博　士　論　文

Individual differences in personality stability and change across the life course: With focus on differential susceptibility

(ライフコースにおけるパーソナリティの変化と安定性の個人差の検討：被影響性の観点に着目して)

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Chapter 1.

Introduction

1.1. History and Current Status of Personality Psychology

Research regarding personality has been widely conducted around the world, and many findings have been compiled. The meaning of the term "personality" has changed over the years (Barenbaum & Winter, 2003; Nicholson, 2003). Personality psychology was considered a topic of abnormal or social psychology (Barenbaum & Winter, 2008). However, personality psychology established a firm position among the subfields of psychology after Allport (1937), Stagner (1937), and Murray (1938) published outstanding books regarding personality (Barenbaum, 2000). Among them, the achievement by Allport (1937) is remarkable. Allport (1937) tried to define personality and described it as "the dynamic organization within the individual of those psychophysical systems that determine his unique adjustments to his environment" (p. 48). This famous definition by Allport (1937) contributed to the idea of "personality traits" that are inner dispositions to direct conduct and are common to all people. On the one hand, Murray tried to understand personality by way of psychoanalysis and abnormal psychology. He called the theory of personality as "Personology," which focused on our "need." Murray (1938) proposed that each person has a unique set of universal basic needs, and that individual differences in these needs are the reason for

the uniqueness of personality.

Afterward, Cattell (1946) qualified traits as the fundamental conceptual sets of personality and argued that the core component of traits is the covariation between behaviors in accordance with Allport. Based on this idea, Cattell (1946) identified 12 factors that represented "the established primary traits" by factor analysis. Although Cattell used oblique rotation to extract these 12 primary traits, Eysenck put more value on orthogonal rather than oblique rotations during the subsequent discussions (Eysenck & Eysenck, 1985). Based on orthogonal factor analysis, Eysenck developed a very simple and influential model of personality, composed of three factors: Psychoticism, Extraversion, and Neuroticism. Eysenck's three traits also became known as the "PEN."

Today, personality psychology has come to focus on psychological trait taxonomy and theoretical models that enable us to explain psychological and behavioral phenomena. Up to the present, factor analysis has promoted the understanding of personality traits. Orthogonally rotated factor analysis provided five robust personality traits—Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to experiences (John, 1990). These five traits are often called the "Big Five" or "Five-Factor Model," which we now have consensus on using (John, Naumann, & Soto,

2008). Extraversion refers to an aggressive approach toward the real world and includes traits such as activity, assertiveness, sociability, and positive emotionality. Agreeableness denotes the prosocial and empathetic orientation toward others and includes traits such as altruism, modesty, tender-mindedness, and trust. Conscientiousness describes the tendency to control impulses according to socially prescribed norms, which facilitates task- and goal-directed behavior. Conscientiousness includes traits such as dutifulness, self-discipline, deliberation, and orderliness. Neuroticism refers to the tendency to experience negative emotions, such as feeling depressed, anxious, nervous, tense, and sad. Neuroticism includes traits such as anxiety, impulsiveness, depression, anger, and vulnerability. Openness to experiences denotes the breadth, depth, and originality of an individual's mental and experiential life and includes traits such as fantasy, aesthetics, adventurousness, and intellect.

The Big Five or the Five-Factor Model was obtained through two approaches. One was a lexical approach that used descriptive human trait adjectives. Goldberg (1990) used the adjective list to reveal the Big Five factors and to verify their generalizability across different samples. Successively, Goldberg (1992) used 100 adjectives to develop a 50-item instrument assessing the Big Five traits. These studies

extracted these five robust common traits from a large number of descriptive trait adjectives (Goldberg, 1990, 1992, 1993). On the other hand, McCrae and Costa developed their personality inventory through a top-down approach. They analyzed the 16PF (Cattell, Eber, & Tatsuoka, 1970) and identified three personality domains—Extraversion, Neuroticism, and Openness to experiences (Costa & McCrae, 1976). Subsequently, they realized that the three personality domains that they identified were very similar to three of the Big Five personality traits. Therefore, they extended their three-domain model of personality by adding Agreeableness and Conscientiousness. In their studies, McCrae and Costa (1985a, 1985b, 1987) showed that their five personality domains were equivalent to the Big Five, and their model was called the Five-Factor Model. Though there was some difference in the domain concepts, such as Openness to experiences, between the Big Five and Five-Factor Model, the two have been used as equivalent models.

However, some personality psychologists have criticized and rejected this five-factor approach (e.g., Block, 1995, 2010; Eysenck, 1992a, 1992b; McAdams, 1992; Pervin, 1994; Westen, 1996). For example, Block (1995, 2010) criticized the assumption, the process, and the statistical method of the five-factor approach.

McAdams (1992) pointed out the inability or limitation of the five-factor approach to explain core constructs of personality functioning and to predict specific behaviors. Despite these various criticisms, the Big Five and Five-Factor Model have made remarkable progress in understanding these broad traits, in offering evidence for their existence, and in providing important findings regarding the outcomes of these traits. Human personality traits can be organized into a hierarchical structure, and the five domains are located at a mid-level (John et al., 2008). Because of this moderate breadth of construct, we can well describe human characteristics using the five domains. Regarding the evidence for their existence, many findings have been accumulated to date. Levels of each Big Five trait are associated with specific gene polymorphisms (Aoki, Iwahashi, Ishigooka, & Ikeda, 2011; Benjamin et al., 1996; Bookman, Taylor, Adams-Campbell, & Kittles, 2002; Ebstein et al., 1996; Eichhammer et al., 2005; Katsuragi et al., 1999; Lesch et al., 1996; Luo, Kranzler, Zuo, Wang, & Gelernter, 2007) and brain structure (Bjørnebekk et al., 2013; DeYoung et al., 2010; Sampaio, Soares, Coutinho, Sousa, & Gonçalves, 2014). Behavioral genetic research revealed that the heritability of these five traits was around .50 (Bouchard & Loehlin, 2001; Johnson, Vernon, & Feiler, 2008; Turkheimer, Pettersson, & Horn, 2014), which suggests that

approximately half of the variance of our personality traits is explained by genetic factors. These findings provided evidence about the biological basis of the Big Five and Five-Factor Model. Moreover, the structure of the five domains was replicated with multiple questionnaires (Costa & McCrae, 2006) and in various cultures (Poortinga, Van de Vijver, & Van Hemert, 2002; Saucier, 2009; Yamagata et al., 2006). Further, these five factors predicted various important outcomes in life (Barrick, Mount, & Judge, 2001; Duckworth, Weir, Tsukayama, & Kwok, 2012; Hampson, Goldberg, Vogt, & Dubanoski, 2006; Ozer & Benet-Martínez, 2006; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007; Turiano, Chapman, Gruenewald, & Mroczek, 2015). Finally, observers by and large concur with the levels of targets' five personality traits (Vazire, 2010; Vazire & Solomon, 2015). All these findings support the existence of the five personality domains.

Furthermore, one additional domain—Honesty-Humility—was recently suggested, and the new model with the added sixth trait was called "HEXACO" (Ashton & Lee, 2007). The HEXACO model suggests that human personality is composed of six rather than five basic domains. The Big Five or the Five-Factor Model and the HEXACO can be compiled into the trait approach to human personality, which

has been the mainstream of personality psychology (Costa & McCrae, 2006; John et al., 2008; Johnson, 1997). This trait approach to human personality offers a collection of viewpoints regarding the fundamental building blocks of human nature and explains humans' moderately consistent behaviors across various situations (Larsen, Buss, & Wismeijer, 2013).

In the meanwhile, another approach to human personality has been debated. While the trait approach considers cross-situational consistency in behavior to be relatively high, the social-cognitive approach considers cross-situational consistency in behavior to be relatively low. This latter approach advocates that social-cognitive mechanisms of situation interpretation are the best way to understand human personality. The social-cognitive approach has its roots in the observation that human behavior is more strongly influenced by the situation than by personality traits (Mischel, 1968). Mischel and Shoda (1995) proposed the concept of cognitive-affective personality system (CAPS), which suggests that the human personality system is composed of multiple cognitive-affective units (CAUs). A CAU refers to a pattern of how an individual reacts to a particular situation as expressed in "if-then" propositions. People have multiple CAUs that constitute the CAPS. In a specific context, which has

certain situational features, particular CAUs become activated and influence cognition, affect, and action. When a situation changes, other CAUs are activated and different actions are derived.

The social-cognitive approach, such as Mischel's (1968), places a particular emphasis on the situations we are in and has been incompatible with the trait approach. In the social-cognitive view, personality is not a collection of traits but an organization of cognitive and affective activities that influence how people respond to certain kinds of situations (Mischel, 2004; Mischel & Shoda, 1995). Thus, the socio-cognitive approach focuses on inter-situation variation of human actions. However, the trait approach insists that individuals with a higher level of certain personality traits act characteristically in a specific situation. In other words, the trait approach focuses on intra-situation variation of human actions. Therefore, the two approaches are not contradictory but rather complementary to each other.

In recent years, an obvious way to integrate these two approaches to personality has been suggested, that is, both traits and situations interact to produce our actions (Funder, 2008; Moskowitz & Fournier, 2015). In this person-situation interactional view, differences between individuals are understood to make a difference only under

specific circumstances. In addition, some traits are specific to certain situations, while other traits are specific to other situations. This situational specificity corresponds to the concept of CAUs as proposed by Mischel and Shoda (1995). This interactional view provides the insight regarding human dynamic behaviors derived from stable traits and changeable situations. Based on this view, we can define personality traits as individual differences in our characteristic patterns of feeling, thinking, and behaving in a particular situation (Roberts, 2009), and can consider personality psychology as a branch of psychology that investigates the stable attributes of human nature and the plastic adaptations to the context in contemporary society (Hogan, 1998).

1.2. Personality Traits over Time

In the person-situation interactional view, situations are changeable but traits are rather stable and dormant. Traits (or CAUs in the socio-cognitive approach) are fixed within one brief segment of time; thus, we wonder if they apply to longer time intervals. Costa and McCrae (1994) stated that personality traits are “set like plaster” over time. However, do people not really change over time? This change-stability debate in personality psychology has continued for over twenty years and been the more recent

and highly regarded. Many studies have addressed stability and change in personality at the population level (e.g., Donnellan, Conger, & Burzette, 2007; Terracciano, McCrae, Brant, & Costa, 2005; Wortman, Lucas, & Donnellan, 2012). Based on these studies, two famous meta-analytic studies showed that personality traits are stable but concurrently changeable (Roberts & DelVecchio, 2000), and that personality traits continue to change over a lifetime (Roberts, Walton, & Viechtbauer, 2006). These descriptive studies revealed the normative developmental trajectories of personality traits and their moderate plasticity.

Recent research has shown that stability and change of personality over time predict socially relevant outcomes. For example, personality stability and change is associated with marital relationships and satisfaction (Roberts, Helson, & Klohnen, 2002; Watson & Humrichouse, 2006), alcohol abuse (Hicks, Durbin, Blonigen, Iacono, & McGue, 2012; Littlefield, Sher, & Wood, 2009), work attitude (Scollon & Diener, 2006; Wille, Hofmans, Feys, & De Fruyt, 2014), academic performance (Klimstra, Luyckx, Germeijs, Meeus, & Goossens, 2012; Robins, Noftle, Trzesniewski, & Roberts, 2005), psychosomatic health (Letzring, Edmonds, & Hampson, 2014; Turiano et al., 2012), and life satisfaction (Boyce, Wood, & Powdthavee, 2013; Magee, Miller, &

Heaven, 2013). In a rapidly changing world, such as the one of today, we should make the most of all our mental and material resources to maintain and enhance well-being (Beddington et al., 2008). These findings are useful to understand our lifelong development and elevate our well-being (Griffin, Mroczek, & Wesbecher, 2015); therefore, research investigating personality stability and change and its outcome is necessary in the future as well.

What other studies have to be carried out? In order to make use of the findings about personality stability and change, we should disclose not only the outcomes but also the determinants and processes of personality stability and change. Previous research investigated the candidate determinants and revealed various factors that partly explained personality stability and change (e.g., Klimstra, Bleidorn, Asendorpf, van Aken, & Denissen, 2013; Lüdtke, Roberts, Trautwein, & Nagy, 2011; Specht, Egloff, & Schmukle, 2011). Especially Lüdtke et al. (2011) and Specht et al. (2011) demonstrated the effects of contextual factors. We expect stability of personality traits to the degree that contextual factors remain stable, but if these factors alter, we would expect change of personality traits (Roberts, Wood, & Caspi, 2008; Turner, Reynolds, Haslam, & Veenstra, 2006; Wood & Denissen, 2015). These findings and ideas offer numerous

suggestions for research about the determinants of personality stability and change. However, compared with research about the outcomes of personality stability and change, research examining the determinants is inadequate because of the low explained variance and various mechanisms underlying the phenomena. Therefore, we have to further investigate additional and robust determinants of personality stability and change.

1.3. Shortage of Research about Personality Stability and Change

As noted in section 1.2., research about determinants of personality stability and change has made progress by focusing on contextual factors (Lüdtke et al., 2011; Roberts et al., 2008; Specht et al., 2011; Turner et al., 2006; Wood & Denissen, 2015). These studies presumed that contextual factors influenced our personality traits, revealed personality changes accompanied by contextual change, and personality stability backed by contextual stability. Environmental causes such as contextual change exert a major impact on our personality. However, previous research revealed a shortage of investigations about individual differences in environmental influences. This perspective has been suggested by several researchers (e.g., Belsky, 1997b, 2005; Boyce

& Ellis, 2005; Ellis, Essex, Boyce, 2005; Rutter, 1996).

In recent years, an evolutionary framework has gained further recognition for understanding personality and individual differences (Buss, 2008; Buss & Hawley, 2010; Buss & Penke, 2015). Belsky (1997, 2005) noted the characteristics of individuals that make them disproportionately vulnerable to adversity and disproportionately likely to benefit from contextual support and referred to these characteristics as "differential susceptibility." A similar concept was referred to as "biological sensitivity to context" (Boyce & Ellis, 2005; Ellis et al., 2005), but these studies converged on the common, unifying claim that individual differences in openness to environmental influences are grounded in and subserved by neurobiological variation in sensitivity to contextual signals and cues (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van Ijzendoorn, 2011). Differential susceptibility, which is underpinned by genetic factors, is adaptive in the evolutionary sense and has been conserved by fluctuating selective pressures that generate different fitness payoffs across different social, physical, and historical contexts (Ellis et al., 2011).

