei Business Publications, Inc. [日経 BP 社].

Parameter of a typical guitar is $l_1 + l_2 = 0.648\text{m}, T_0 = 50\text{N}, \kappa = 3240\text{N}$.



Discussion

We tested whether position that a string is pressed on affects the limit of weight when it breaks. In our hypothesis, the center of strings is the most breakable, because a string bents the most when we pull it on the center. Contrary to our expectation, the result showed us the position did not have significant effects. Therefore, there is no evidence to support our hypothesis.

One possible explanation is that the strings were "cut" with the hanger, probably because the hanger was keener than we expected. We define "what is string breaking." When a string is broken, there are two possible explanations: snapping and cutting. Snapping is caused only by tension of the string. When a string cannot endure its tension, it will snap. By contrast, cutting is caused by a cut. A cut causes stress concentration. This stress concentration enables a small tension to break bodies (Sawa, 2000). Thus, we thought the strings are cut. However, most of the broken strings were

The Effect of Positions on Breaking Strings

Introduction

Vibrato is a musical effect consisting of a regular, pulsating change of pitch. It is used to add expression to vocal and instrumental music. Vibrato is also used in playing the guitar. Guitarists produce finger vibrato on a string by cyclic hand movement. The movement requires specialized finger strength and it often cause the string to break. This difficulty has annoyed guitarists and then they wants to avoid breaking the strings. Guitarists have contrived to find many small causes and to solve it, but, ironically they also avoid the fundamental question, "Where is the easiest for us to break strings?"

If you have played with Zip-line (or Flying fox), you might know immediately by intuition that the center of the strings is the easiest to break, because the cable of Zip-line bends the most when we come at the center.

The objective of our research is to demonstrate whether positions affect breakage of strings. Based on experiences such as Zip-line, we formed a hypothesis: The most breakable position on strings is the center of the strings.

In order to confirm this hypothesis, we designed two methods. First, we actually use a guitar and measure quantitatively the maximum weight that each position on the string withstands. Second, we use computer and analyze the result of the first method.

Method

We prepare an electric guitar because strings of an electric guitar are finer than those of an acoustic guitar and so we can break strings easily. The subject is the finest string, which is 0.009 inch (= 0.23 mm) in diameter, of Fernandes and made of steel.

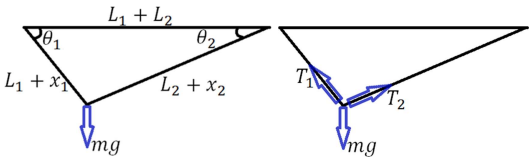
In order to know the weight when the string breaks, we use plastic bottles. The bottles are fixed to hanger and it is hung on 20 positions called frets. Water is gradually poured into the bottle. When the string is broken, we weigh the bottles. This procedure is conducted on each position.

Using the quantitative model below, we calculate the tension and extension of the string. For the quantitative model, we postulated that the string can be considered as a stiff spring even when it is very extended. This spring satisfies the formula below.

$$\Delta T = k\Delta x$$

$$\begin{pmatrix} \Delta T[\mathrm{N}]: \text{variation of tension} \\ k[\mathrm{N/m}]: \text{spring constant} \\ \Delta x[\mathrm{m}]: \text{extension of string} \end{pmatrix}$$

A string of which length is $l_1 + l_2[\mathrm{m}]$ is tightening horizontally with tension $T_0[\mathrm{N}]$. At this point, the string is extending and its length is $L_1 + L_2[\mathrm{m}]$. At length L_1 from the left edge, a weight of which mass is $m[\mathrm{kg}]$ is hung. Assume the weight does not slide on the string.



Mathematical relations between forces are

$$T_1 \cos\theta_1 = T_2 \cos\theta_2 \qquad (1)$$
$$T_1 \sin\theta_1 + T_2 \sin\theta_2 = mg \qquad (2)$$

If a spring is cut into halves, these two strings have double the spring constant of the original spring because of Hooke's law. Generally, if a spring cut into r times, the spring constant become $1/r$ times.

$$T_1 = T_0 + \kappa\frac{x_1}{l_1}\ , T_2 = T_0 + \kappa\frac{x_2}{l_2} \qquad (3)$$

$$(\kappa[\mathrm{N}]: \text{spring constant per unit length of the string})$$

x_1 is the only variable for T_1. Equally, x_2 is the only variable for T_2. Therefore, Δx_1 is the only variable for ΔT_1. Equally, Δx_2 is the only variable for ΔT_2.

$$\Delta T_1 = \kappa\frac{\Delta x_1}{l_1}\ , \Delta T_2 = \kappa\frac{\Delta x_2}{l_2} \qquad (4)$$

When the weight mg pull the string and work to the string, the work ΔW done by the weight is not converted to heat or electromagnetic waves, and thus all of the work ΔW conserve and convert to elastic energy.

$$\Delta W = T_1\Delta x_1 + T_2\Delta x_2 \qquad (5)$$

According to (1),

$$\Delta T_1 \cos\theta_1 = \Delta T_2 \cos\theta_2 \qquad (6)$$

Using (4), (5) and (6),

$$\Delta x_1 = \frac{\Delta W}{T_1 + T_2\frac{l_2\cos\theta_1}{l_1\cos\theta_2}}\ , \Delta x_2 = \frac{\Delta W}{T_2 + T_1\frac{l_1\cos\theta_2}{l_2\cos\theta_1}} \qquad (7)$$

We calculated $(x_1(W+\Delta W), x_2(W+\Delta W), T_1(W+\Delta W), T_2(W+\Delta W))$ from the preceding state $(x_1(W), x_2(W), T_1(W), T_2(W))$.

$$x_1(W+\Delta W) = x_1(W) + \Delta x_1\ , x_2(W+\Delta W) = x_2(W) + \Delta x_2 \qquad (8)$$
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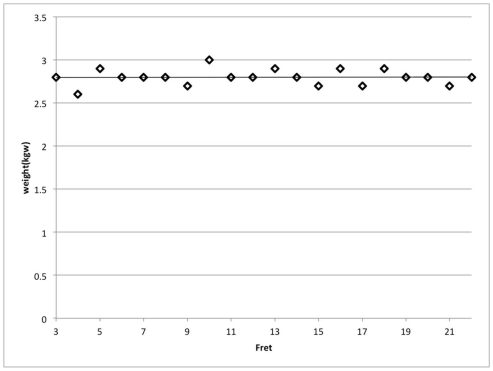
Result



The maximum weights nearly equal each other.

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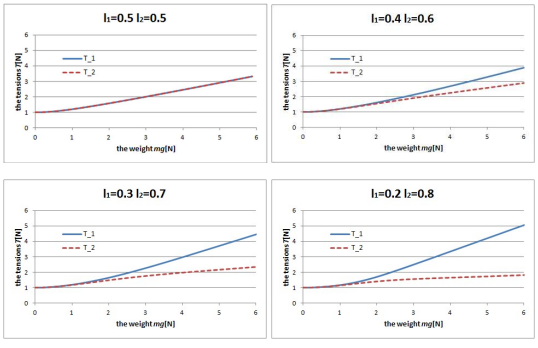
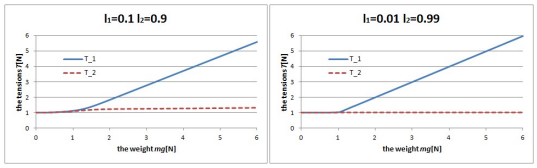
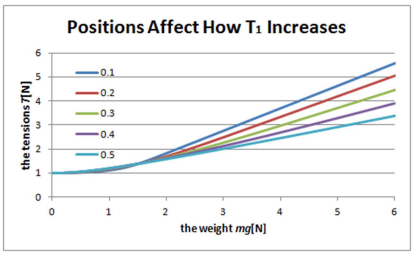
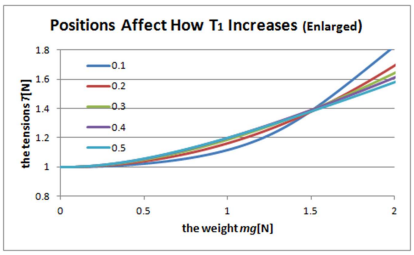




As the weight increase, the tensions increase. The tension of the shorter string, which is T_1 now, is larger than the other tension (T_2).