According to the emphasis of evolutionary perspective in personality psychology (Buss, 2008; Buss & Hawley, 2010; Buss & Penke, 2015), it is helpful to

introduce the concept of differential susceptibility to research about personality stability and change. Based on the concept of differential susceptibility, we expect that highly susceptible individuals are influenced by contextual factors. Therefore, if the contextual factors change, highly susceptible individuals might experience more changes of their personality traits. Though the psychology of change has focused on this person-environment interactional view (Reynolds & Branscombe, 2015), it is new to research about personality stability and change. To bring an end to this stagnant situation, the present study investigated personality stability and change focusing on the concept of differential susceptibility.

1.4. Present Study

The main purpose of this study was to investigate stability and change of personality traits over time. As an important viewpoint, this study further focused on the concept of differential susceptibility. There have been abundant previous studies about personality stability and change; however, studies examining their determinants are relatively scarce. Moreover, there are very few studies that incorporated evolutionary perspectives, which are held to be important in personality psychology (Buss, 2008;

Buss & Hawley, 2010; Buss & Penke, 2015). Therefore, the present study examined personality stability and change from the viewpoint of differential susceptibility. For the purpose of the present study, the author outlines previous research about stability and change of personality traits in the next chapter. Because the claim that an individual's personality has changed or remained stable over time is imprecise, we have to first confirm the statistical means to examine stability and change of personality traits in longitudinal research. By doing this, we can establish the conceptual definition of stability and change of personality traits. Then, the author reviews the normative developmental trajectories of personality traits and their individual differences. As described above, especially the individual differences have not been investigated enough. Hence, the author summarizes previous findings about individual differences and proposes the concept of differential susceptibility as one of the determinants.

In Chapter 3, the author examined the individual differences in personality stability and change. The longitudinal data of personality trait scores revealed the normative developmental trajectories and large individual differences. In subsequent Chapter 4, the author investigated the etiology of personality stability and change. Describing only how much personality trait scores change over time does not disclose

the underpinnings of the phenomena. By using longitudinal twin data, we can investigate how genetic and environmental factors affect personality stability and change. In addition, if differential susceptibility, which has firm genetic foundations, contributes to personality change, we can expect that genetic factors significantly influence the change of personality traits. This point is also examined in this chapter.

Differential susceptibility theory can be interpreted from the viewpoint of life history theory (McArthur & Wilson, 1967; Wilson, 1975), which is an integrative and comprehensive theory of organic life-course variability in behavioral and evolutionary ecology. Therefore, in Chapter 5, the author focused on human life-history strategies as differential susceptibility variables and investigated whether highly susceptible individuals tend to be easily influenced by contextual factors. In the subsequent chapter, the author examined this person-environment interaction in the daily environment. Since attachment security is one of the facets of human life-history strategies, and insecure attachment reflects susceptible characteristics, we can expect that individuals with insecure attachment tend to experience personality change through daily environmental influences. The findings in Chapter 5 and 6 provide evidence that susceptible individuals are likely to experience personality change if the contextual

factors change, which supports the usefulness of the differential susceptibility concept to explain personality stability and change.

Finally, the author summarizes the findings of this study and discusses the significance of differential susceptibility theory in the last chapter. Based on the obtained findings, future orientation of research about personality stability and change is discussed.

Chapter 2.

Discussion about Personality Stability and Change

2.1. Conceptual Issues about Personality Stability and Change

Personality stability and change can be examined from various aspects. In this chapter, the author comprehensively outlines a wide range of aspects and a large body of evidence that have been accumulated. Personality stability and change are two facets that constitute human personality development (Larsen et al., 2013). Personality development refers to both the continuities and consistencies of personality traits and the change of personality traits as people age. Large numbers of previous studies have revealed that personality traits develop with age throughout the life span (for reviews, see Roberts et al., 2008; Specht et al., 2014). Though personality traits are defined as stable individual differences in our characteristic patterns of feeling, thinking, and behaving (Roberts, 2009), they can and do change by slow yet certain degrees with age (Roberts et al., 2008; Specht et al., 2014).

This statement seems contradictory. However, stability of personality traits does not denote their complete fixation. Living organisms have open systems characterized by a dynamic equilibrium (von Bertalanffy, 1950), and motility is the core nature of living organisms (Ikegami, 2007). Brickman and Campbell (1971) showed that psychological states fluctuate in people and usually return to an equilibrium level,

which is conducive to a dynamic equilibrium theory of subjective well-being (Headey & Wearing, 1989). Heady (2006) recently illustrated characteristic developmental profiles in subjective well-being over time based on the dynamic equilibrium theory. According to Heady (2006), subjective well-being at a particular time deviates from its normal equilibrium levels. However, when looking at the overall trajectories, the equilibrium level of each person is stable. This stable equilibrium level might change when a major exogenous event occurs, which is also true of personality traits. The levels of personality traits at a particular time deviate from their normal equilibrium levels, but the equilibrium levels are stable over time. That is, our personality is an open system composed of plentiful fluctuating states, which is maintained at an equilibrium level as a whole (cf. Fleeson & Jayawickreme, 2015). Therefore, the equilibrium level is expected to be stable and consistent, but the personality states within an individual are dynamic. When some exogenous events happen, the equilibrium level of the system might change.

Based on the dynamic equilibrium theory, personality development can be defined as change and stabilization of the equilibrium levels of personality traits with age throughout life. Thus, the most important notion is that personality development has

two aspects: stability and change. Change of personality traits does not refer to the fluctuations of states but the change of equilibrium levels, and stability of personality traits denotes the constancy of the equilibrium levels. Since this study did not focus on the stative fluctuations but the equilibrium levels of personality traits, it used quantitative analyses with large samples.

Then, how can we examine personality stability and change? Rank-order stability and mean-level change are basic ways of thinking about personality stability and change over time. Rank-order stability refers to the maintenance of relative ranking of individuals within a group or population. Some researchers call it “differential stability” or “rank-order consistency,” but this study used “rank-order stability” because of the heavy usage in previous studies. In addition, “stability” describes the condition of being steady. The core concept of rank-order stability is steadiness of relative ranking. According to this definition, “rank-order stability” is thought of as more applicable and was thus used in this study.

Rank-order stability is verified with correlation coefficients between the same personality measures administered at two points in time. Correlations are used as an index to examine whether the rank-order of individual personality trait levels within a

group are stable across time and circumstances. When a correlation coefficient is equal to 1, relative ranking of individuals within a group endures over time. The point to note is that rank-order stability coefficients cannot tell us the extent to which individuals grow and mature over time. Rank-order stability coefficients can only show the degree of maintenance of relative ranking.

Compared with rank-order stability, mean-level change refers to the change of average trait levels within a group or population over time. Some researchers call it "absolute change." However, "absolute" is misleading because rank-order change can exist even if the average level is completely stable. Thus, this study used "mean-level change" in accordance with many preceding studies. Examination of mean-level change reveals whether average trait levels increase, decline, or remain constant over time. There are various analytic methods to examine mean-level change. The paired t-test is now a classic method. In recent years, latent growth curve modeling (LGCM: Duncan, Duncan, Strycker, Li, & Alpert, 1999) or hierarchical linear modeling (HLM: Raudenbush & Bryk, 2002) has been used frequently.

LGCM and HLM methods are superior in terms of investigating individual differences in mean-level change. In LGCM and HLM analyses, two latent factors

(intercept and slope) are derived from a set of repeated measurements. The latent intercept factor refers to the initial level at the first wave of measurement, whereas the latent slope factor refers to the change per unit of assessment interval. In these analyses, variances of the latent slope factor denote individual differences in change. Mean-level change and rank-order stability focus on the population level. However, there are also large individual differences in personality stability and change within a group or population. LGCM and HLM analyses can deal with these individual differences as variances of the slope factor.

2.2. Rank-order Stability of Personality

As for rank-order stability of personality traits, several reviews or meta-analyses on this topic have reached similar conclusions that rank-order stability increases with age and does not appear to plateau until after age 50 (Ardelt, 2000; Bazana & Stelmack, 2004; Ferguson, 2010; Roberts & DelVecchio, 2000; Schuerger, Zarrella, & Hotz, 1989). Moreover, rank-order stability coefficients are approximately the same across personality traits, gender, and assessment method. Personality traits show high rank-order stability coefficients that are approximately .5 even over relatively long intervals.

Further, the longer an assessment interval becomes, the lower the rank-order stability gets (Fraley & Roberts, 2005).

These reviews and meta-analyses revealed that rank-order stability linearly increases with age from adolescence onwards. However, its level in childhood, adolescence, and young adulthood was much higher than expected (Roberts et al., 2008). Adolescence is a life-changing phase of humans (Greydanus, 2012), and young adulthood is another demographically dense period of the life course due to life-changing roles and identity decisions (Arnett, 2000). Personality traits show relatively high rank-order stability during these periods despite some large contextual changes.

As described above, the meta-analytic findings showed that rank-order stability linearly increases with age approximately until age 50 (Ardelt, 2000; Bazana & Stelmack, 2004; Ferguson, 2010; Roberts & DelVecchio, 2000; Schuerger et al., 1989), and the final stability level is far from reaching complete consistency. However, the findings regarding rank-order stability after age 50 are inconsistent. Some meta-analytic reviews insist that rank-order stability reaches a plateau after age 50 (Bazana & Stelmack, 2004; Roberts & DelVecchio, 2000), while other reviews claim that rank-order stability continues to increase in old age (Ferguson, 2010; Schuerger et al., 1989).

However, Ardelt (2000) pointed out that rank-order stability coefficients decrease again in old age, which has been supported by recent empirical studies (Lucas & Donnellan, 2011; Specht et al., 2011). In either case, the important point is that rank-order stability of personality traits is relatively high and increases with age from adolescence to late adulthood. Moreover, personality traits show some degree of change at all ages. Costa and McCrae (1994) maintained that personality traits are essentially fixed and unchanging after age 30. However, we consider their perspective to be incorrect.

Despite the moderate changeability of personality traits, they also show a pattern of increasing rank-order stability across the life course. This was outlined as the cumulative continuity principle (Roberts et al., 2008). Rank-order stability remains relatively high with age across various personality traits (Ardelt, 2000; Bazana & Stelmack, 2004; Ferguson, 2010; Roberts & DelVecchio, 2000; Schuerger et al., 1989). In the background of the cumulative continuity throughout life are several reasons including gene-environment correlations and the processes of identity development (Roberts et al., 2008). For example, active gene-environment correlations or active niche picking may enhance the stability of personality traits. Active gene-environment correlations reflect the processes by which people are drawn to and choose experiences

with qualities that are consistent with their own personalities. Based on these processes, people actively select personality-reinforcing context and rank-order stability increases over time.

People's self-concepts about their own personality, which have been described as identity structures, are also associated with personality stability (Roberts & Wood, 2006). In the process of identity development, people develop opinions about themselves through reflection and receiving feedback from others. It was suggested that the set of processes of identity development—exploring, committing to, and maintaining an identity—promotes stability of personality traits (Roberts & Caspi, 2003). Reynolds et al. (2012) used an experimental design and showed that social identity processes could explain personality stability. Moreover, identity is associated with higher levels of psychological well-being and adjustment that are related to high levels of personality stability (Donnellan et al., 2007). As seen above, rank-order stability of personality traits increases with age throughout life because of various underlying factors, such as gene-environment correlation and identity development. The important notion is that high rank-order stability does not signify mean-level stability.

2.3. Mean-level Change of Personality

Mean-level change of personality traits is the second standpoint of personality stability and change and denotes changes of average trait levels within a group or population over time. Mean-level change of personality traits has been examined in many studies. A meta-analytic review used 92 longitudinal studies and showed the patterns of mean-level change of personality traits across the life course (Roberts et al., 2006). Their results showed that the levels of social dominance (one of the facets of Extraversion) and Conscientiousness increase with age. In contrast, the levels of social vitality (the other facet of Extraversion) and Openness increase in adolescence but then decline in old age. The level of Neuroticism declines with age especially in young adulthood, while the level of Agreeableness increases only in old age. The noteworthy feature of this finding is that 4 of the 6 personality traits demonstrated significant increase or decline in middle and old age. Moreover, cross-sectional studies with large samples offered results consistent with this meta-analytic finding (Donnellan & Lucas, 2008; Jackson et al., 2009; Kawamoto et al., 2015; Lehmann, Denissen, Allemand, & Penke, 2013; McCrae et al., 1999, 2000; Soto, John, Gosling, & Potter, 2011; Srivastava, Oliver, Gosling, & Potter, 2003). Further, these overall patterns have also

been found using peer-reports of personality traits (McCrae, Terracciano, & Members of the Personality Profiles of Cultures Project, 2005) and experience sampling methodologies (Noftle & Fleeson, 2010).

Because these widespread trajectories of personality trait changes correspond to people's nature becoming more functional (Roberts & Wood, 2006), they are described as the maturity principle (Roberts et al., 2008). Maturity denotes that people have come to possess qualities that serve to facilitate functioning in society. As people get older, they begin to increasingly appreciate communal characteristics, such as being confident, generous, truthful, and dependable (Wortman & Wood, 2014). Moreover, mean-level changes of personality traits are associated with those of trait-related goals (Roberts, O'Donnell, & Robins, 2004). Thus, people change in measures of personality traits in a direction toward becoming socially more mature and functional with age.

As the maturity principle shows, the levels of our personality traits alter in a socially desirable way over the lifetime. The contextual demands in our circumstances canalize the overall trajectories of personality change (Roberts et al., 2008; Turner et al., 2006; Wood & Denissen, 2015). However, if the contextual factors change, do the normative trajectories of personality alter? For example, there are gender differences in

desirable and undesirable traits (Ricciardelli & Williams, 1995). These different contextual factors might cause gender differences in the way these traits develop over time. Previous empirical findings showed that reliable gender differences exist for several personality traits (e.g., Schmitt, Realo, Voracek, & Allik, 2008). However, small or no gender differences in personality trait development over time have been found (e.g., Klimstra, Hale, Raaijmakers, Branje, & Meeus, 2009; Roberts, Caspi, & Moffitt, 2001; Terracciano et al., 2005). This aspect has been questioned within mean-level personality change.