These curves intersect when the weight is 1 to 2. The graph below is the enlarged view.



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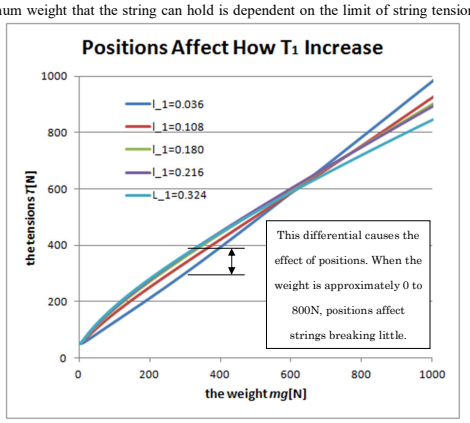
pressed position.

Another possible explanation we considered for the result is that the maximum weight that the string can hold is dependent on the limit of string tension. A



string has its proper limit of the tension. It is when tension of a string reaches the limit tension that the string breaks. Differential shown on the graph above causes the effect of positions. When the weight is approximately 0 to 800N, positions affect strings breaking little. On the other hand, when the weight is over 800N, position affect strings breaking much.

At first, we postulated that the string can be considered as a stiff spring even when it is very extended. However, this is an audacious approximation, because direct proportion is valid as long as the tension does not exceed the material's elastic limit. If possible, it is desirable to simulate using a more precise tension function.

On this research, we experimented and simulated about the effect of position on breaking strings. The experiment showed us that our hypothesis is wrong, and the simulation gave us the reason why the result is so. Especially the simulation reveals interesting phenomena. For example, as graph2 show, T_1 begin increasing proportionally at $mg = T_0$ when L_1 nearly equal 0. This reason has not been

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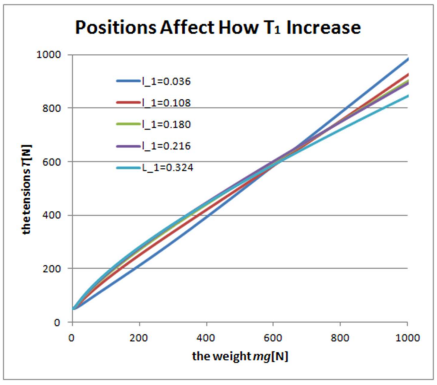

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References

Sawa, T. [沢俊行] (2000). Kiso-kouza sai-nyumon zairyou-kagaku (2) [基礎講座 再入門・材料化学(2). Basic Lectures: materials science once again]. *Nikkei mechanical* [日経メカニカル]. Tokyo: Nikkei Business Publications, Inc. [日経 BP 社].

S18's Pre-session Paper

Introduction

Password must be entered on various occasions: withdrawing money from a cash machine, getting access to websites that handle personal information, or getting into computer systems of companies or universities. The date of birth or family names (or combination of the two) is a common password, but this kind of passwords might be easily guessed at and personal data might be abused. (なにかほしい)In order to create a highly secure password, one of the best possible ideas could be a random combination of numbers and letters.

Creating a random password might seem relatively easy if people only have to choose numbers or letters randomly to do so. However, in 1949, Reichenbach claimed that humans are not able to produce something random, even when they intend to do so. He indicated that what considered random was not really random.

One possible explanation for this claim could be given from several reports. For example, Griffiths and Tenenaum (2003) conducted an experiment on people's judgments about randomness, using two letters, T and H (they are initials of 'Tail' and 'Head'). Participants in their research were firstly shown sequences of T and H (such as 'THHTTHHT' and 'TTTTHHHH'), and then instructed to classify those sequences into two categories: random and not random. It is reported that people tended to classify

(given) sequences as 'not random' when the sequences had parts in which letters appeared symmetrically or in which the same letter appeared continuously. (まとめの文があってよいかも)

However, there are still some questions remaining about human perception of randomness. Firstly, sequences composed of more than three letters (such as T, H, and P) might lead to a different result. Secondly, using numbers rather than letters might also lead to another different result. Therefore, the object of this research is to reveal tendency of human beings about randomness by using numbers from 0 to 9 as constituents of sequences, instead of T and H.

Repetition of the same number might be avoided, as Griffiths and Tenenbaum pointed out, despite the fact that numbers must be selected independently.

The objective of this research is to reveal tendency of human beings when producing numbers randomly. This will be explored by making both humans and a computer produce numbers, and comparing responses of the two. Considering the

research mentioned above, my hypothesis is that human beings tend to avoid repeating same numbers and

Method

Firstly, 40 students of the University of Tokyo were recruited as volunteers. Each of them was given a paper (Figure 1) and then instructed to write 50 numbers randomly as quickly as possible, less than one minute. Next, in order to produce random numbers by computer, 9th Nippon Kaisho System Tools, free online software, was run (ran). It produced a sequence consisting of 2000 (random) digits. As a result, 2000 'random' numbers were produced by human beings and computer. Finally, a program for analyzing and processing the data was written and installed on my computer with the help of an Science TA, and Microsoft Excel was also used for analyzing the data.

The program mentioned above processed the data in following ways: it was instructed to compare two numbers next to each other, and it added one to 'the number for counting the repetition of same numbers' when it found the same two numbers. For example, a count for a sequence of '3 8 5 5 7' was one, and for '3 8 5 5 5 7' was two (it is important to remember that this program always compares just two numbers next to each other, not compare three or more numbers at a time). Times of producing consecutive numbers were likewise counted: a sequence '1 4 5 2 8 7' was judged as two

('4 5'and '8 7'), for example, and '3 4 5 4 6 5' was judged as four ('3 4', '4 5', '5 4' and '6 5').

This operation was performed ten times の情報はいるか？
あああはくどいのでは？

Results

2000 numbers were written by 40 students and produced by 9th Nippon Kaisho System Tools. The results of processing the data collected by humans and computer are shown in Figure 1-3. Human beings produced the same number less frequently (Figure 1) and produced consecutive numbers more frequently than computer (Figure 2). Figure 3 shows us detail information about Figure 2: human beings produced more consecutive numbers than computer both in ascending order and in descending order and, into the details, the figures for ascending order are significantly different between humans and computer. Human produced consecutive numbers in ascending orders nearly twice as many times as computer. The results of processing the data in terms of difference between two numbers next to each other are shown in Figure 4. Consecutive numbers (±

1) were very much preferred by human beings, and from ± 3 to ± 8 the columns for computer are higher than those of humans.

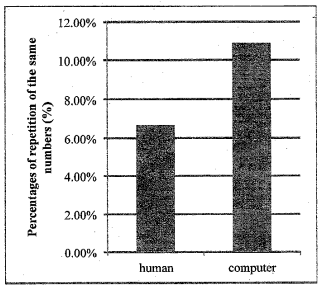

Figure 1: Difference between humans and computer, in percentages of repetition of the same numbers

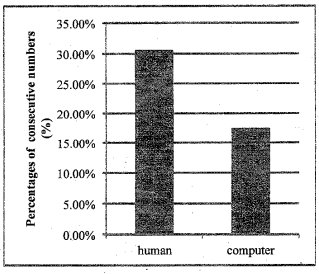

Figure 2: Difference between humans and computer, in percentages of producing consecutive numbers

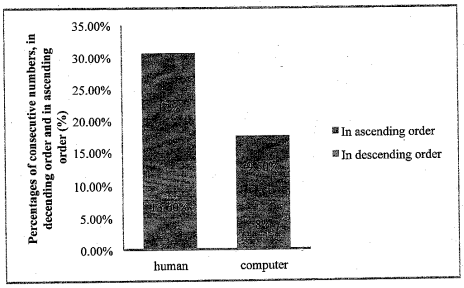

Figure 3: Composition of percentages of consecutive numbers

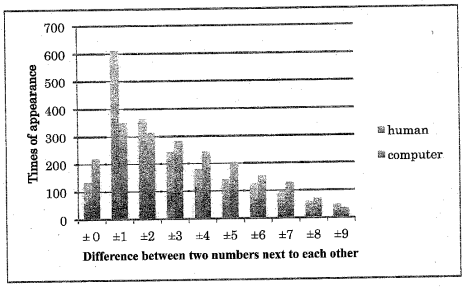

Figure 4: Times of numbers appearance, in terms of difference between two numbers next to each other

Discussion

The present study shows that human beings tend to avoid the same numbers and prefer consecutive numbers, as compared to the response of computer, when producing numbers randomly. They also preferred consecutive numbers in ascending order rather than in descending order. It could be concluded from these facts that a tendency is found in the sequences produced by humans.

Teraoka (1963) pointed out in his paper that human have a tendency to arrange things in such a way that seems natural to them. It is argued by Chater and Vitanyi (2003) that a preference for simplicity can be seen throughout cognition. Considering these claims, consecutive numbers, especially in ascending order, such as '34' or '78' seemed natural to participants in this research and they looked simple. On the other hand

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Human perception of randomness

Introduction

Password must be entere on various occasions: withdrawing money m cash machine, getting access to we ites that handle personal information, or g ing into computer systems of companies universities. The date of birth or family na es (or combination of the two) is an easy p sword to remember, but this kind of passw d might be easily guessed at by other peopl In order to create a highly secure p swo , one of the best possible ideas could be a ranc n combination of numbers and ters.

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to classify given sequences as 'not random' when the sequences had parts in which letters appeared symmetrically or in which the same letter (T or H) appeared continuously. The results suggest that repetition and symmetry are important factors about human perception of randomness.

However, further research is needed under more complex conditions to replicate these findings. Sequences composed of more than two letters (such as T, H, and P) might lead to a different conclusion. Moreover, using numbers instead of letters might have an impact on people's judgments on randomness.

To examine these two possibilities, present study was conducted using numbers from 0 to 9 as constituents of sequences, instead of T and H. Since it is difficult to confirm two different possible factors, 'repetition' and 'symmetry', the focus is provided on the former. Therefore, the objective of this research is to confirm whether people have a tendency to avoid repeating same numbers continuously when producing numbers randomly, and furthermore, to find other tendency of human beings than avoiding same numbers. My hypothesis is that human beings tend to avoid consecutive repetition of same numbers.

Metho

In order to confirm a tendency to avoid repeating same numbers and to find other tendency people exhibit when producing numbers randomly, a sequence of 2000 digits was produced by human beings, analyzed, and compared with theoretical probability.

Firstly, 40 students of the University of Tokyo were recruited as volunteers. Each of them was given a paper and then instructed to make a sequence of 50 digits as quickly as possible. One minute was the time limit. A sequence of 2000 digits was constructed by linking together 40 sequences of 50 digits. Total times of consecutive repetition of same numbers in this sequence were counted by a computer program. It was written and installed on my computer with the help of TA. This program was instructed to calculate times of repetition by comparing two numbers next to each other. For example,'555' was counted as two repetitions, and '5555' as three repetitions.

Next, based on mathematical theory of probability, theoretical times of repetition of same numbers were calculated in following ways:

$$2000 \times \frac{x}{10 \times 10}$$

x : how many sets of numbers there are in producing a two-digit number with difference of ± 0 - ± 9

2000 is a total digit of the sequence, and there are $10 \times 10 = 100$ kinds of two-digit numbers.

Finally, the sequence was also analyzed in terms of differences between two numbers next to each other Differences between two numbers were ranged between ±1-±9 (±0 was equal to repetition of same numbers). Number of times of producing two consecutive numbers with the difference ±1-±9 were calculated The same process was also calculated in theory using formula above.

By comparing the data of human beings with that of mathematical calculation, the results below was obtained.

Results

The results of analyzing and comparing the data are presented in Figures 1-3. Human beings repeated same numbers (or ±0) less frequently than the theory predicted (Figure 1). Figure 2 shows this:

$$times\ of\ appearance\ for\ human\ beings / times\ of\ appearance\ \ theory\ predicted$$

Figure 2 shows that the number of repetition as to ±0 was approximately two-thirds of that for theory. However, in Figure 2, there was no significant difference between ±0 and ±2 ~ ±9 in how far the figures were from a red line, which suggests that actual human's data equaled to mathematical theory. On the contrary, consecutive numbers (or ±1) were very much preferred by participants in this research (Figure 1). People produced consecutive numbers approximately 1.7 times as frequently as predicted (Figure 2) and the figure for this was much higher than a red line, as compared to ±0 and ±2 ~ ±9. A detailed information as to consecutive numbers is shown in Figure 3.

Human beings produced more consecutive numbers in ascending order than ones in descending order. Figures for ascending order were significantly different between humans and computer; consecutive numbers in ascending orders were produced by humans nearly twice as many times as computer.

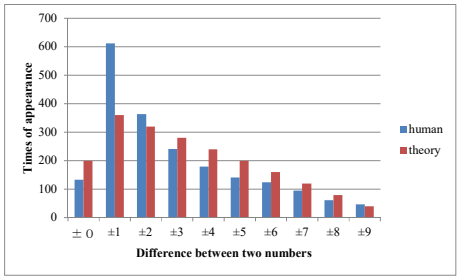

Figure 1: Times of numbers appearance, in terms of difference between two numbers next to each other

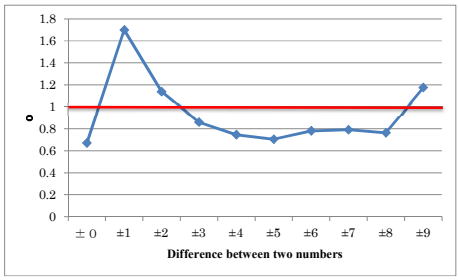

Figure 2: Times of producing two numbers by human beings divided by theoretical ones

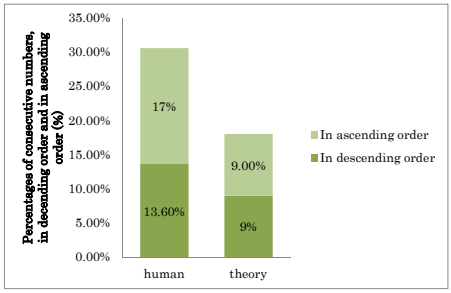

Figure 3: Composition of percentages of consecutive (±1) numbers

Discussion

Consecutive repetition of same numbers (± 0) were preferred indeed as compared to prediction by mathematical calculation. However, when compared to $\pm 1 - \pm 9$, it cannot be concluded that human beings have a definite tendency to avoid repeating same numbers continuously. One reason could be a length of sequences one person produced. Making a sequence of 50 digits in less than one minute might have been boring and stressful for many people, so they could have written same numbers in rush to finish this task. For further research, it might be a good idea to give instructions to produce what they think a random sequence of 8 digits, analyze and then compare the mathematical calculations.