Based on the evolutionary perspective on human personality and individual differences (Buss, 2008; Buss & Hawley, 2010; Buss & Penke, 2015), there has been some indication about gender differences in personality development. For example, evolutionary theorists pointed out gender differences in mate selection (Buss, 1989; Kenrick, Sadalia, Goth, & Trost, 1990) and sociosexuality (Gangestad & Simpson, 1990; Schmitt, 2005). Buss (1994) contended that strong gender differences are reliably observed in domains closely linked with sex and mating, precisely as predicted by psychological theories based on sexual selection. According to these suggestions, we can expect that substantial gender differences emerge in the developmental trajectories

of the Big Five traits, because they are associated with sex, mating, and parenting (de Miguel & Buss, 2011; Nettle, 2005; Nettle & Clegg, 2006, 2008; Nettle & Liddle, 2008).

Besides gender differences, both cohort and generation were related to differential patterns of mean-level change. Cultures change over time and create various social contexts and environments. Cohort and generation are shaped by these social contexts and environments. It was suggested that broad cultural norms and values can affect personality and its development (Twenge, 2015). Younger cohorts are more extraverted (Twenge, 2001), more neurotic (Twenge, 2000), and more narcissistic (Twenge & Foster, 2010), as demonstrated in American samples. Moreover, they are more likely to favor extrinsic values, which are called self-enhancement values, and less likely to favor intrinsic values, which are called self-transcendent values (Twenge, Campbell, Freeman, 2012). However, different tendencies have been confirmed in other regions (Billstedt et al., 2013; Smits, Dolan, Vorst, Wicherts, & Timmerman, 2011). Thus, these cohort findings emphasize the importance of social contexts, social climates, and culture in which people live at a particular time. Presumably, these social factors might influence desirable traits, values, and goals, which then affect the way in

which our personality traits develop.

2.4. Individual Differences in Personality Change

Though a meta-analytic review of mean-level personality change showed that people experience changes of personality trait levels (Roberts et al., 2006), reviews of rank-order stability suggested that the relative rankings of personality trait levels are not completely maintained over time (Ardelt, 2000; Bazana & Stelmack, 2004; Ferguson, 2010; Roberts & DelVecchio, 2000; Schuerger et al., 1989). Not everyone shows the same patterns of mean-level change of personality traits across the life course; instead, each person shows different developmental patterns. In other words, there are broad individual differences in personality change. Many studies examining mean-level change and rank-order stability of personality have been conducted, which were summarized in meta-analytic reviews. In contrast, the number of studies examining individual differences in personality change is relatively small.

When investigating individual differences, past research used the reliable change index (RCI: Christensen & Mendoza, 1986; Jacobson & Traux, 1991), which quantifies the probability of observing a difference score equal to or greater than the one observed

previously, assuming that no change has occurred. Using RCI scores, previous studies classified individuals as having increased or declined on each personality trait (e.g., Roberts et al., 2001; Robins, Fraley, Roberts, & Trzesniewski, 2001). They indicated that some people show no reliable change of any personality trait, while other people experience reliable increase or decline of some personality traits. In other words, there are broad individual differences in personality change.

Recent studies have used relatively new statistical methods, such as HLM and LGCM analyses, to examine individual differences. As described above, these methods simultaneously investigate both the normative mean-level change of personality traits and their individual differences. In these analyses, individual differences are evaluated as variances of the slope factor. Some recent studies used these methods to show substantial individual differences (e.g., Terracciano et al., 2005; Terracciano, McCrae, & Costa, 2006; Vaidya, Gray, Haig, Mroczek, & Watson, 2008; Van den Akker, Deković, Asscher, & Prinzie, 2014). The findings of these studies demonstrate that not only the initial levels of personality trait scores but also their changes can have high variances and that these can be partly explained by gender, cohort, and other factors.

In addition, individual differences in personality change have been investigated

from the viewpoint of life experiences. For example, the levels of some personality traits can increase or decline due to work involvement and investment (Hudson, Roberts, & Lodi-Smith, 2012; Le, Donnellan, & Conger, 2014; Roberts, Caspi, & Moffitt, 2003), international mobility and overseas study (Eby, 2005; Zimmermann & Neyer, 2013), and various life events (Kandler, Bleidorn, Riemann, Angleitner, & Spinath, 2012; Lüdtke et al., 2011; Vaidya, Gray, Haig, & Watson, 2002). These studies demonstrate the importance of various environmental factors for the personality change that people individually experience. Some behavioral genetic studies also contend that non-shared environmental factors chiefly account for variances of personality change (for a review, see Bleidorn, Kandler, & Caspi, 2014), which supports the phenotypic findings.

However, these previous studies have two problems. First, there has been a lacking viewpoint of gene-environment or person-environment interaction in previous studies, which merely investigated mean-level influences of life experiences on personality changes. However, Bleidorn et al. (2014) pointed out that gene-environment interaction may be involved in shaping developmental trajectories of personality traits, which is one of the future research issues about personality development. To explain a

larger portion of the variance of personality change, we should pay attention to the interaction between person and environment.

Second, as pointed out above, previous studies examining individual differences in personality change have failed to focus on an evolutionary perspective. Nonetheless, some recent reviews have contended the significance of an evolutionary perspective for personality psychology (Buss, 2008; Buss & Hawley, 2010; Buss & Penke, 2015). From the viewpoint of evolutionary adaptive individual differences, individual differences of personality reflect condition-linked differences in the costs and benefits of personality traits (Lewis, 2015). Furthermore, based on the condition-dependent model of personality, changes of personality traits over time are caused by changes in condition across the lifespan (Lewis, 2015). This evolutionary adaptive perspective supports the plasticity of human personality traits. However, within the framework of evolutionary adaptive individual differences, not everyone adapts to an environmental condition. Some previous studies contended the existence of individual differences in susceptibility or sensitivity to environmental influences (Belsky, 1997b, 2005; Boyce & Ellis, 2005; Ellis et al., 2005; Rutter, 1996). As noted above, Belsky (1997, 2005) suggested the concept of differential susceptibility, which corresponds to intra-

individual characteristics maintained in evolutionary history. Differential susceptibility theory insists that certain characteristics called susceptibility, which are partly determined by genetic factors, interact with environmental factors and create individual differences. Hence, the gist of differential susceptibility is person-environment interactions in development (Belsky, 1997b, 2005; Ellis et al., 2011). These two problems listed above further seem to be interlinked. Thus, the question arises: Who has susceptible characteristics? The next section explains this point.

2.5. Who Is Susceptible? Discussion from an Evolutionary Perspective

As indicated in the preceding section, individual differences in personality change have not been sufficiently investigated. In addition, previous studies have paid relatively little attention to the person-environment interaction and evolutionary perspective. Recently, a thought-provoking suggestion was offered in evolutionary psychology. The strategic differentiation-integration effort (SD-IE) hypothesis is a new evolutionary theory relating individual differences in organization of life history traits to life history strategy (Figueredo, Woodley, Brown, & Ross, 2013). This variability in the organization of conative traits might cause individual differences in the adaptation to

environmental conditions. Thus, the SD-IE hypothesis predicts that individuals evolving and developing in predictable and controllable environments strategically adapt to stable and specific conditions; in contrast, those evolving and developing in unpredictable and uncontrollable environments strategically maximize their flexibility in migrating between different conditions (Figueredo et al., 2013). The subsequent section first describes life history theory, which comprises the basis of the SD-IE hypothesis in detail, and then provides explanations of the SD-IE hypothesis.

2.5.1. Fundamentals of life history theory

Life history (LH) theory (McArthur & Wilson, 1967; Wilson, 1975) has been used mainly in evolutionary biology and ecology. LH proposes manners of survivorship and reproduction of organisms, while LH strategy indicates planned composites of LH traits including some characteristics related with growth, reproduction, and survivorship of organisms, such as reproductive years, fecundity, and dispositions associated with how individuals allocate their resources. LH theory explains that organisms allocate their total bioenergetic and material resources between the somatic (devoted to the continued survival and maintenance of the individual organism) and reproductive effort.

The latter can be divided into two components: mating effort (or obtaining and retaining sexual partners) and parental effort (enhancing the survival of the offspring).

LH theory has been applied to explain differences between species. The contrast between r- and K-selected species (Pianka, 1970) has been used to illustrate the variability of species-specific energy allocation based on LH theory. The former usually allocate more resources to the mating effort, while the latter distribute their energy more to the somatic and parental effort. More recently, researchers have used this theory to explain individual differences within species. In this case, the contrast between r- and K-selected behaviors accounted for LH strategies determining the resource allocation by members of a particular species as adaptations to environmental conditions (Rushton, 1985). LH theory was initially developed to explain animal behavior but has become increasingly useful for understanding human behavior (e.g., Belsky, Houts, & Fearon, 2010). According to LH theory, individuals with a high-*K* LH strategy, who allocate more energy to somatic than to reproductive effort and focus more on parental effort than on mating, manifest better general health, more positive development in psychosomatic functioning, and greater investment in biological relatives, because more energy is channeled to biological pathways of somatic maintenance, growth, activity,

and parenting than to mating (Kirkwood & Austad, 2000). To put it simply, more bioenergetic and material resources of high-*K* individuals are allocated into cellular maintenance and repair processes, immune function, and so forth, which correlates directly with health and longevity, resulting in better general health and more positive development.

LH theory has led to numerous hypotheses about human behaviors and diseases—for example, LH strategies can be associated with general health, personality, social relationships, or demographic variables, (e.g., Figueredo, Vásquez, Brumbach, & Schneider, 2004, 2007; Figueredo, Vásquez et al., 2005), which are considered LH indicators. Alternatively, some studies found that adult LH strategies are partly determined by specific features of their early environment (Belsky et al., 2010; Kuzawa, McDade, Adair, & Lee, 2010). Furthermore, nowadays, some psychological and epidemiological research has considered how early adverse environments predict adult behaviors and disorders (Listl, Watt, & Tsakos, 2014; Waynforth, 2012). LH theory is thus used as a valuable framework for understanding human lifelong development.

2.5.2. The strategic differentiation-integration effort hypothesis

The LH strategies of individuals become adapted to their environments through two fundamental processes: evolution and development. Organisms allocate their resources through a combination of evolutionary and developmental responses to environmental harshness and unpredictability. These allocation trade-offs are conducive to adaptive coordination between LH strategies and environmental conditions. (Ellis, Figueredo, Brumbach, & Schlomer, 2009). According to LH theory, high-*K* LH strategies are favored in stable and predictable environments through natural selection. By contrast, low-*K* LH strategies are favored in unstable and unpredictable environments. Because of the stability and predictability of extrinsic environments, high-*K* LH strategies are controllable by genetically influenced developmental processes, which results in stability of environmental conditions that make LH strategies higher-*K* selected. However, low-*K* LH strategies are uncontrollable by genetically influenced developmental processes because of instability and unpredictability of environments, which results in instability of environmental conditions that make LH strategies lower-*K* selected (Ellis et al., 2009).

These reinforcing processes theoretically yield the idea that the predictability and controllability of the environment over time affect not only the patterns of resource

allocation but also the optimization of niche fitting that prescribes the organization of life history traits (Figueredo et al., 2013). According to the idea of Figueredo et al. (2013), individuals evolving and developing in predictable, controllable environments are socially selected to become more socio-ecologically specialized. That is, individuals with high-*K* LH strategies should become more strategically differentiated in behavior to adapt to stable and specific socio-cultural micro-niches. In contrast, individuals evolving and developing in unpredictable, uncontrollable environments are socially selected to become more socio-ecologically generalized to allow contingent switching among unstable socio-cultural micro-niches. In other words, individuals with low-*K* LH strategies should become more strategically integrated in behavior to maximize flexibility in migrating between socio-cultural micro-niches.

The strategic differentiation and integration of LH traits are a core belief of the SD-IE hypothesis. Through strategic differentiation, high-*K* individuals separately allocate resources among components of fitness, and the resource allocation pattern is consistent over time. As a result, high-*K* individuals achieve socio-ecological specialization among people in conative dimensions. Meanwhile, through strategic integration, low-*K* individuals reallocate resources among alternative components of

fitness depending on the changing environmental conditions. Therefore, in low-*K* individuals, the resource allocation pattern is transient. Consequently, low-*K* individuals receive more merits by socio-ecological generalization based on strategic integration (Figueredo et al., 2013).

Figueredo et al. (2013) examined whether the SD–IE could be validated in both student and other demographic samples at the level of individual differences and showed that the theory held at the individual level. Subsequent studies showed that it also held at the population level (Fernandes & Woodley, 2013; Woodley & Fernandes, 2014; Woodley, Fernandes, & Madison, 2014). According to these empirical studies, the SD-IE hypothesis seems to be validated.

2.5.3. Susceptibility and SD-IE hypothesis

As described above, the SD-IE hypothesis contends that high-*K* individuals strategically differentiate their LH traits to adapt to stable, predictable environments. By contrast, low-*K* individuals integrate their LH traits to adapt to unstable, unpredictable environments (Figueredo et al., 2013). As a result of this adaptation, high-*K* individuals' LH traits are considered temporally stable; in contrast, those of low-*K* individuals are

considered changeable and malleable. Hence, we can expect that low-*K* individuals have susceptible characteristics to adapt to unstable, changing, and unpredictable environments. When confronted with changes in environmental conditions, they are liable to change their LH traits to adapt to the new environment. In sum, based on the SD-IE hypothesis, individual differences in the LH continuum (*r*–*K*) reflect those in susceptibility.

Differential susceptibility is one of the conditional adaptation strategies (Belsky, 1997b, 2005; Ellis et al., 2011). From an evolutionary perspective, it is adaptive to use earlier experiences to guide later development in recurring environmental conditions in which the future is roughly consistent with the past (Pigliucci, 2001). However, because the future is inherently uncertain, conditional adaptation strategies have some theoretical problems. Based on this argument, Belsky (1997, 2005) proposed that natural selection in evolutionary history has maintained genes for conditional developmental strategies. Therefore, individual differences in susceptibility have been shaped by evolutionary processes and have firm genetic foundations. It was pointed out that such conditional strategies are shaped not only by environmental factors to better fit the organism to the future environment but also by firm genetic factors (Rowe,

Vazsonyi, & Figueredo, 1997). Moreover, LH strategies are shaped by genetic and environmental factors (Figueredo et al., 2004). These consistent observations also demonstrate that the LH continuum reflects the degree of susceptible characteristics.