On the other hand, consecutive numbers (± 1) were definitely preferred by humans. They also preferred consecutive numbers in ascending order to ones in descending order. In this respect, Teraoka (1963) pointed out in his paper that human have a tendency to arrange things in such a way that seems natural to them. It is argued by Chater and Vitanyi (2003) that a preference for simplicity can be seen throughout cognition. Considering these claims, consecutive numbers, especially in ascending order, such as '34' or '78' seemed natural to participants in this research and, at the same time, simple.

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S19's Pre-session Paper

The relationship between stimulus and generating randomness

Introduction

Humans can discover patterns in noises, such as identifying the particular word in noises. This ability also has another aspect. For example, people are given two binary sequences, such as HHTHTHTT and HHHHHHHH, some people feels the former is more random. However, these two sequences are equally random, since they have the same probability of being produced by a fair coin (Griffiths & Tenenbaum, 2003). The randomness generated by humans is not really objective. It is called subjective randomness. In psychological research, it has been studied since 1920s. The concept of subjective randomness is not equal to mathematical randomness (Wagenaar, 1972). In contrast to mathematical randomness, the random number sequences generated by humans tend to be affected by the number they said just before (Chapanis, 1953). When we define the sequence made by humans as $R(n)$, the absolute value of $R(n)$ $R(n-1)$ tend to be 1 (Mori, 1986).

These researches say that the randomness produced by humans has a particular pattern (Urushido, 2011). However, they have not revealed what the cause of that phenomenon is. Mental activities may be related to the subjective randomness. We hypothesized certain senses may affect the pattern of random number made by humans. We investigated which stimulus such as sight, hearing and taste, is the most effective on human-generated randomness. We hypothesized that the subjectiveness would be reduced when humans feel stimulus to the sense, since humans consciousness would be preoccupied by the certain stimulus when humans feel something. It is said that the communication capacities of five senses are 10^7 bit/s (sense of sight), 10^6 bit/s (touch), 10^5 bit/s (hearing), and 10^3 bit/s (smell and taste) (Yamada, 1986). The more information content humans receive, the more humans' consciousness will become bothered. Therefore when humans feel the stimulus on sight particularly, the subjectivity will be reduced, since humans will be deprived of the consciousness of making random numbers by the sense of sight. On the other hand, when humans feel the stimulus on smell, the subjectivity will be scarcely removed, since the communication capacity of smell is $1/10^4$ of sight.

Figure 1: The screen shot of "Flying Get"

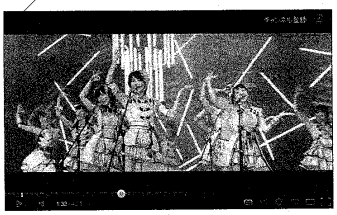


Table 1: The definition of each function

	D(n)
Normal	D_1
Hearing	D_2
Chewing gum	D_3
Watching	D_4
Computer	D_5

Methods

To investigate what stimulus is effective on subjective randomness, volunteers (3 males, 6 females, aged 18-20, students of Tokyo University) were tested in 4 experiments. Random number sequences were made in 4 different situations. Volunteers were asked to try to make random number sequences. 500 numbers (0 to 9) were said without time limit. The 1st situation was normal situation (no additional activities). The 2nd situation was giving stimulus on the sense of hearing. Volunteers said random numbers while hearing their own favorite music. The music each volunteer had heard 10 times at least, since strange music does not attract volunteers. In the 3rd situation, volunteers were given stimulus on the sense of taste. Volunteers said number sequence while chewing gum. XYLITOL (LOTTE, mint flavor) was chosen which has strong stimulus so that volunteers would not fail to feel stimuli on taste. Volunteers were also given stimulus on the sense of sight in the 4th situation. Volunteers made number sequence with watching movie. A video clip, "Flying Get" of a Japanese artist group (AKB48) was chosen, since the whole volunteers knew this group and this video clip was colorful and active, which attracted volunteers (Figure 1).

To investigate random number sequences under 4 different situations are how subjective, these sequences were compared with the random number sequence (0 to 9, 500 numbers) generated by computer. The function, "RANDBETWEEN" (Microsoft Excel), which generate numbers from 0 to 9 randomly, was used. The sequences were made by computer 9 times in order to compare humans and computer.

Each random number sequence was defined as $R(n)$ and $R(n+1)$-$R(n)$ was defined as $D(n)$ (Table 1). The data of number sequences under four different situations was analyzed by counting each value of $D(n)$. The range of the values of $D(n)$ was from -9 to +9. The histogram of $D(n)$ was made. In addition, the histograms of four different situations and computer were compared with each other. The standard deviation of $D(n)$ was computed by using "STDEV.P" (Microsoft Excel).

This series of experiments was done two times in order to ensure that each volunteer has the particular pattern of reaction to each stimulus, for example, sight may be most influential occasionally but taste may be most influential two weeks later. A month later from the experiments for the first time, exactly same experiments were done by the same 9 volunteers, and we compared these two result.

Results

An example of a histogram of $D(n)$ is shown in Table 2. Other data was treated in the same way.

Table 2: The histogram of D(n) (volunteer 1 and computer 1)

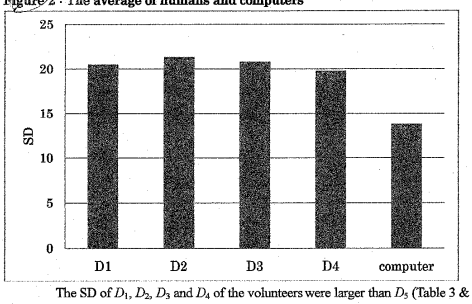
Value of D(n)	D_1	D_2	D_3	D_4	D_5
-9	3	2	3	3	7
-8	6	8	6	5	13
-7	4	8	9	4	14
-6	19	30	20	17	19
-5	27	11	21	28	18
-4	35	25	45	32	28
-3	38	50	41	44	34
-2	51	44	42	69	37
-1	72	76	66	42	40
0	4	7	7	7	50
1	64	56	55	75	44
2	47	53	51	44	47
3	42	35	36	34	40
4	27	36	35	39	22
5	21	19	17	24	24
6	14	12	16	11	17
7	9	9	12	6	13
8	12	13	11	8	10
9	4	5	6	7	7
Standard deviation	20. 8	20.7	18.8	21.3	13.7

The standard deviation (SD) of $D(n)$ was calculated by computer. The SD of each volunteers and computers is shown in Table 3. Also, a figure was made in order to compare the average of humans and the average of computers (Figure 2).