2.6. Investigating Individual Differences in Personality Change from the Viewpoint of Susceptibility

Differential susceptibility theory contends that individuals with high susceptibility tend to increase or decline various trait levels in response to positive and negative alterations of environmental conditions. As noted above, previous studies investigating individual differences in personality change have examined the effects of life experiences (Kandler et al., 2012; Lüdtke et al., 2011; Vaidya et al., 2002). However, by introducing the differential susceptibility perspective into this research, we can focus on the person-environment interaction of personality change, which has been deemed an important issue (Bleidorn et al., 2014; Johnson, 2007). According to the SD-IE hypothesis, the LH continuum reflects individual differences in susceptibility. Especially low-*K* individuals are considered to be relatively more susceptible and responsive to changes in environmental conditions, because such susceptible

phenotypes are adaptive to unstable, unpredictable environments. In contrast, high-*K* individuals are considered relatively stable, because such temporarily stable phenotypes are adaptive to stable, predictable environments.

Unlike the diathesis–stress model (see Zuckerman, 1999), the concept of differential susceptibility contends that susceptible individuals produce more negative outcomes under negative environments and more positive outcomes under positive environments. The diathesis–stress model, which is the dominant paradigm in psychology and psychopathology, claims that individuals with a specific vulnerability are disproportionately or even exclusively likely to be adversely affected only by environmental stressors. By contrast, differential susceptibility theory focuses not only on being adversely affected by negative environmental factors, but also on being positively affected by positive environmental factors. The idea of person-environment interaction is new to studies on personality change; however, it is also unique and valuable to focus on being positively affected by favorable environmental conditions.

Chapter 3.

Personality Stability and Change in Japanese: Focusing on Individual Differences

3.1. Introduction

Much research about personality stability and change has been conducted over the past twenty years. Researchers have been interested in whether personality can change. Costa and McCrae (1994) suggested that personality traits are set like plaster after the age of 30. However, considerable evidence for personality change has been presented (e.g., Bleidorn, 2012; De Fruyt et al., 2006; Josefsson et al., 2013; Klimstra et al., 2013; Mõttus, Johnson, & Deary, 2012; Neyer & Lehnart, 2007; Parker, Lüdtke, Trautwein, & Roberts, 2012; Pullmann, Raudsepp, & Allik, 2006; Roberts et al., 2001; Robins et al., 2001; Specht et al., 2011; Terracciano et al., 2005; van Aken, Denissen, Branje, Dubas, & Goossens, 2006; Wortman et al., 2012). Today, personality traits are considered to be plastic and adaptable to new environmental conditions (Lewis, 2015). However, as noted in the preceding chapter, research focusing on individual differences in personality change is not enough despite the abundant evidence of mean-level change and rank-order stability of personality traits. Therefore, this chapter examines individual differences in personality change with an adolescent sample that has received relatively scant attention.

3.1.1. Overview of mean-level change in personality

Many studies have examined mean-level changes in personality and discussed how much average personality scores change over time (for a meta-analytic review, see Roberts et al., 2006). Both longitudinal and cross-sectional studies have reported mean-level personality changes in the Big Five, which measures human personality in five domains—Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to experiences—and is widely used (John et al., 2008), across the life span (e.g., Donnellan & Lucas, 2008; Jackson et al., 2009; Lehmann et al., 2013; Mõttus et al., 2012; Soto et al., 2011; Srivastava et al., 2003; Terracciano et al., 2005; Wortman et al., 2012). Findings from both of these longitudinal and cross-sectional studies are largely concordant with a meta-analytic summary of mean-level changes in longitudinal samples (Roberts et al., 2006). Generally, average levels of Agreeableness and Conscientiousness increase across the life span, but Conscientiousness may decline in later life. Neuroticism increases in adolescence and gradually declines, although some studies have failed to support this pattern (e.g., Donnellan & Lucas, 2008). Extraversion and Openness tend to decline across the life span, although Roberts et al. (2006) showed important differences between these two Extraversion facets: the mean levels of social

dominance, one of the facets of Extraversion, increased from the college years, while the mean levels of sociability, the other facet of Extraversion, remained constant.

3.1.2. Personality change in adolescence

Mean-level personality changes have been discussed principally in Western countries, and it has been shown that younger people, especially adolescents, are relatively prone to experience a larger degree of personality change (Roberts & Delvecchio, 2000; Roberts et al., 2006). Therefore, it is better to investigate personality change in adolescence for the purpose of verifying the extent to which personality traits change and the factors related to personality change.

There are several previous studies focusing on personality change in adolescence. Most of them examined adolescent personality change with a measure of the five major personality domains (Branje, Van Lieshout, & Gerris, 2007; De Fruyt et al., 2006; Klimstra et al., 2009; McCrae et al., 2002; Pullmann et al., 2006; Van den Akker et al., 2014), while some studies used other personality measures, such as the Eysenck Personality Questionnaire (Canals, Vigil-Colet, Chico, & Martí-Henneberg, 2005) or the California Child Q-Set (Lamb, Chuang, Wessels, Broberg, & Hwang,

2002). All of them utilized Western adolescent samples, which is one of the problems with previous research on adolescent personality change. To discover more detailed developmental trajectories of adolescent personality change, we have to obtain additional findings from non-Western countries.

Moreover, one of the major problems in previous studies is that the findings are contradictory and ambiguous. For example, McCrae et al. (2002) analyzed adolescent Big Five personality changes with the Revised NEO Personality Inventory (Costa & McCrae, 1992), and showed that only female adolescents increased in their level of Neuroticism. This interaction effect between age and gender on Neuroticism was observed in other longitudinal (Canals et al., 2005; Van den Akker et al., 2014) and cross-sectional research (Soto et al., 2011). However, other studies failed to support this gender and age interaction pattern in Neuroticism. Some studies showed a stable level of Neuroticism in adolescence (Branje et al, 2007; Lamb et al., 2002), while others indicated a decrease in Neuroticism (De Fruyt et al., 2006; Klimstra et al., 2009; Pullmann et al., 2006). Much the same is true for Extraversion. Van den Akker et al. (2014), for example, investigated mean-level personality development in Flemish children from 6 to 20 years of age with the Hierarchical Personality Inventory for

Children (HiPIC; Mervielde & De Fruyt, 1999) and found a decrease in Extraversion, which was supported by other studies (Branje et al., 2007; Lamb et al., 2002; Soto et al., 2011). However, Pullmann et al. (2006) and Canals et al. (2005) conversely found that Extraversion increased, while other research failed to observe a significant change (De Fruyt et al., 2006; Klimstra et al., 2009; McCrae et al., 2002).

As described, the findings of the preceding studies are inconsistent and were obtained only from Western samples. Thus, this study focused on a Japanese adolescent sample, which had not been examined previously, and investigated mean-level personality changes, especially in Neuroticism and Extraversion.

3.1.3. Yatabe-Guilford Personality Inventory

The sample in this study was given the Yatabe-Guilford Personality Inventory (YGPI; Yatabe, 1975), which was developed in Japan based on three Guilford-Martin inventories (Guilford, 1940; Guilford & Martin, 1943a, 1943b). The YGPI consists of 12 traits: *Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Nervousness*, *Lack of Objectivity*, *Lack of Cooperativeness*, *Lack of Agreeableness, General Activity*, *Rhathymia*, *Thinking Extroversion*, *Ascendance*, and *Social Extroversion*. *Depression*

refers to the inclination to become gloomy and pessimistic and to have feelings of guilt. *Cyclic Tendency* describes the tendency to conspicuously change one's mood and to become emotionally unstable. *Inferiority Feelings* denotes a lack of confidence, uncomfortableness, and underestimation of oneself. *Nervousness* represents the tendency to become surprised, impatient with trivial matters, and restless. *Lack of Objectivity* indicates the inclination to refer everything to oneself, to be sensitive to criticism, and to become easily confused. *Lack of Cooperativeness* describes the inclination to suspect others, to dislike successful people, and to have the belief that people are dishonest. *Lack of Agreeableness* represents the tendency to hate to lose, to be selfish, and to quarrel with others. *General Activity* denotes the tendency to be lively and eager. *Rhathymia* describes the tendency to be easygoing, lighthearted, and happy. *Thinking Extroversion* indicates the tendency to not pay attention to details and to take one's failures quite easily. *Ascendance* refers to social dominance and social leadership. *Social Extroversion* describes a social vitality and tendency to seek social relationships. Item examples of each YGPI scale are shown in Appendix A.

The 12 YGPI scales cover the Neuroticism and Extraversion domains of the Big Five personality inventory (Shimonaka, 1996; Natsuno, 1998). In this regard, the YGPI

is similar to the Guilford-Zimmerman Temperament Survey (GZTS; Guilford, Zimmerman, & Guilford, 1976). Shimonaka (1996) investigated correlations between the YGPI and the Revised NEO Personality Inventory (NEO-PI-R), for which the results are also shown in Appendix A. The NEO-PI-R domains, especially Neuroticism and Extraversion, are correlated with some of the YGPI subscales.

3.1.4. Cross-sectional and multilevel modeling studies of mean-level personality changes

Cross-sectional studies are an effective method for measuring personality development trajectories. Several studies have taken cross-sectional approaches to investigate lifelong personality development and have shown personality development trajectories at the population level. However, these findings can only be substantiated if the birth cohort effect is eliminated. Compared with the limited approaches, such as cross-sectional studies, longitudinal studies are a more informative and effective approach to understand personality changes or development. When dealing with longitudinal data, multilevel modeling approaches including hierarchical linear modeling (HLM; Bryk & Raudenbush, 1987, 1992) represent one of the most

efficacious strategies. Although the number of assessments and ages at which participants are tested differ from person to person, HLM, a very flexible method, can accommodate these differences. For example, Terracciano et al. (2006) adopted an HLM method for the GZTS data collected between 1958 and 2002 in the Baltimore Longitudinal Study of Aging (BLSA), which varied in retest interval and number of administrations per individual and showed cumulative mean-level changes in some subscales of the GZTS across adulthood. Other research similarly utilized HLM analyses to reveal normative personality developmental curves and individual differences (e.g., Helson, Jones, & Kwan, 2002; Jones, Livson, & Peskin, 2003; Steunenberg, Twisk, Beekman, Deeg, & Kerkhof, 2005; Terracciano et al., 2005).

To maximize the information from the data of this study, we employed both a cross-sectional approach and HLM on Japanese adolescent data to determine normative personality changes. Additionally, this study investigated two variables, gender and birth cohort, which may moderate normative age changes. Personality changes may differ for male and female adolescents. As mentioned above, cross-sectional (Soto et al., 2011) and longitudinal studies (Canals et al., 2005; McCrae et al., 2002; Van den Akker et al., 2014) have indicated different age trajectories between both genders.

The birth cohort is also thought to influence personality. Two meta-analytic studies have indicated a shift in Neuroticism and Extraversion toward substantially higher levels in American samples (Twenge, 2000, 2001). As for Extraversion, recent empirical studies support the meta-analytic research (Twenge, 2001). For example, Terracciano et al. (2005, 2006) found that later-born cohorts showed linear increases in some facets of Extraversion in an American sample, and a similar trend was observed in a Dutch (Smits et al., 2011) and Swedish sample (Billstedt et al., 2013). However, the findings regarding secular change in Neuroticism are inconsistent. Though Twenge (2000) insisted on the shift of Neuroticism toward substantially higher levels in Americans, some empirical studies have shown the opposite trend (Smits et al., 2011; Terracciano et al., 2005, 2006) or a non-shift of Neuroticism (Billstedt et al., 2013).

Based on the above, we can make two statements especially for the Neuroticism and Extraversion domains: the shift of Neuroticism toward higher levels has remained unclear, while the preceding studies mostly reflect a shift toward higher levels of Extraversion. Because the birth cohort effect can be thought to reflect the sociocultural context in each culture or society, it is important to collect empirical data across many cultures or nations to comprehensively understand the effect of the birth cohort on

personality. Although these previous studies indicated moderating effects of gender and birth cohort, no research has focused on this aspect in a Japanese sample. Therefore, the present study attempted to investigate normative age changes in Japanese adolescents focusing on gender and birth cohort moderation effects.

3.1.5. Present study

This study investigated Japanese adolescent personality changes with the YGPI. According to Shimonaka (1996), *Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Nervousness*, *Lack of Objectivity*, and *Lack of Cooperativeness* are positively correlated with Neuroticism of the NEO-PI-R. Therefore, we can expect that the scores of these 6 traits may increase during adolescence. In addition, the increase for female adolescents may be larger, because previous studies have shown that the Neuroticism scores of females tend to increase (Canals et al., 2005; McCrae et al., 2002; Soto et al., 2011; Van den Akker et al., 2014). It is also expected that these 6 traits of the YGPI may be influenced by the birth cohort. Because previous findings in non-American samples suggested a shift of Neuroticism toward lower (Smits et al., 2011) or stable levels (Billstedt et al., 2013), it is expected that the Neuroticism related trait scores will

decrease or remain stable across birth cohorts.

As for Extraversion, previous studies reached inconsistent conclusions; however, relatively recent studies have shown a decrease of Extraversion in adolescence (e.g., Branje et al., 2007; Van den Akker et al., 2014). The current study investigates whether Extraversion decreases during adolescence. In the YGPI, *General Activity*, *Rhathymia*, *Ascendance*, and *Social Extroversion* are positively correlated with Extraversion in the NEO-PI-R. Therefore, we can expect that these 4 scales may decline during adolescence, and that the birth cohort may elevate the scores of these scales because previous studies have suggested that birth cohort changes Extraversion in a positive direction (Billstedt et al., 2013; Smits et al., 2011; Terracciano et al., 2005, 2006; Twenge, 2001).

As for *Thinking Extroversion*, this scale is positively correlated with Extraversion but negatively associated with Neuroticism (Shimonaka, 1996). Thus, we can expect that this scale declines during adolescence, and the degree of decrease may be larger in female adolescents. Because *Lack of Agreeableness* is weakly correlated with all Big Five traits except for Conscientiousness, this study did not build a hypothesis for that scale.

3.2. Material and Methods

3.2.1. Participants and procedures

The sample consisted of 3,656 students who entered the secondary school affiliated with the Faculty of Education, at the University of Tokyo. The students were invited to participate in the study after entering the school. The research began in 1950, and numerous educational, psychological, and physical indicators have been collected up to the present. The personality indicators were collected from 1981 to 2010 with the YGPI (Yatabe, 1975). The YGPI was administered to the sample once or twice during the 6 years of attendance at the school. The mean age at the first administration was 13.23 years (N = 3,656; SD_{age} = 1.35; range 12–18; 1,832 female) and that of the second was 15.85 (N = 1,733; SD_{age} = 0.84; range 15–18; 857 female). In short, the YGPI was administered once to 1,923 students (975 female; $Median_{\text{birth cohort}}$ = 1974; $Mean_{\text{birth cohort}}$ = 1977; $SD_{\text{birth cohort}}$ = 10.8; range 1963–1998) and twice to the remaining 1,733 students (857 female; $Median_{\text{birth cohort}}$ = 1986; $Mean_{\text{birth cohort}}$ = 1984; $SD_{\text{birth cohort}}$ = 7.5; range 1966–1994). A chi-square test revealed that gender distribution was not biased between the two groups (χ^2 = 0.521, df = 1, p = .47), and Welch's t-test revealed

that the sample that took the YGPI once was born earlier than the rest of the sample (t = –21.97, df = 3445.80, p < .001).

3.2.2. Measure

The Yatabe-Guilford Personality Inventory (Yatabe, 1975) was used to measure adolescent personality. The 12 YGPI scales are valid and reliable (Tsujioka, 2000). The internal consistency reliability coefficients range from .70 to .92 (*Median* = .85), and the test-retest reliability estimates from one month for the 12 scales range from .56 to .82 (*Median* = .73; Tsujioka, 2000). All participants in the present study completed the YGPI at school. Each trait of the YGPI contains 10 items rated on a 3-point scale: 0 (no), 1 (yes and no), and 2 (yes). The score for each trait was calculated from the 10 items after dealing with reverse scoring. The theoretical range of personality scores is from 0 to 20.

3.2.3. Data analyses

3.2.3.1. Cross-sectional analyses

Cross-sectional analyses were performed on the first administration available for

each participant (N = 3,656; M_{age} = 13.23; SD_{age} = 1.35; range 12–18; 1,832 female). The YGPI scores were standardized as T-scores (M = 50, SD = 10). We used regression models to determine the relation of age and gender to the YGPI personality scores. Based on previous studies of curvilinear age effects on personality (e.g., Srivastava et al., 2003; Terracciano et al., 2005), it seemed that cubic models with gender interactions are the most complex models in cross-sectional analyses of personality age differences. Therefore, the cubic models were set as a practical limit on the model complexity, and the three following models were considered for each YGPI scale.

Linear: $YGPI = \alpha + \beta_1(age) + \beta_2(gender) + \beta_3(age \times gender)$.

Quadratic: $YGPI = \alpha + \beta_1(age) + \beta_2(gender) + \beta_3(age \times gender) + \beta_4(age^2) + \beta_5(age^2 \times gender)$.

Cubic: $YGPI = \alpha + \beta_1(age) + \beta_2(gender) + \beta_3(age \times gender) + \beta_4(age^2) + \beta_5(age^2 \times gender) + \beta_6(age^3) + \beta_7(age^3 \times gender)$.

To select the best model among these three, the criterion was set that a more complex model would only be adopted if it improved the fit at $F > 4.61$ (p = .01) over a simpler model. Data analysis of the cross-sectional approach was conducted using the *psych* package (Revelle, 2014) by R 3.1.0 (R Core Team, 2013).

3.2.3.2. HLM analyses

HLM can be applied to evaluate individuals' growth trajectories and can address data that include a varying number and spacing of measurements across persons based on the assumption that the time-series observations in every individual are nested within a person. In addition, even data from individuals who were assessed only once can be used to stabilize estimates of the mean and variance. Thus, HLM can use all available data in the analyses without loss of any information, which is a strong point of performing analysis with HLM.

HLM is termed hierarchical in that it can investigate both individual-level changes (Level-1) and individual-level differences in change (Level-2). At Level-1, the data of each individual are in general fitted to a regression model (linear, quadratic, or other higher-order models). Because the data used in this study were composed of participants tested only once or twice, a linear regression model was used. At Level-2, individual difference variables, such as gender and birth cohort, are used to explain between-individuals variation in the intercepts and linear slopes obtained in the Level-1 models. To appraise the curves of personality change, the Level-1 model was

determined first and then tested with possible Level-2 predictors. After the Level-1 model was determined, gender and year of birth were entered in the model as Level-2 variables. Age was centered on the grand mean (M = 14.1 years), and year of birth was centered on its grand mean (1981). Data analysis of the HLM approach was conducted using Mplus ver. 7 (Muthén & Muthén, 2012).

3.3. Results

3.3.1. Age differences in the mean levels of the YGPI by cross-sectional analyses

Because the number of people whose first administration occurred at 18 years of age was small (3 for male; 2 for female), we decided to combine them with those at 17 years of age. Descriptive statistics for each age group (12, 13, 14, 15, 16, and 17 and over) are shown in Table 3.1. The results of the linear regressions for the 12 scales are reported in Table 3.2. Significant linear (for *Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Nervousness*, *Lack of Agreeableness*, *Thinking Extroversion*, and *Ascendance*), curvilinear (for *Social Extroversion*), and cubic (for *Lack of Cooperativeness*) effects of age were observed. The linear slopes suggest that there were age differences from 2 to 6 *T*-score points among the 6 years.

Gender differences of approximately 2 *T*-score points were also observed (for *Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Lack of Objectivity*, *Lack of Cooperativeness*, *Lack of Agreeableness*, *Rhathymia*, *Thinking Extroversion*, *Ascendance*, *Social Extroversion*), which suggest that female adolescents scored higher than male adolescents on the Neuroticism and Extraversion scales of the YGPI. In addition, an Age × Gender interaction was observed for *Nervousness*. The interaction shows that male adolescents became more nervous during their adolescent years.

3.3.2. HLM analyses of mean-level changes in the YGPI

To estimate the proportion of stable variance in the YGPI personality traits, which can be computed as the proportion of between-individual variance (u_0: intercept variance) to the total variance (u_0: intercept variance + σ_0^2: within-individual variance), the researcher used between- and within-individual variance estimates from the random-coefficients regression model (Raudenbush & Bryk, 2002, p. 26). This ratio, which is called *intraclass* correlation, indicates that the proportion of variance that was stable over the course of this study ranged from 40.3% for *Thinking Extroversion* to 56.9% for *Social Extroversion* (*Median* = 46.2%; *Mean* = 47.9%), and the remaining portion was

within subjects. The HLM results for the final models of the 12 YGPI scales are reported in Table 3.3.

3.3.2.1. Fixed effects

The linear fixed effects are very important for specifying the shape of the developmental trajectory. Estimated age trajectories for the 9 YGPI scales in which age effects were statistically significant are described in Figure 3.1. For the scales in which cohort effects were significant, three different birth cohort trajectories (1971, 1981, and 1991) are depicted, and trajectories are shown separately for male and female adolescents for the scales that showed significant gender differences. As for the six YGPI scales related to Neuroticism, the results show that the scores of these scales, except for *Lack of Cooperativeness*, increase linearly in adolescence. In contrast, the four YGPI scales related to Extraversion have different patterns. The *General Activity* and *Rhathymia* scores are stable, and the *Ascendance* and *Social Extroversion* scores decline slightly in adolescence. The remaining two scales, *Lack of Agreeableness* and *Thinking Extroversion*, showed statistically significant linear fixed effects. The *Lack of Agreeableness* score increases and the *Thinking Extroversion* score declines during

adolescence.

3.3.2.2. Random effects

The random effect terms (u_0: variance) associated with the intercepts showed between-individual differences in personality traits. They were all statistically significant and similar to the residual within-individual variance (σ^2). Variances associated with the linear slopes were significant for four YGPI scales, indicating that for those scales, the individual slopes deviated from the overall trends.

3.3.2.3. Gender and birth cohort effect on the intercept and slope

Gender was a significant predictor of the intercept for 10 of the 12 YGPI scales. Female adolescents scored higher on Neuroticism related scales—*Depression*, *Cyclic Tendency*, *Inferiority Feelings,* and *Lack of Objectivity*—and Extraversion related scales—*Rhathymia*, *Ascendance*, and *Social Extroversion*. Furthermore, female adolescents also scored higher on *Thinking Extroversion*, which is correlated with both Neuroticism and Extraversion. In contrast, male adolescents scored higher on *Lack of Cooperativeness* and *Lack of Agreeableness*. As for the effects on linear slope, gender

might not be a substantial predictor. Gender had effects on the linear slopes only for *Inferiority Feelings* and *Nervousness*, which indicates that male adolescents increased scores on those scales at a larger rate than females during adolescence.

The birth cohort centered on the mean (1981) was a significant predictor of the intercept for 9 of the 12 YGPI scales. Later-born cohorts had higher intercepts (approximately 0.5 *T*-score point per five years) on six Neuroticism related scales—*Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Lack of Objectivity*, and *Lack of Cooperativeness*—and lower intercepts on three other scales—*Lack of Agreeableness*, *Thinking Extroversion*, and *Social Extroversion*. The birth cohort was also a significant predictor of the linear slope of *Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Lack of Objectivity*, *Lack of Agreeableness*, and *Social Extroversion*. Later-born cohorts increased more in these scales, except for *Social Extroversion*, in which they declined more.

3.4. Discussion

This study examined personality changes during adolescence in a Japanese sample. The strengths of this study include the large sample size, the use of a relatively

rare Japanese adolescent sample, the use of multiple statistical analyses, and the use of the birth cohort as a continuous variable. In contrast, the limitations of this study are the use of a single, self-report questionnaire to measure adolescent personality, the Japanese domestic questionnaire (i.e., Yatabe-Guilford Personality Inventory), and the fact that the sample was obtained from one school. Stable individual differences in self-report response styles have been indicated (McCrae & Costa, 2008), and it is well known that mono-rater measures of personality constructs are susceptible to random and systematic error components (Campbell & Fiske, 1959). To control for these biases, it is crucial to use additional measurement methods or independent ratings by well-informed observers (Hofstee, 1994; Kandler, Riemann, Spinath, & Angleitner, 2010). Indeed, some empirical studies have obtained reasonable findings regarding personality development through the use of self- and peer-reported personality scores (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2012; Kandler, Bleidorn et al., 2010; Kandler, Riemann, & Angleitner, 2013). Future research should investigate adolescent personality development with multiple-method or multiple-rater personality data to reduce random and systematic errors. Much of the same is true for the sampling issue. We should collect additional data from other schools in Japan to further validate the

findings of this study in future research.

Further, the small number of measurements of personality was a limitation of the present study. Because individuals with only 1 or 2 waves of longitudinal data provide less information about within-person variation, they contribute less to the variance component estimation (Singer & Willett, 2003, p. 148). The variances of the linear slopes were small, and only for *Cyclic Tendency*, *Nervousness*, *Ascendance*, and *Social Extroversion* were the residual variances significantly associated with the linear slopes. The present study dealt with two variables (birth cohort and gender) as covariates. Future research should collect longitudinal data from three or more assessments, resulting in further investigation of individual differences in personality change with multiple covariates.

Despite these limitations, this study obtained significant results. The linear changes were statistically significant for 9 of the 12 YGPI scales. Notably, the Neuroticism related scale scores increased linearly, and the Extraversion related scale scores were stable or declined linearly, which supports the hypotheses of this study. The amount of estimated change in these traits ranged approximately from 1.5 to 5 *T*-score points per five years in the cross-sectional analyses. In the HLM analyses, the estimated

change in these traits ranged approximately from 2.5 to 7.5 *T*-score points per five years, which was slightly larger than the cross-sectional analysis results. The amount of estimated change obtained in this study is relatively larger than that in preceding studies focusing on adult samples (e.g., Helson et al., 2002; Terracciano et al., 2005, 2006). As the meta-analysis by Roberts et al. (2006) noted, personality change is relatively easy to observe at a younger age.

Gender had an influence on adolescent personality in the present study. Both cross-sectional and HLM analyses revealed that female adolescents were more neurotic and extraverted. These results also support the hypotheses. In addition, the birth cohort had an influence on adolescent personality. The HLM analyses indicated that later-born cohorts showed higher Neuroticism related trait scores and larger increases in these scores. For some Extraversion related traits, later-born cohorts had lower scores and showed more decline. The hypotheses regarding birth cohort effect on Neuroticism and Extraversion related traits were not supported by these results.

3.4.1. Normative mean-level change of adolescent personality

This study indicated that adolescents experience normative negative changes in

the Neuroticism and Extraversion related traits, which means that adolescents become more neurotic and less extraverted during their adolescent years. These results are concordant with previous findings (e.g., Soto et al., 2011; Van den Akker et al., 2014). Examining the change in Extraversion in more detail, the *General Activity* and *Rhathymia* scores were stable in the cross-sectional and HLM analyses. The *Ascendance* score, which refers to social dominance and social leadership, declined at a rate of approximately 2.5 *T*-score points per five years, both in the HLM and cross-sectional analyses. In neuroscience research, it has been noted that adolescent brains show a functional imbalance, such that the reward and aversive systems are relatively more activated than the top-down control systems, which are belatedly activated after the adolescent years (Casey, Duhoux, & Cohen, 2010; Casey, Getz, & Galvan, 2008; Spear, 2013). The top-down control systems develop and enable emotional perspective taking during adolescence (Choudhury, Blakemore, & Charman, 2006). Therefore, adolescents' socially dominant behaviors may decrease gradually because of their acquired capacity for the emotional perspectives of other people.

The *Social Extroversion* score declined at a rate of approximately 2.5 *T*-score points per five years in the HLM; however, the cross-sectional analysis showed a

quadratic age effect on this scale. Because the data in this study included the participants whose personality was assessed only once or twice during the 6 years of attendance at school, the quadratic and cubic age effects were not examined in the HLM analysis. The HLM analysis showed a negative cohort effect on the slope of *Social Extroversion*. In addition, the sample that completed the YGPI once was born earlier than the rest of the sample. Combined with these two points, the result of *Social Extroversion* in the cross-sectional analysis was biased toward reducing the decrease of this scale. Thus, we can place our confidence in the HLM result of *Social Extroversion* that there was a linear decline. However, why do Japanese adolescents' scores of *Social Extroversion*, which indicates sociability or social vitality, decline? It was suggested that some Japanese adolescents develop *taijin kyofusho*, which refers to a disorder of fear of interpersonal relations, and even normal adolescents tend to show some social anxiety (Okada, 1993). The decline of *Social Extroversion* may be thought of as a culturally specific trend, and it is necessary to further investigate this issue.