Table 3 : The standard deviation of humans and computer

	D_1(order)	D_2(order)	D_3(order)	D_4(order)
Volunteer 1	20.8 (2)	20.7 (3)	18.8 (4)	21.3 (1)
Volunteer 2	18.8 (2)	25.9 (1)	17.0 (4)	18.4 (3)
Volunteer 3	21.9 (1)	16.5 (3)	16.0 (4)	18.0 (2)
Volunteer 4	22.0 (2)	21.6 (3)	22.1 (1)	19.6 (4)
Volunteer 5	28.4 (1)	26.0 (2)	24.4 (3)	22.5 (4)
Volunteer 6	19.4 (3)	22.0 (2)	22.7 (1)	18.6 (4)
Volunteer 7	23.4 (3)	21.0 (4)	25.3 (1)	24.2 (2)
Volunteer 8	23.1(2)	21.9(3)	24.2(1)	21(4)
Volunteer 9	16.8(2)	15.9(3)	17.1(1)	15.1(4)
Average of humans	20.5(3)	21.3(1)	20.8(2)	19.8(4)
Computer 1	13.7			
Computer 2	14.3			
Computer 3	15			
Computer 4	14.9			
Computer 5	15.1			
Computer 6	12.2			
Computer 7	13.8			
Computer 8	12.7			
Computer 9	12.2			
Average of computer	13.8			

Figure 2 : The average of humans and computers



The SD of D_1, D_2, D_3 and D_4 of the volunteers were larger than D_5 (Table 3 & Figure 2). In addition, there was no significant difference between D_1, D_2, D_3 and D_4.

On the other hand, each volunteer's order of the value of SD was different to each other and there was no apparent relationship between 9 volunteers (Table 3). This property was not distorted, a month later. The experiments were done a month later and the result is shown in the Table 4.

Table 4 : The standard deviation of humans and computers

	D1	D2	D3	D4
Volunteer 1	21.9(2)	20.0(4)	21.1(3)	22.5(1)
Volunteer 2	25.5(3)	25.2(4)	29.2(2)	30.2(1)
Volunteer 3	17.1(4)	20.8(1)	17.3(3)	17.4(2)
Volunteer 4	20.6(1)	21.0(2)	17.0(3)	16.4(4)
Volunteer 5	22.8(1)	22.8(2)	24.2(4)	24.2(3)
Volunteer 6	23.6(3)	27.1(1)	22.0(4)	26.1(2)
Volunteer 7	23.1(1)	22.4(4)	23.1(2)	22.6(3)
Volunteer 8	18.9(4)	24.1(3)	28.1(1)	26.5(2)
Volunteer 9	15.4(2)	16.1(1)	14.2(3)	14.1(4)
Average of human	21.0(4)	22.1(2)	21.8(3)	22.2(1)

Not only there was no apparent relationship between 9 volunteers (Table 4), but also there was no apparent relationship between 1st experiments and the experiments a month later, for example, volunteer 1's order of SD, $D_4 > D_1 > D_2 > D_3$, was replaced by $D_4 > D_1 > D_3 > D_2$ a month later.

Discussion

Firstly, this study shows that subjectiveness affect the SD of $D(n)$ to be larger, since every D_1 was larger than D_5 (Table 3). The reason of this is that the value of D_1 tends to be 1 or -1, and the counts of D_1 (=0) were far less than that of D_5 (=0) (Table 5). The ratio of the count of D_1 (=1 or -1) to the count of D_5 (=1 or -1) is about 7 to 5, and the ratio of the count of D_1 (=0) to the count of D_5 (=0) is about 2 to 5. This supports the previous researches which concluded that humans tended to say the number next to the number just before (Chapanis, 1953). In addition, this result suggests that humans regard the successive numbers as not random. The ratio of the count of D_1 (=0) to the count of D_1 (=1 or -1) is about 10 to 3 or 3 to 1. However, mathematically, the probability that D(n) is equal to 0 is larger than the probability that D(n) is equal to 1 or -1, since 10 combination of binary numbers can be made (0-0, 1-1, ···, 9-9) when the difference of these number is 0, but 9 combination of binary numbers can be made (0-1, 1-2, ···, 8-9) when the difference of these number is 1. The difference between humans' concept of "random" and computer's was shown in this study.

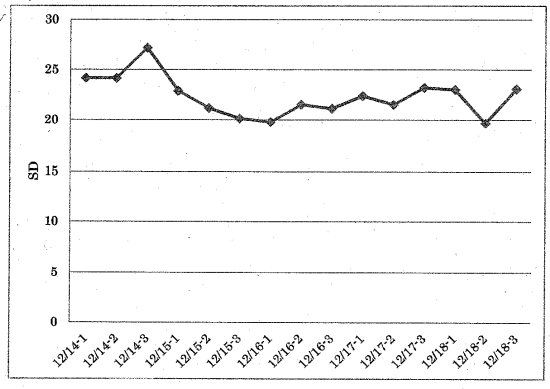
Table 5: The counts of D_1 & D_5

D_1=	1	-1	0
Volunteer 1	64	72	4
Volunteer 2	59	82	27
Volunteer 3	83	71	2
Volunteer 4	82	75	13
Volunteer 5	115	79	52
Volunteer 6	58	64	62
Volunteer 7	94	61	6
Volunteer 8	39	40	7
Volunteer 9	55	47	8
Average	72.1	65.0	20.1

D_5=	1	-1	0
Computer 1	44	40	49
Computer 2	39	37	52
Computer 3	52	36	51
Computer 4	42	47	54
Computer 5	42	31	56
Computer 6	56	41	56
Computer 7	50	44	44
Computer 8	43	42	46
Computer 9	53	45	52
Average	46.0	40.8	51.3

Secondly, this study suggests that there was no relationship between subjective randomness and stimulus on humans' senses. From Table 3 and Table 4, each volunteers' particular pattern of order such as $D_4 > D_1 > D_3 > D_2$ could not found, since the order changed a month later. If each person has the particular pattern of order, the order may not change few weeks later, and if changes, it should not be called "each person's particular order". The suggestion of the absence of relationship between subjective and stimulus is also supported by another experiment we did. A experiment: for five weeks, one of the volunteer generated random numbers (500 numbers, 0 to 9) in normal situation 3 times every day, was done in order to investigate if subjectivity changes as time passes. From Dec. 14, 2011 to Dec. 18, 2011, this experiment was done and the result is shown in Figure 3.

Figure 3 : The relationship between SD and elapsed time



The SD changes in five weeks and even in a day (Figure 3). Also, there is no apparent rule of shift. Therefore, it cannot be said that the orders of Table 3 and Table 4 are not changed by the type of stimulation, since SD changes without stimulus as time passes. There is no connection with stimulus, however, Figure 3 shows a significant result. Figure 2 means that human has the subjectivity, but it does not mean that humans do not have the randomness at all, since the SD of human changes at random as time passes (Figure 3).

Finally, there is an application for our experiment. In our study, it was shown that the subjectivity: humans tend to say successive numbers such as 0-1 or 2-1, and do not think the binary numbers such as 0-0 or 1-1 are not random, make humans distinct from computer. Therefore, it can be said that if humans are forced not to say successive numbers more than 90 times (Table 5), and to say repeated numbers at least 50 times (Table 5), the SD becomes close to computer's SD. In other words, humans may be liberated from subjectivity by some rules.