As for Neuroticism related scales, the estimated changes in these traits were approximately 5 *T*-score points per five years in the HLM analyses and 3.5 *T*-score points per five years in the cross-sectional analyses. As with *Social Extroversion*, the

HLM results were slightly different from the cross-sectional results. Because the HLM analyses showed a positive cohort effect on the slope of Neuroticism related traits, which is further discussed later in this discussion, and because the sample that completed the YGPI once was born earlier than the rest of the sample, the results of these traits in the cross-sectional analyses were biased toward reducing the increase in these scales. We can place more value on the HLM results of the Neuroticism related traits that indicate a linear increase. Although this study showed an increase in Neuroticism in both male and female adolescents, previous studies have shown that female adolescents become more neurotic/less emotionally stable (Canals et al., 2005; McCrae et al., 2002; Van den Akker et al., 2014). In other words, the results of this study unexpectedly show that male adolescents also increase their Neuroticism level. These results have been confirmed by prior findings in Japan. For example, Denda, Kako, Kitagawa, and Koyama (2006) found a significant increase in Japanese adolescents' depression scores with increasing age. Suzuki et al. (2011) showed that Japanese adolescents' mental health status worsens with advancing grades in school and that their mental health status is associated with their sleep status. Such a trend of Neuroticism in Japanese adolescents might be due to physiological changes in that

period, because it was suggested that a depressive tendency in children and adolescents is associated with some hormonal abnormality (e.g., Abe et al., 2009). This might also be due to stress specific to the adolescent period in Japan. Ishige and Muto (2005) indicated that Japanese adolescents tend to feel anxiety or depression under academic stress, especially from examinations. These contextual environmental effects could also influence Japanese adolescents.

3.4.2. Gender and birth cohort effects on adolescent personality change

Gender had an effect on both Neuroticism and Extraversion related traits. It was shown that female adolescents are more neurotic and extraverted. The HLM analyses suggested that gender had an influence mainly on the intercepts but not on the slopes, which indicates gender differences in the initial levels of personality. The females' higher scores on Neuroticism and Extraversion are concordant with preceding studies regarding gender differences in personality (e.g., Schmitt et al., 2008). However, why are female adolescents' scores higher on these two traits? These gender differences in the initial levels of personality may be related to differences in cerebral cortical development. During early adolescence, females undergo a faster acceleration in their

cerebral cortical development than males (Giedd et al., 1999) and remain more advanced than male adolescents until 14–15 years (Andrich & Styles, 1994; Colom & Lynn, 2004). Consequently, female adolescents are generally approximately 2 years ahead of male adolescents both in social-cognitive and intellectual functioning (Silberman & Snarey, 1993; Porteous, 1985). These differences in brain development may explain the earlier personality development of female adolescents compared to male adolescents.

The gender differences in the initial levels of personality may also be interpreted as a reflection of the traditional gender roles in Japan. According to the social role model approach (Eagly, 1987), gender differences derive from common social expectations of how males and females should feel, think, and behave. Gender roles are internalized in infancy and childhood through socialization processes and shape both personality traits and trait-relevant behaviors. Because the traditional gender role in Japan that females should be quiet and gregarious is alive and well (Morinaga, Frieze, & Ferligoj, 1993; Shirakawa, Shiraishi, & Sukemune, 1992), the higher initial levels of female Neuroticism and Extraversion can be thought of as an expression of gender roles. To further investigate this issue, future research should examine adolescent

personality development from childhood or earlier.

Birth cohort effects on personality were also revealed in the present study. The trend that later born cohorts in this study showed higher Neuroticism related trait scores and a greater increase in Neuroticism was reflected in previous meta-analysis studies with American samples (Twenge, 2000). The novel finding in the present study consists of the cohort effects on the slopes of Neuroticism related traits. Though modest birth cohort effects were observed in the study by Terracciano et al. (2005), the consistent cohort effects on the slopes of Neuroticism in the present study have never been observed. This is because the sample size of every birth cohort was relatively well balanced and the power of the cohort effect was large. In contrast, the birth cohort effects on Extraversion in this study are inconsistent with preceding studies in Western countries (Billstedt et al., 2013; Smits et al., 2011; Twenge, 2001; Terracciano et al., 2005, 2006). These previous studies found that later-born cohorts were more extraverted; however, such a trend was not observed in this study. Moreover, one Extraversion related trait, *Social Extroversion*, showed the opposite trend to the previous findings that later-born cohorts were less extraverted. *Thinking Extroversion*, which is correlated with both Extraversion and Neuroticism, also showed a decline. In

sum, later-born Japanese adolescents showed more Neuroticism and less Extraversion at the initial level and became more neurotic than the earlier born cohorts.

Such cohort effects on the initial levels may be due to a secular trend in puberty (for a review, see Walvoord, 2010). The early onset of puberty may cause earlier and more severe emotional instability specific to adolescence (Mensah et al., 2013). Thus, we believe that these cohort effects are established by the early onset of puberty in later-born cohorts. Alternatively, such effects may also be due to Japanese sociocultural factors. In Japan, a significant increase in income inequality occurred in the 1980s and 1990s, and the poverty rate is one of the highest among advanced countries (Tachibanaki, 2006). The poverty rate of young people is particularly high, which results from the very high rate of youth unemployment and low wages caused by shorter working hours. A sense of social stagnation in Japan has become stronger since the end of the 1980s because of these conditions (Hein, 2008). This sociocultural background could have a relatively large influence on adolescents' Neuroticism and Extraversion levels. As for the cohort effects on the slopes of Neuroticism, the sociocultural background may also have an influence. Adolescents are thought to be more affected by the social context as they grow up, because what is expected from them by society

becomes greater and greater. Moreover, because many adolescents head for college and postpone taking a job, the suspenseful adolescent years are extended, which may cause the increase in Neuroticism. Being in unpredictable situations may elicit anxiety and depression in the adolescents.

The cohort effects obtained in this study are from a Japanese sample that lives in a Westernized, educated, industrialized, rich, and democratic (WEIRD) country. As described above, these cohort effects can be thought of as a reflection of sociocultural factors. Though there are some differences in the details between the results of this study and those of preceding studies, they are broadly similar. It is necessary to investigate cohort effects on personality development in non-WEIRD countries in the future.

3.5. Conclusion and Suggestion

The present chapter investigated individual differences in personality stability and change. According to the results, Japanese adolescents increase the level of Neuroticism and slightly decrease the level of Extraversion across their adolescent years. In addition, these changes involve much variance, which refers to large individual

differences in personality stability and change. Moreover, the variances were partly explained by participants' gender and birth cohort: female adolescents were more neurotic and more extraverted, while later-born cohorts showed higher initial levels of Neuroticism and became more neurotic than earlier-born cohorts.

These findings offer fundamental descriptions of adolescent personality development. Because previous findings focusing on adolescent years have been inconsistent, the findings of this study provide material for discussion. Along with this, they provide valuable suggestions that could be applied to clinical areas. Adolescents become relatively independent from their parents (Casey, 2015), are more susceptible to peer influences than adults (Steinberg & Monahan, 2007), and form romantic relationships that are as important as peer relationships (Connolly & McIsaac, 2009). At the same time, they are predisposed to develop mental health problems such as clinical depression and suicidal behaviors (McKenna, Hawk, Mullen, & Hertz, 2011). Adolescents are primarily burdened by these mental health problems (Gore et al., 2011), and the current study indicated that they showed an increase in Neuroticism levels of nearly 0.5 *SD* over the adolescent years. Based on this finding, adolescents who show a greater increase in Neuroticism levels should be considered in need for help and

assistance.

In addition, the observed secular trends are thought of as evidence that personality stability and change are influenced by contextual factors. This finding is also important for education policymakers. In addition to the findings of this study, the level of adolescent self-esteem has decreased linearly with survey year in Japan (Oshio, Okada, Mogaki, Namikawa, & Wakita, 2014). Combining these findings, Japanese adolescents seem to show increasingly negative developmental trajectories in psychological traits. As noted above, the change of social climate and socioeconomy in Japan is considered the possible reason (Hein, 2008; Tachibanaki, 2006). Furthermore, it is rather important for teachers, schools, and students to use this finding to improve educational practice.

In recent years, socioemotional development in childhood and adolescence has received increased attention globally (OECD, 2015). Because socioemotional development across the life course can affect well-being and successful aging, it has attracted research attention including the possibility of effective intervention methods (Beddington et al., 2008). The obtained finding raises the possibility to affect students' socioemotional development by altering their social context. In addition, it emphasizes

the need to consider countermeasures against the negative trends in Japanese adolescents. However, the empirical studies regarding socioemotional development of Japanese children and adolescents are scarce; thus, more empirical evidence should be accumulated first.

Table 3.1

Means of the YGPI scales from the first administration for each age

	Age											
	Male						Female					
YGPI scales	12	13	14	15	16	17 and 18	12	13	14	15	16	17 and 18
Depression	47.89	48.88	48.25	50.40	50.74	54.35	50.39	50.56	51.02	52.97	53.37	53.60
Cyclic Tendency	48.39	49.16	46.89	49.63	50.27	52.90	50.61	51.00	50.50	51.02	51.90	51.57
Inferiority Feelings	48.81	49.26	48.36	50.04	48.81	52.35	50.83	50.83	48.84	51.05	51.16	50.33
Nervousness	48.86	49.82	48.46	51.08	50.19	54.73	50.52	50.08	48.26	49.93	51.54	50.28
Lack of Objectivity	48.40	49.28	46.17	50.09	47.54	49.22	51.39	51.42	50.59	50.70	50.23	49.66
Lack of Cooperativeness	50.26	51.70	49.82	49.39	49.72	52.75	49.14	49.62	46.68	48.13	48.51	48.07
Lack of Agreeableness	49.73	50.55	50.80	52.11	52.04	54.25	48.78	48.90	49.65	51.53	50.89	51.70
General Activity	49.75	49.50	50.73	49.97	51.24	50.61	50.27	49.92	50.44	51.15	49.17	51.66
Rhathymia	49.54	49.72	50.01	48.54	48.87	49.77	50.70	50.45	51.22	49.67	50.64	48.82
Thinking Extroversion	49.37	49.19	49.43	47.77	48.14	45.82	51.08	51.29	52.57	50.18	50.81	48.41
Ascendance	50.02	48.76	49.24	48.85	49.42	47.29	51.57	50.68	51.48	49.36	49.24	51.17
Social Extroversion	50.17	48.27	48.39	49.24	49.94	48.76	51.36	50.80	51.97	49.87	50.66	50.56
N	571	844	97	143	80	89	569	850	99	130	98	86

Table 3.2

Results of the cross-sectional analyses of each scale of the YGPI

	Depression			Cyclic Tendency			Inferiority Feelings		
Regression term	*B*	*B SE*	*p*	*B*	*B SE*	*p*	*B*	*B SE*	*p*
Constant	**49.01**	**0.23**	**.00**	**49.07**	**0.23**	**.00**	**49.27**	**0.23**	**.00**
Age	**1.00**	**0.17**	**.00**	**0.59**	**0.17**	**.00**	**0.40**	**0.17**	**.02**
Gender	**1.98**	**0.33**	**.00**	**1.86**	**0.33**	**.00**	**1.47**	**0.33**	**.00**
Age×Gender	−0.26	0.24	.29	−0.39	0.24	.11	−0.45	0.24	.07
R^2	.024			.012			.013		

	Nervousness			Lack of Objectivity			Lack of Cooperativeness		
Regression term	*B*	*B SE*	*p*	*B*	*B SE*	*p*	*B*	*B SE*	*p*
Constant	**49.81**	**0.23**	**.00**	**48.83**	**0.23**	**.00**	**51.44**	**0.34**	**.00**
Age	**0.78**	**0.17**	**.00**	0.05	0.17	.76	−0.38	0.30	.21
Gender	0.39	0.33	.24	**2.35**	**0.33**	**.00**	**−2.18**	**0.48**	**.00**
Age×Gender	**−0.78**	**0.24**	**.00**	−0.38	0.24	.12	−0.01	0.44	.99
Age^2							**−0.72**	**0.23**	**.00**
Age^2×Gender							0.50	0.34	.14
Age^3							**0.23**	**0.06**	**.00**
Age^3×Gender							−0.16	0.10	.10
R^2	.006			.015			.013		

	Lack of Agreeableness			General Activity			Rhathymia		
Regression term	*B*	*B SE*	*p*	*B*	*B SE*	*p*	*B*	*B SE*	*p*
Constant	**50.68**	**0.23**	**.00**	**49.81**	**0.23**	**.00**	**49.55**	**0.23**	**.00**
Age	**0.78**	**0.17**	**.00**	0.26	0.17	.13	−0.09	0.17	.59
Gender	**−1.35**	**0.33**	**.00**	0.37	0.33	.26	**0.89**	**0.33**	**.01**
Age×Gender	−0.12	0.24	.62	−0.13	0.24	.60	−0.14	0.24	.56
R^2	.014			.001			.004		

	Thinking Extroversion			Ascendance			Social Extroversion		
Regression term	*B*	*B SE*	*p*	*B*	*B SE*	*p*	*B*	*B SE*	*p*
Constant	**48.94**	**0.23**	**.00**	**49.14**	**0.23**	**.00**	**48.51**	**0.31**	**.00**
Age	**−0.55**	**0.17**	**.00**	**−0.34**	**0.17**	**.05**	**−0.71**	**0.27**	**.01**
Gender	**2.12**	**0.33**	**.00**	**1.71**	**0.33**	**.00**	**2.34**	**0.44**	**.00**
Age×Gender	0.22	0.24	.36	0.01	0.24	.97	0.41	0.39	.29
Age^2							**0.29**	**0.11**	**.01**
Age^2×Gender							−0.23	0.16	.14
R^2	.015			.009			.012		

Notes. Age is mean-centered at the mean age (M = 13.23). Gender is coded: male = 0, female = 1. The partial regression coefficients which are significant at $p < .05$ level are in boldface.