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S19's Revised Paper

The relationship between stimulus and generating randomness

Introduction

Humans can discover patterns in noises, such as identifying the particular word in noises. This ability also has another aspect. For example, people are given two binary sequences, such as HHTHTHTT and HHHHHHHH, some people feels the former is more random. However, these two sequences are equally random, since they have the same probability of being produced by a fair coin (Griffiths & Tenenbaum, 2003). The randomness generated by humans is not really objective. It is called subjective randomness. In psychological research, it has been studied since 1920s. The concept of subjective randomness is not equal to mathematical randomness (Wagenaar, 1972). In contrast to mathematical randomness, the random number sequences generated by humans tend to be affected by the number they said just before (Chapanis, 1953). When we define the sequence made by humans as $R(n)$, the absolute value of $R(n)-R(n-1)$ tend to be 1 (Mori, 1986).

These researches say that the randomness produced by humans has a particular pattern (Urushido, 2011). However, these researchers have not revealed what the cause of that phenomenon is. Mental activities may be related to the subjective randomness. We hypothesized that certain senses may affect the pattern of random number made by humans. We also hypothesized that the subjectivity would be reduced when humans feel stimulus to the sense, since humans consciousness would be preoccupied by the certain stimulus when humans feel something. It is said that the communication capacities of five senses are 10^7 bit/s (sense of sight), 10^6 bit/s (touch), 10^5 bit/s (hearing), and 10^3 bit/s (smell and taste) (Yamada, 1986). The external stimuli which humans receive will bother consciousness. Therefore when humans feel the stimulus particularly on sight, the subjectivity will be reduced, since humans will be deprived of the consciousness of making random numbers by the sense of sight. On the other hand, when humans feel the stimulus on smell, the subjectivity will be scarcely removed, since the communication capacity of smell is $1/10^4$ of sight. In order to test our hypothesis, we investigated which stimulus such as sight, hearing and taste, is the most effective on human-generated randomness.

Figure 1 : The screen shot of "Flying Get"

Table 1: The definition of each function

	D(n)
Normal	D_1
Hearing	D_2
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Methods

To investigate what stimulus is effective on subjective randomness, volunteers (3 males, 6 females, aged 18-20, students of Tokyo University) were tested in 4 experiments. Random number sequences were made in 4 different situations. Volunteers were asked to try to make random number sequences. 500 numbers (0 to 9) were said without time limit. The 1st situation was normal situation (no additional activities). The 2nd situation was giving stimulus on the sense of hearing. Volunteers said random numbers while hearing their own favorite music. The music each volunteer had heard 10 times at least, since strange music does not attract volunteers. In the 3rd situation, volunteers were given stimulus on the sense of taste. Volunteers said number sequence while chewing gum. XYLITOL (LOTTE, mint flavor) was chosen which has strong stimulus so that volunteers would not fail to feel stimuli on taste. Volunteers were also given stimulus on the sense of sight in the 4th situation. Volunteers made number sequence with watching movie. A video clip, “Flying Get” of a Japanese artist group (AKB48) was chosen, since the whole volunteers knew this group and this video clip was colorful and active, which attracted volunteers (Figure 1).

To investigate how subjective the random number sequences under 4 different situations were, these sequences were compared with the random number sequence (0 to 9, 500 numbers) generated by computer. The function, “RANDBETWEEN” (Microsoft Excel), which generate numbers from 0 to 9 randomly, was used. The sequences were made by computer 9 times in order to compare humans and computer.

Each random number sequence was defined as $R(n)$ and $R(n+1)-R(n)$ was defined as $D(n)$ (Table 1). The data of number sequences under four different situations was analyzed by counting each value of $D(n)$. The range of the values of $D(n)$ was from -9 to +9. The histogram of $D(n)$ was made. In addition, the histograms of four different situations and computer were compared with each other. The standard deviation of $D(n)$ was computed by using “STDEV.P” (Microsoft Excel).

This series of experiments was done two times in order to ensure that each volunteer has the particular pattern of reaction to each stimulus, for example, sight may be most influential occasionally but taste may be most influential two weeks later. A month after the first experiments, exactly the same experiments were done by the same 9 volunteers, and we compared these two results.

Results

An example of a histogram of $D(n)$ is shown in Table 2. Other data was treated in the same way.

Table 2: The histogram of $D(n)$ (volunteer 1 and computer 1)

Value of D(n)	D_1	D_2	D_3	D_4	D_5
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-7	4	8	9	4	14
-6	19	30	20	17	19
-5	27	11	21	28	18
-4	35	25	45	32	28
-3	38	50	41	44	34
-2	51	44	42	69	37
-1	72	76	66	42	40
0	4	7	7	7	50
1	64	56	55	75	44
2	47	53	51	44	47
3	42	35	36	34	40
4	27	36	35	39	22
5	21	19	17	24	24
6	14	12	16	11	17
7	9	9	12	6	13
8	12	13	11	8	10
9	4	5	6	7	7
Standard deviation	20. 8	20.7	18.8	21.3	13.7

The standard deviation (SD) of the count of $D(n)$ was calculated by computer. The SD of each volunteer and computer, and the order of SD are shown in Table 3. Also, a figure was made in order to compare the average of humans and the average of computers (Figure 2).

Table 3 : The standard deviation of humans and computer (first experiments)

	D_1 (order)	D_2 (order)	D_3 (order)	D_4 (order)
Volunteer 1	20.8 (2)	20.7 (3)	18.8 (4)	21.3 (1)
Volunteer 2	18.8 (2)	25.9 (1)	17.0 (4)	18.4 (3)
Volunteer 3	21.9 (1)	16.5 (3)	16.0 (4)	18.0 (2)
Volunteer 4	22.0 (2)	21.6 (3)	22.1 (1)	19.6 (4)
Volunteer 5	28.4 (1)	26.0 (2)	24.4 (3)	22.5 (4)
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Volunteer 7	23.4 (3)	21.0 (4)	25.3 (1)	24.2 (2)
Volunteer 8	23.1 (2)	21.9 (3)	24.2 (1)	21.0 (4)
Volunteer 9	16.8 (2)	15.9 (3)	17.1 (1)	15.1 (4)
Average of humans	20.5 (3)	21.3 (1)	20.8 (2)	19.8 (4)
Computer 1	13.7			
Computer 2	14.3			
Computer 3	15.0			
Computer 4	14.9			
Computer 5	15.1			
Computer 6	12.2			
Computer 7	13.8			
Computer 8	12.7			
Computer 9	12.2			
Average of computer	13.8			

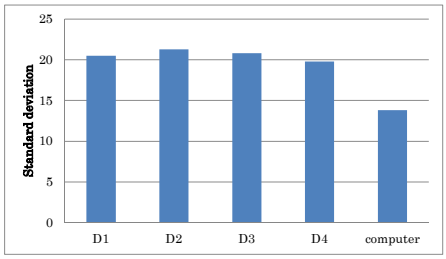

Figure 2 : The average of humans and computers

The SD of D_1, D_2, D_3 and D_4 of the volunteers were larger than D_5 (Table 3 & Figure 2). In addition, there was no significant difference between D_1, D_2, D_3 and D_4. On the other hand, each volunteer's order of the value of SD was different to each other and there was no apparent relationship between 9 volunteers (Table 3). This property was not distorted, a month later. The experiments were done a month later and the result is shown in the Table 4.