Table 3.3

HLM coefficients and variance estimates of the intercepts and linear terms for the YGPI scales

YGPI Scales	Residual Within-Individual Variance (σ^2)	Intercept				Linear			
		M (γ_{00})	Gender (γ_{01})	Cohort (γ_{02})	Variance (u_0)	*M* (γ_{10})	Gender (γ_{11})	Cohort (γ_{12})	Variance (u_1)
Depression	51.48***	48.89 (0.23)***	2.12 (0.30)***	0.11 (0.02)***	45.52***	1.52 (0.18)***		0.03 (0.01)*	0.00
Cyclic Tendency	52.15***	49.03 (0.23)***	2.09 (0.30)***	0.06 (0.01)***	41.43***	0.91 (0.18)***		0.03 (0.01)*	1.31*
Inferiority Feelings	48.80***	49.32 (0.23)***	1.44 (0.30)***	0.10 (0.01)***	49.56***	0.81 (0.17)***	−0.47 (0.22)*	0.02 (0.01)*	0.01
Nervousness	53.48***	49.76 (0.23)***		0.08 (0.02)***	45.57***	1.19 (0.18)***	−0.74 (0.22)***	0.03 (0.01)*	0.05*
Lack of Objectivity	54.28***	48.94 (0.22)***	2.54 (0.30)***	0.08 (0.01)***	43.05***	0.56 (0.15)***		0.06 (0.01)***	0.00
Lack of Cooperativeness	54.07***	50.91 (0.22)***	−1.80 (0.30)***	0.08 (0.01)***	43.42***				
Lack of Agreeableness	57.79***	50.63 (0.22)***	−0.92 (0.30)**	−0.07 (0.02)***	40.84***	0.71 (0.18)***		0.03 (0.01)*	0.00
General Activity	46.87***	49.85 (0.23)***			51.79***				
Rhathymia	52.70***	49.68 (0.23)***	0.99 (0.31)***		46.20***				
Thinking Extroversion	59.07***	49.07 (0.23)***	1.94 (0.30)***	−0.09 (0.02)***	39.33***	−0.93 (0.18)***			0.00
Ascendance	42.93***	49.03 (0.23)***	1.83 (0.31)***		55.52***	−0.49 (0.17)**			0.18*
Social Extroversion	42.65***	48.95 (0.23)***	1.90 (0.31)***	−0.05 (0.01)**	55.62***	−0.48 (0.17)**		−0.03 (0.01)**	0.04*

Notes. Standard errors are shown in parentheses. HLM = hierarchical linear modeling; YGPI = Yatabe-Guilford Personality Inventory. *N* = 3,656. Significance of coefficients was tested by t-statistic (coefficients/standard error). The significance of variance terms was tested with chi-square. Gender is coded: male = 0, female = 1. Coefficients are applied to (Age - 14.1). The cohort is year of birth centered on the mean (1981). * $p < .05$, ** $p < .01$, *** $p < .001$.

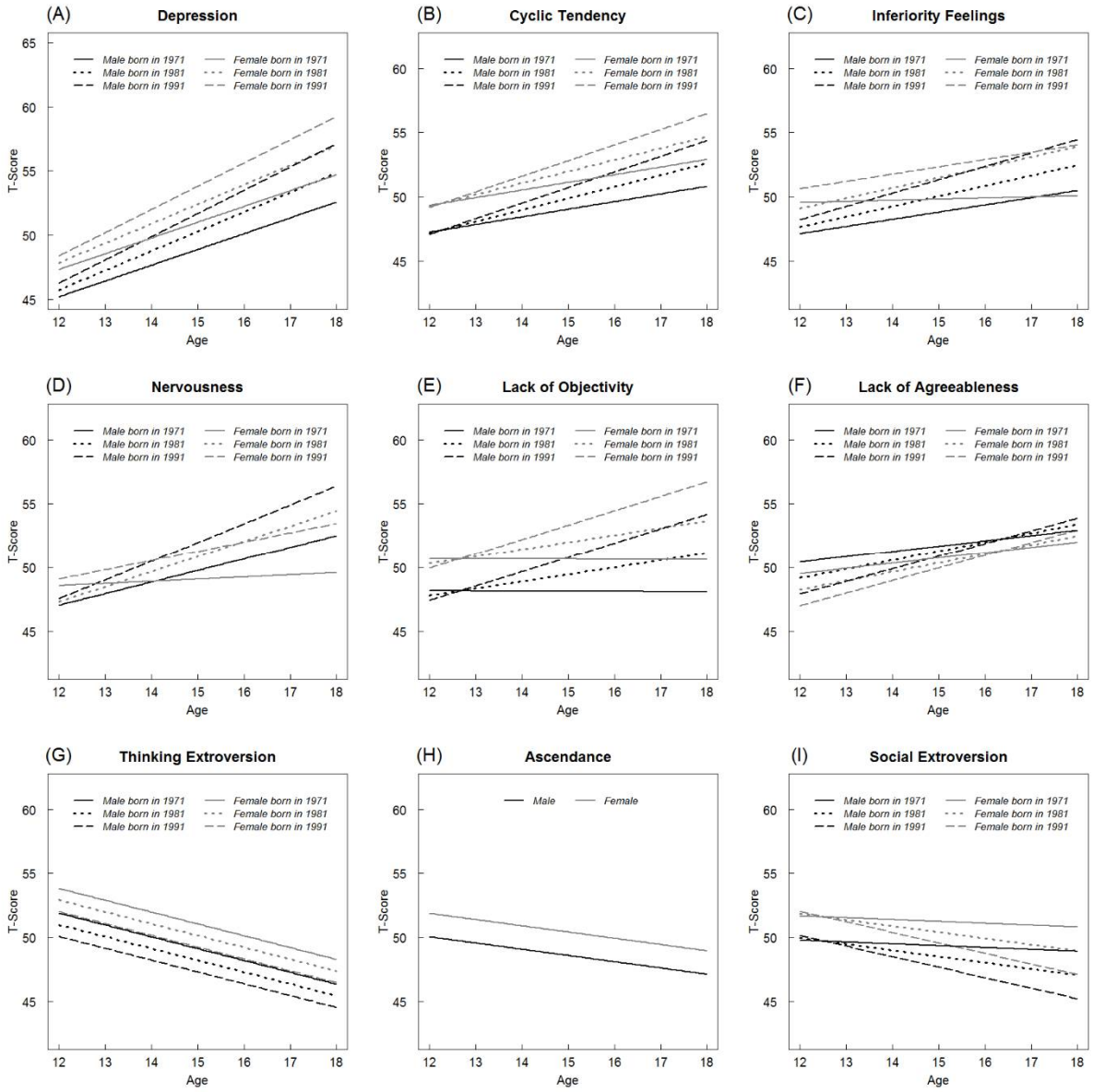

Figure 3.1. Trajectories of the YGPI scales with significant age effects obtained from HLM analyses. YGPI = Yatabe-Guilford Personality Inventory; HLM = hierarchical linear modeling.

Chapter 4.

Genetic and Environmental Contributions to Rank-order Stability and Mean-level Change of Personality

4.1. Introduction

Chapter 3 examined individual differences in personality stability and change with longitudinal data of personality trait scores. Consequently, the preceding chapter showed that personality stability and change involve large individual differences, which are partly explained by gender and birth cohort. However, these findings only describe how levels of personality traits change or remain stable. We do not know the underpinnings of these individual differences. Therefore, this chapter examined developmental sources of stability and change of personality traits.

Two types of stability and change at the population level, mean-level change and rank-order stability, have repeatedly been examined (for meta-analytic reviews, see Roberts & DelVecchio, 2000; Roberts et al., 2006). To date, both longitudinal and cross-sectional studies have reported mean-level personality changes in the Big Five across the life span. Taking particular note of mean-level personality change across adolescence, the findings of previous studies have been inconsistent. The meta-analytic results by Roberts et al. (2006) indicated significant increases in social dominance, one of the facets of Extraversion, and emotional stability, the opposite pole to Neuroticism, across adolescence. Two studies also showed increases in Extraversion (Canals et al.,

2005; Pullmann et al., 2006); in contrast, other studies have failed to observe a significant change in Extraversion (Allik, Laidra, Realo, & Pullmann, 2004; De Fruyt et al., 2006; Klimstra et al., 2009; McCrae et al., 2002), or conversely, have found its decline (Branje et al., 2007; Lamb et al., 2002; Soto et al., 2011; Van den Akker et al., 2014). In respect of Neuroticism, De Fruyt et al. (2006), Klimstra et al. (2009), and the meta-analysis results by Roberts et al. (2006) indicated declines in Neuroticism (i.e., increases in emotional stability). Alternatively, some previous studies have failed to observe a significant change in Neuroticism (Allik et al., 2004; Branje et al., 2007; Lamb et al., 2002; Pullman et al., 2006) or found an increase, especially in female adolescents (Canals et al., 2005; McCrae et al., 2002; Soto et al., 2011; Van den Akker et al., 2014).

The literature shows that there is stability and change in Extraversion and Neuroticism; however, these findings are inconsistent. As for this inconsistency, the preceding chapter offered significant findings: levels of Neuroticism related traits generally increase in adolescence and those of Extraversion related traits remain stable or slightly decline in adolescence. However, previous studies and the preceding chapter only describe the phenomenon but do not provide information about the causal

relationships, namely, which factors contribute to the stability or change of personality during specific periods of the lifespan. Behavioral genetic studies on longitudinal data offer ways to reveal the genetic and environmental factors contributing to stability and change in personality (Johnson, 2008). It is considered a fact that heritability estimates for broad personality traits, such as the Big Five, are approximately .50. Although the remaining variance is derived from non-shared environmental influences, which make twins within the same family more different from each other, and shared environmental influences, which make twins within the same family more similar to each other, they seem to play only a limited role (for reviews, see Johnson et al., 2008; Turkheimer et al., 2014).

Several longitudinal behavioral genetic studies on personality development have recently been conducted. These studies focused on three issues: stability and change in heritability and environmentality during the measurement interval, stability and change in genetic and environmental influences on personality over time, and the extent of genetic and environmental influences on stability and change in personality (Bleidorn et al., 2014). As for the first issue, although some studies focusing on young adulthood showed that heritable and environmental effects are stable during this period (Blonigen,

Carlson, Hicks, Krueger, & Iacono, 2008; Bratko & Butkovic, 2007; Hopwood et al., 2011), other empirical studies (Kandler, Bleidorn, et al., 2010; Kandler et al., 2013; McGue, Bacon, & Lykken, 1993) and a meta-analytic review (Kandler, 2012) indicated that contributions of heritability for specific personality traits decrease during the entire adulthood. Based on the latter, Bleidorn et al. (2014) argued that genetic factors seem to be most important in early adulthood and tend to decrease during middle and older adulthood.

With respect to the second issue, previous studies have examined these factors by two indexes: genetic correlation (r_g) and environmental correlation (r_e). These correlations, representing the rank-order stability of genetic or environmental factors over two measurement points, indicate the degree to which contributions of genetic or environmental factors to individual differences remain stable over time. Therefore, if a genetic or environmental correlation coefficient is equal to 1, genetic or environmental factors contributing to individual differences in personality endure across measurement points; if a genetic or environmental correlation coefficient is equal to 0, there is no overlap in them across the two time points. Previous studies investigating genetic and environmental correlations with longitudinal adult twin samples showed that genetic

rank-order stability is relatively high and that environmental rank-order stability is low (Blonigen et al., 2008; Bratko & Butkovic, 2007; Hopwood et al., 2011; Johnson, McGue, & Krueger, 2005; Kandler, Bleidorn, et al., 2010; Kandler et al., 2013; McGue et al., 1993; Viken, Rose, Kaprio, & Koskenvuo, 1994). These studies have established strong evidence for a highly stable genetic foundation of individual differences in broad personality traits in adulthood.

In terms of the third issue, longitudinal twin studies have investigated the extent to which genetic and environmental factors influence stability and change in personality. There are several studies that particularly examined the genetic and environmental foundations of stability in personality traits, and that demonstrated that the stability of personality in adulthood is mainly due to a firm genetic underpinning and partly due to the stability of environmental influences (Bratko & Butkovic, 2007; Johnson et al., 2005; McGue et al., 1993). Additionally, more recent longitudinal twin studies have investigated the genetic and environmental contributions to personality change. For example, Hopwood et al. (2011) used latent growth modeling to show that the foundations of personality changes across young adulthood were explained by both genetic and non-shared environmental factors. Similar findings were reported by other

studies (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009; Blonigen et al., 2008). However, some studies with longitudinal multiple-rater twin data (i.e., data including both self- and peer-reported personality) offered slightly different findings, that personality change is chiefly due to environmental factors (Bleidorn et al., 2012; Kandler, Bleidorn et al., 2010). These recent studies, with some exceptions, confirmed that both genetic and non-shared environmental factors influence personality development, although some earlier studies found genetic factors to affect rank-order stability in personality.

Although there are some studies focusing on personality stability and change in adulthood, as described above, similar studies in childhood or adolescence are scarce. One of the previous studies with childhood or adolescent samples by De Fruyt et al. (2006) showed high stability in genetic influences and a change in non-shared environmental influences on personality over a time period of three years from late childhood to early adolescence. Similar findings were obtained in a more recent study (Spengler, Gottschling, & Spinath, 2012). However, until the present, there have been no longitudinal twin studies from early to late adolescence. Therefore, this study aimed to fill this gap in the literature with a longitudinal twin study in adolescence.

The present study was designed to address these three issues about the influences on personality stability and change across adolescence with a sample of Japanese twins. In particular, this study first investigated contributions of heritability and environmentality to personality change from early to late adolescence. Based on previous studies in children or young adults, we expected similar heritability and environmentality as the preceding findings that were characterized by roughly equal genetic and non-shared environmental influences. Then, we examined stability and change in genetic and environmental influences on adolescent personality over time. Because the pattern of high stability in genetic influence and the relatively lower stability in environmental influence over time have been replicated by many previous studies using adult or child twin samples from different nations and with different measures of personality, we expected a similar pattern of genetic and environmental factors with a Japanese adolescent sample. Lastly, we investigated the degree of genetic and environmental contributions to the change of personality traits. Because there is no study investigating the genetic and environmental contributions to personality change during adolescence, the present study examined this issue with latent growth modeling analysis. Based on preceding studies in adults, we expected that both genetic and

environmental factors influence personality change, and that genetic factors chiefly affect personality stability.