Table 4 : The standard deviation of humans and computers (a month later)

	D_1 (order)	D_2 (order)	D_3 (order)	D_4 (order)
Volunteer 1	21.9 (2)	20.0 (4)	21.1 (3)	22.5 (1)
Volunteer 2	25.5 (3)	25.2 (4)	29.2 (2)	30.2 (1)
Volunteer 3	17.1 (4)	20.8 (1)	17.3 (3)	17.4 (2)
Volunteer 4	20.6 (1)	21.0 (2)	17.0 (3)	16.4 (4)
Volunteer 5	22.8 (1)	22.8 (2)	24.2 (4)	24.2 (3)
Volunteer 6	23.6 (3)	27.1 (1)	22.0 (4)	26.1 (2)
Volunteer 7	23.1 (1)	22.4 (4)	23.1 (2)	22.6 (3)
Volunteer 8	18.9 (4)	24.1 (3)	28.1 (1)	26.5 (2)
Volunteer 9	15.4 (2)	16.1 (1)	14.2 (3)	14.1 (4)
Average of human	21.0 (4)	22.1 (2)	21.8 (3)	22.2 (1)

Not only there was no apparent relationship between 9 volunteers' order (Table 4), but also there was no apparent relationship between first experiments (Table 3) and the experiments a month later (Table 4), for example, Volunteer 1's order of SD, $D_4 > D_1 > D_2 > D_3$, was replaced by $D_4 > D_1 > D_3 > D_2$ a month later.

Discussion

Firstly, this study shows that subjectivity affect the SD of $D(n)$ to be larger, since every D_1 was larger than D_5 (Table 3). The reason of this is that the value of D_1 tends to be 1 or -1, and the counts of D_1 (=0) were far less than that of D_5 (=0) (Table 5). The ratio of the count of D_1 (=1 or -1) to the count of D_5 (=1 or -1) is about 3 to 2, and the ratio of the count of D_1 (=0) to the count of D_5 (=0) is about 2 to 5. This supports the previous researches which concluded that humans tended to say the number next to the number just before (Chapanis, 1953). In addition, this result suggests that humans regard the successive numbers as not random. The ratio of the count of D_1 (=0) to the count of D_1 (=1 or -1) is about 7 to 2 or 3 to 1. However, mathematically, the probability that D(n) is equal to 0 is larger than the probability that D(n) is equal to 1 or -1, since 10 combination of binary numbers can be made (0-0, 1-1, ・・・, 9-9) when the difference of these number is 0, but 9 combination of binary numbers can be made (0-1, 1-2, ・・・, 8-9) when the difference of these number is 1. The difference between humans' concept of "random" and computer's was shown in this study.

Table 5: The counts of D_1 & D_5

D_1=	1	-1	0
Volunteer 1	64	72	4
Volunteer 2	59	82	27
Volunteer 3	83	71	2
Volunteer 4	82	75	13
Volunteer 5	115	79	52
Volunteer 6	58	64	62
Volunteer 7	94	61	6
Volunteer 8	39	40	7
Volunteer 9	55	47	8
Average	72.1	65.0	20.1

D_5=	1	-1	0
Computer 1	44	40	49
Computer 2	39	37	52
Computer 3	52	36	51
Computer 4	42	47	54
Computer 5	42	31	56
Computer 6	56	41	56
Computer 7	50	44	44
Computer 8	43	42	46
Computer 9	53	45	52
Average	46.0	40.8	51.3

Secondly, the relationship between subjective randomness and stimulus on humans' senses was not confirmed in our study. From Table 3 and Table 4, each volunteer's particular pattern of order such as $D_4 > D_1 > D_3 > D_2$ could not found, since the order changed a month later. If each person has a particular pattern of order, the order may not change few weeks later, and if the order changes, it should not be called "each person's particular order". The absence of relationship between subjective and stimulus is also supported by preliminary experiment we conducted[1]. An experiment was done in order to investigate if subjectivity changes as time passes. From this experiment, the relationship between the SD and elapsed time is shown in Figure 3.

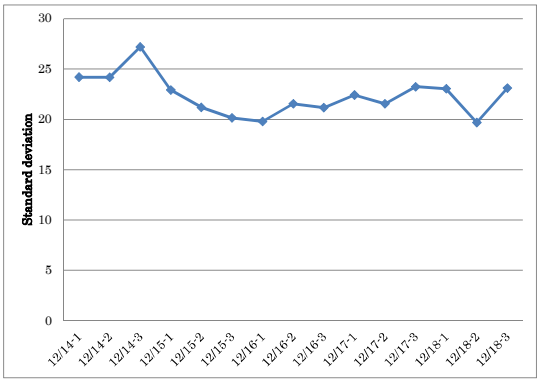

Figure 3 : The relationship between the standard deviation and elapsed time

The SD changed in five weeks and even in a day (Figure 3). Also, there was no apparent rule of shift. Therefore, it cannot be said that the orders of Table 3 and Table 4 are not changed by the type of stimulation, since SD changes without stimulus as time passes. In addition, Figure 3 shows some significant results. Figure 2 indicates that human has the subjectivity, but it does not necessarily mean that humans do not have the randomness at all, since the SD of human changes randomly as time passes (Figure 3).

[1] One of the volunteers generated random numbers (500 numbers, 0 to 9) in the normal situation (no additional activities) 3 times every day, for 5 days from Dec. 14, 2011 to Dec. 18, 2011.

Finally, there is an application of our experiment. In our study, we suggested that there was no relationship between stimulus and subjectivity, since there was not the same order in volunteers and each order changed a month later. These reasons are not reliable, however, since the number of volunteers was insufficient. The 24 patterns of order can be made when 4 quantities are given, and mathematically the probability that there are not the same orders in 9 volunteers is about 18.0 percent.

$$\frac{4!\,{}_9C_9 \cdot 9!}{4!^9} = 0.1795$$

In order to conclude that there is no common order, more volunteers should be needed. Also, if we analyze the data of more volunteers and we do experiments 6 months later or a year later not only a month later, a common order or some rules of change of order may be found, and a certain of relationship between stimulus and subjectivity may be found.

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Introduction

Thierry et al. (2009) showed that language-specific terminology had an implicit effect on human color perception. They found that Greek could perceive light and dark blue grater and faster than English, because there are 2 color terms, ghalazio and ble, which can distinguish light and dark blue in Greek, whereas English has no terms corresponding to them.

Perception is one of the steps of memory. No one can memorize something without seeing or hearing it. Therefore, I hypothesized that color perception had an effect on human memory; when humans try to ~~memory~~ memorize letters, the more familiar with the letters' color ~~humans were~~ are, the better humans memorized them. To test this hypothesis, two different colors were used. One was typical blue, and the other was ~~un~~typical blue. Participants were asked to memorized numbers whose color was typical or ~~un~~typical blue.

~~Now~~ Today we are surrounded ~~with~~ by a lot of letters, such as advertisements, books, marks and etc. The results of this study can be useful to them, because these things should be memorized better, if color familiarity influences humans' memory.

hand in Method draft 2.

In this study, in order to test whether or not familiarity with colors has an effect on humans' memory, two experiments were conducted.

In experiment 1, I prepared two different types of paper; one ~~is~~ was typical blue and the other ~~is un~~ was typical blue, and on each paper, random sequences of numbers(1~9) whose colors were white were written.

In experiment 2, I prepared two different types of white paper; on one paper, random sequence of numbers whose colors were typical blue were written, and on the other paper, numbers whose colors were ~~un~~typical blue were written.

The reason why I choose blue was blue is one of the three primary colors.

After the experiments were prepared, I collected 30 people to participate in these experiments. All participants were students in the university of Tokyo.

In both experiments, 40 numbers were written, and participants were asked to memorize the numbers for thirty seconds and how many numbers they could memorize were recorded.

The Relation between Color Familiarity and Human Memory

Abstract

Thierry et al. (2009) showed that people whose native language has a terminology that represents a certain color could perceive the color greater than people whose native language doesn't have. It is considered that people whose native language has a terminology are more familiar to the color than people whose native language doesn't have. That is to say Thierry et al. (2009) showed that color familiarity affects human perception, but it didn't show the relation between color familiarity and human memory. Perception has a relation with memory. Therefore I wondered whether more familiar color leaded to better memory and I conducted experiments in order to investigate the relationship between color familiarity and human I show that color familiarity affects human memory. Participants could memorize more numbers when paper and letters whose color was atypical blue was used than typical blue. This result will be applied to advertisement and marketing; colors which are easier to memorize will be use preferentially, although further research which will use more kinds of color and a large number of participants in a wide age range is needed before firm conclusion can be drawn.

Keywords: color familiarity, human memory,

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It is considered that people whose native language has a terminology are more familiar to the color than people whose native language doesn't have. That is to say previous research showed that color familiarity affects human perception, but didn't show relation between color familiarity and human memory.

Perception has a relation with memory. No one can memorize something without seeing or hearing it. Therefore, I hypothesized that color perception had an effect on human memory; when humans try to memorize letters, the more typical the letters' color were, the better they memorized them. To test this hypothesis, two different colors were used. One was typical blue, and the other was atypical blue. Participants were asked to memorize numbers whose color was typical or atypical blue.

Today we are surrounded by a lot of letters, such as advertisements, books, marks and etc. The results of this study can be useful to advertising and marketing, because these things should be more easily memorized. If color typicality influences humans' memory, for example, advertisement agencies may use easier color to remember. Authors may use easier color to remember when they write things that they want to emphasize.

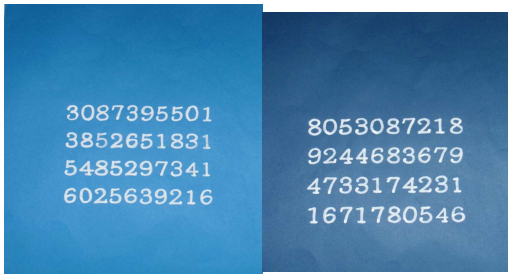
In this study, two experiments were conducted, in order to test whether or not color familiarity has an effect on humans' memory.

Method

In experiment 1, two different types of paper were prepared; one was typical blue and the other was atypical blue, and on each paper, random sequences of numbers (0~9) whose colors were white were written (Fig.1).

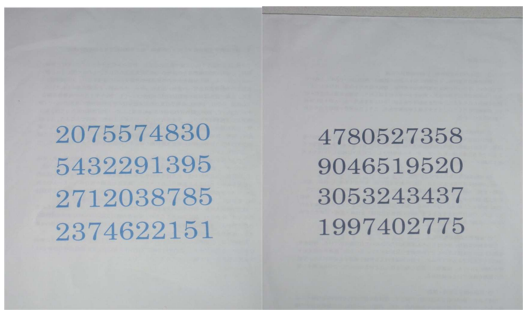
In experiment 2, two different types of white paper were prepared; on one paper, random sequence of numbers whose colors were typical blue were written, and on the other paper, numbers whose colors were atypical blue were written (Fig.2).

In both experiments, 40 numbers were written. After the experiments were prepared, I collected 20 people to participate in these experiments. All participants were university students (14men and 6 women). Participants were asked to memorize the numbers for 30 seconds and how many numbers they could memorize were recorded.



Typical Atypical

Figure 1 papers used in the experiment 1.



Typical Atypical

Figure 2. Papers used in the experiment 2

Results

When typical blue paper and atypical blue paper were used in experiment 1, participants could memorize slightly more numbers on the atypical blue paper than on the typical blue paper.

When the color of numbers was typical blue or atypical blue in experiment 2, participants also could memorize slightly more numbers whose color was atypical blue than typical blue.

In short, when atypical blue was used, participants could memorize more letters. In addition, the difference of the number of the letters that participants were able to memorize was larger in experiment 2 than in experiment 1.

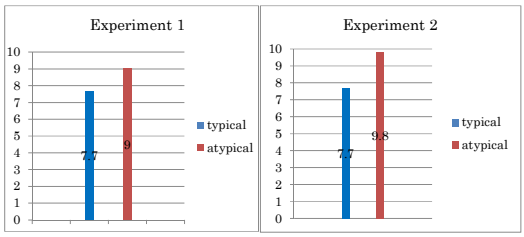


Table 1. The average number of letters participants were able to memorize

Discussion

The result of experiment 1 and 2 is contrary to my hypothesis (when humans try to memorize letters, the more familiar the letters' color is, the better they memorize them).

One possible explanation for this result is that atypical blue attracts more attention than typical blue. because people usually don't see the atypical blue. Strong attention may lead to better memory. Another possible explanation is that the readability is higher when atypical blue was used. If a brightness difference between the color of the paper and the color of the letters is big, the readability is high. And the letter is easier to be memorized so that readability is higher. In these experiments, luminosity difference between white and atypical blue was bigger than typical blue. Therefore experiments with atypical blue which brightness difference with white is smaller should be conducted in the future experiment.

And I found that the difference of the number of the letters that participants were able to memorize was larger in experiment 2 than experiment 1. A possible explanation of this result is that when letters are chromatic color and background is achromatic color, people can memorize them better than a reverse combination. Because it is more important to read the meaning of the letter than the recognition of the existance, it will be easier to memorize letters when they have color.

However, it must be noted that there were some limitations in these experiments. Firstly, only blue was used in these experiments. There are many typical and atypical colors in the world. Secondly, only numbers were used in these experiments. The result may change when alphabets or kanji is used. Thirdly, participants were only university students. Different result might be gotten if younger and older people participate. Therefore, further research will be needed to test the effect of these factors.

If such experiments are accumulate and the relation between color familiarity and human memory become clearer, the knowledge will surely help make a better advertisements or publications or marks.

References

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山脇恵子(Yamawaki Keiko)色彩心理のすべてがわかる本 ナツメ社

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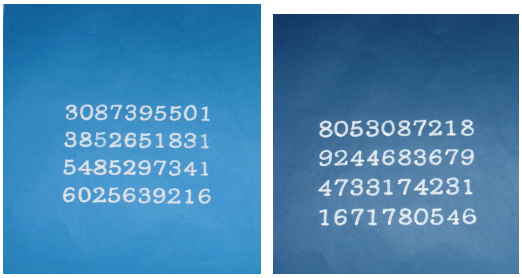

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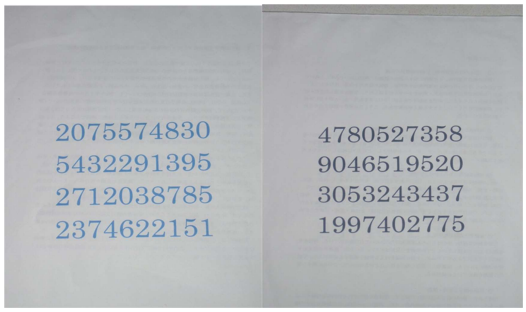

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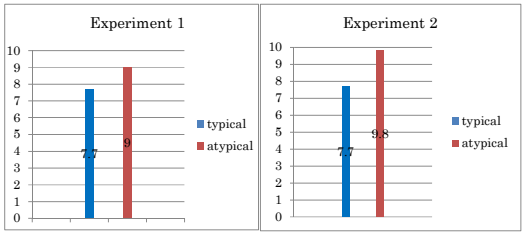

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