4.2. Material and Methods

4.2.1. Participants and procedures

This study used archival data from students who entered a secondary school affiliated with the Faculty of Education, the University of Tokyo. The students in the school were invited to participate after entering the school. The research began in 1950, and numerous educational, psychological, and physical indicators have been collected up to the present. In addition to non-twin students, the school takes in approximately 10 to 20 twin pairs every year, and many variables from the twin students have been gathered. Personality indicators of the twin students were collected from 1981 to 2010 and were assembled as part of the archival data.

The archival data used in this study included 321 same-sex twin pairs (180 female twins). The analyses presented here were carried out on all twins participating in the study (273 monozygotic [MZ] and 48 dizygotic [DZ] twin pairs). Approximately 45% of the total, 146 twins (121 MZ and 25 DZ twin pairs), completed the

questionnaire approximately three years later (M = 3.2, SD = 0.66, range 2−4 years). The age range varied from 12 to 14 years (M = 12.7; SD = 0.59) at the first time point, and from 15 to 17 years (M = 15.8; SD = 0.74) at the second time point.

Zygosity diagnosis was conducted at school entry. Approximately 30 physiological indicators were checked by school physicians including blood type, serum, uric acid level, cholesterol level, height, weight, etc.

4.2.2. Measure

The sample for this study was given the Yatabe-Guilford Personality Inventory (YGPI; Yatabe, 1975), which was developed in Japan based on three Guilford-Martin inventories (Guilford, 1940; Guilford & Martin, 1943a, 1943b). The YGPI consists of 12 traits: *Depression*, *Cyclic Tendency*, *Inferiority Feelings*, *Nervousness*, *Lack of Objectivity*, *Lack of Cooperativeness*, *Lack of Agreeableness, General Activity*, *Rhathymia*, *Thinking Extroversion*, *Ascendance*, and *Social Extroversion*. The definitions of each trait are given in Chapter 3. Item examples of each YGPI scale are shown in Appendix A.

As described in Chapter 3, the 12 YGPI scales cover the Neuroticism and

Extraversion domains of the Big Five personality inventory (Natsuno, 1998; Shimonaka, 1996). In this regard, the YGPI is similar to the Guilford-Zimmerman Temperament Survey (GZTS; Guilford et al., 1976). Shimonaka (1996) examined correlations between the YGPI and the NEO-PI-R, for which the results are also shown in Appendix A. The NEO-PI-R domains, especially Neuroticism and Extraversion, are correlated with some of the YGPI subscales.

The YGPI 12 scales have sufficient validity and reliability (Tsujioka, 2000). Cronbach's alpha reliability coefficients range from .70 to .92 (*Median* = .85), and test–retest reliability estimates within one month for the 12 scales ranged from .56 to .82 (*Median* = .73; Tsujioka, 2000). All participants in the present study completed the YGPI at school. Each trait of the YGPI contains 10 items rated on a three-point scale: 0 (yes), 1 (yes and no), and 2 (yes). The score of each trait was calculated from the 10 items after dealing with the reverse scoring. The theoretical range of personality scores is from 0 to 20.

4.2.3. Data Analyses

4.2.3.1. Phenotypic analyses.

Before all data analyses, the YGPI scores were standardized as *T*-scores (M = 50, SD = 10). Phenotypic analyses were conducted on all available data. We first calculated correlations for the YGPI trait scores between co-twins and two time points. Then, in order to examine mean-level changes of the YGPI scores, we applied the change score model (McArdle, 2009) to each YGPI score. We can estimate the means and variances of the score changes, and test whether these estimates are statistically significant with this model. These phenotypic analyses were conducted with R 3.1.0 (R Core Team, 2013).

4.2.3.2. Biometric analyses.

Genetic model fitting of twin data utilizes the difference in genetic similarity between MZ, who share 100% of their genetic material, and DZ twins, who share an average of 50% of their segregating genetic material, to index the relative genetic and environmental contributions to an observed phenotype. This analytic method typically decomposes the variance of a phenotype into three components: additive genetic effects (a^2), shared environmental effects (c^2), and non-shared environmental effects (e^2). The additive genetic effects describe the effect of multiple genes that have a linear or

additive influence. The shared environments represent influences that are common to each member of a twin pair. The non-shared environments, including measurement error and state fluctuations, stand for influences that are unique to each member of a twin pair. This methodology is based on the equal environments assumption (EEA), which assumes that MZ pairs are no more likely to share the environmental events of etiologic importance for the phenotype under study than DZ pairs (Kendler, Neale, Kessler, Heath, & Eaves, 1993). Thus, any differences in the MZ and DZ correlations are assumed to be attributed to differences in the genetic similarity of the corresponding twins.

To evaluate the origins of rank-order stability of personality, we fitted a Cholesky decomposition model. Within this model (see Figure 4.1), the variance within and the covariance between personality traits across each assessment are split into their genetic and environmental components. The genetic, shared environmental, and non-shared environmental covariances can be standardized on their respective variances to produce genetic, shared environmental, and non-shared environmental correlations in this model. These statistics indicate the extent to which a particular effect at one assessment is correlated with the same effect at another assessment. A genetic

correlation of 1.0 (i.e., $r_g = 1$) would mean that all genetic influences persist across assessments, whereas a correlation of zero would indicate no genetic overlap. Much the same is true for an environmental correlation. Thus, this model made it possible for us to specifically estimate the extent to which genetic and environmental influences contribute to the rank-order stability of personality over time.

To evaluate the origins of mean-level change in personality, we fitted a Cholesky decomposition model onto the change score model (Figure 4.2). Within this model, the variance within and the covariance between the personality trait score at Time 1 and the latent difference score are split into their genetic and environmental components. The genetic, shared environmental, and non-shared environmental covariances are described as path coefficients (a_{12}, c_{12}, and e_{12}) in this model (see Figure 4.2). These statistics indicate the extent to which a particular effect at the first assessment influences the latent difference score. Since the latent difference score refers to mean-level change in personality traits, genetic, shared, and non-shared environmental components on the latent difference score stand for those contributing to the mean-level change in personality, which is the main consideration of the present study. Cholesky models were fitted via maximum likelihood using Mplus ver. 7 (Muthén & Muthén, 2012).

When fitting a Cholesky model, variances, covariances, and means are freely estimated by minimizing the deviance statistic minus twice the log-likelihood (–2lnL). The –2lnL under this unrestricted baseline model is compared with –2lnL under more restrictive biometric models. This comparison provides a likelihood-ratio chi-square test of goodness of fit for the model. The model fit was assessed by chi-square difference tests, Akaike information criterion (AIC; Akaike, 1974), Bayesian information criterion (BIC; Schwartz, 1978), and root-mean-square error of approximation (RMSEA) (cf. Hu & Bentler, 1999). Lower χ^2 values, more negative AIC and BIC (AIC = $\chi^2 - 2df$; BIC = $\chi^2 - k\ln[n]$) values, and a lower RMSEA suggest a better fit.

4.3. Results

4.3.1. Attrition analyses

Almost 45% of the Time 1 participants completed the questionnaires at Time 2 in the present study. Attrition effects were inspected for split samples by comparing mean age, gender, zygosity, and personality scores at Time 1 between participants (MZ and DZ twins) who completed the YGPI at both assessments (MZ, $N = 121$; DZ, $N = 25$) and those who completed it at Time 1 but did not take part in the next assessment

(MZ, $N = 152$; DZ, $N = 23$). For demographic variables, we found no differences in zygosity ($\chi^2 = 0.79$, $df = 1$, $p = .38$) and gender ($\chi^2 = 0.60$, $df = 1$, $p = .44$). However, a small difference in mean age was observed ($t = 2.63$, $df = 249.9$, $p = .009$, Cohen's $d = 0.30$), which shows that the mean age of participants who completed the YGPI at both times was slightly lower. Uncorrected for multiple testing effects, no differences were revealed in each YGPI scale for both co-twins ($-1.58 < t\text{s} < 1.37$, $p\text{s} > .115$). Therefore, the twins who participated in both assessments did not substantively differ from the other twins who took part in only the first assessment, except for their mean age.

4.3.2. Phenotypic results

4.3.2.1. Rank-order stability and twin intra-class correlation

Rank-order stability coefficients of longitudinal twin data and twin intraclass correlation coefficients are reported in Table 4.1. Results showed moderate stability of the YGPI scores across adolescent years. Because of the small sample size of the DZ twins, the estimates of their rank-order stability coefficients varied widely. The magnitude of rank-order stability was not substantially different across MZ and DZ twins.

4.3.2.2. Mean-level change.

For an illustration of mean-level changes of the YGPI scales, we fitted the change score model to the 2-wave longitudinal data. The scores of *Depression*, *Cyclic Tendency*, *Nervousness*, and *Lack of Agreeableness* significantly declined over the interval. In contrast, the score of *Thinking Extroversion* statistically increased. The variances of the latent difference scores of all YGPI scales were statistically significant, which indicates broad individual differences. The detailed results are given in Table 4.2.

4.3.3. Biometric results

4.3.3.1. Longitudinal bivariate genetic analyses.

Based on the obtained pattern of MZ-DZ correlations shown in Table 4.1, the first tested model included A, C, and E. Compared to the longitudinal Cholesky decomposition models by chi-square tests and other model-fit indices, the AE model, including additive genetic and non-shared environmental effects, was the best fit for all YGPI scales. Detailed results of model fittings are given in Table 4.3. Thus, we show the parameter estimates of AE models (Figure 4.1) for each YGPI scale. The detailed

estimates are presented in Table 4.4. Heritability estimates obtained from the bivariate genetic analyses ranged from .27 (for *Thinking Extroversion* at Time 1) to .62 (for *Ascendance* at Time 2). Estimates of genetic and environmental correlation coefficients for each YGPI scale reveal if genetic or environmental influences contribute to stability or change in personality in the period from early to late adolescence. Genetic correlation coefficients (*Median* = .74) ranged between .62 (for *Thinking Extroversion*) to .83 (for *Nervousness*), and environmental correlations (*Median* = .31) ranged from .26 (for *Lack of Cooperativeness*) to .35 (for *Rhathymia*). These estimates indicate that genetic influences on individual differences highly persist across measurement points, and that environmental influences moderately change over time.

4.3.3.2. Longitudinal genetic analyses on mean-level personality change.

Based on the change score model, we tested the model that included A, C, and E first (see Figure 4.2). Then, we applied the AE and CE model to the longitudinal twin data. Compared with the longitudinal Cholesky decomposition models by chi-square tests and other model-fit indices, the AE model, including additive genetic and non-shared environmental factors, was the best fit for all YGPI scales. Thus, we show the

parameter estimates of AE models for each YGPI scale. Detailed results of model fittings are shown in Table 4.5.

Heritability estimates of the latent difference scores (*Median* = .29) ranged from .17 (for *G*) to .49 (for *Co*). These results indicate that both genetic and environmental factors contributed to mean-level changes of the YGPI scale scores. As for the two factors of personality scores at Time 1, non-shared environmental effects had a substantial negative influence on latent difference scores. However, genetic factors had no or small negative effects on mean-level changes. The detailed parameter estimates are given in Table 4.6.

4.4. Discussion

This study extends the research on personality development by examining genetic and environmental contributions to rank-order stability and mean-level change in adolescent personality traits. The strengths of this study were the use of a relatively rare Japanese sample and filling the gap in the literature with a longitudinal twin study of adolescence. In particular, it is an advantage that we provide findings regarding the underpinnings of mean-level change in personality across adolescent years, which have

not been directly examined yet. There have been several findings about genetic contributions to mean-level personality change in adulthood. However, studies focusing on adolescence have been scarce. Thus, the findings of this study fill the gap in the literature about the etiology of personality change.

The limitations of this study are the use of a single, self-reported questionnaire to measure adolescent personality; the Yatabe-Guilford Personality Inventory, which is limited to Japan; the small sample size, especially the number of DZ twin pairs; and the small number of measurements of personality. It has been indicated that there are stable individual differences in self-report response styles (McCrae & Costa, 2008), and it is well known that mono-rater measures of personality constructs are susceptible to random and systematic error components (Campbell & Fiske, 1959). To control for these biases, it is effective to use additional measurement methods or independent ratings by well-informed observers (Hofstee, 1994; Kandler, Riemann et al., 2010). Indeed, some previous studies have obtained reasonable findings regarding personality development through the use of self- and peer-reported personality scores (Bleidorn et al., 2012; Kandler, Bleidorn et al., 2010; Kandler et al., 2013). Future research should investigate adolescent personality development with multiple-method or multiple-rater

personality data to reduce random and systematic error effects. Moreover, the small number of assessment times was a limitation of this study. As for the number of assessment times, the two-wave design impeded more flexible longitudinal analysis methods, such as latent growth curve modeling (LGCM; Duncan, Duncan, Strycker, Li, & Alpert, 1999). Because of the structure of the archival data, we could not utilize LGCM to examine genetic and environmental effect on mean-level change and stability in personality. In future research, we should conduct follow-up surveys to obtain additional assessments, which would enable us to use more sophisticated statistical methods, and examine how the developmental pattern of personality across adolescence influences later outcomes in adulthood.

Despite these limitations, this study obtained significant results. Results of the bivariate Cholesky decomposition model analyses showed that additive genetic and non-shared environmental influences explained the variances of each YGPI scale and that heritability was approximately 40%, which is consistent with previous studies (De Fruyt et al., 2006; Spengler et al., 2012) and supports the hypotheses of this study. Results of the bivariate analyses also showed that the rank-order stability of personality traits across adolescence is mainly due to high genetic rank-order stability, which agrees

with previous studies evaluating samples after emerging adulthood (Blonigen et al., 2008; Bratko & Butkovic, 2007; Hopwood et al., 2011; Johnson et al., 2005; Kandler et al., 2010, 2013; McGue et al., 1993; Viken et al., 1994) and supports the hypotheses of the present study. Further, using the change score model (McArdle, 2009), we could manage the mean-level changes in personality with two-wave data. Because the latent difference score in the model refers to the mean-level change, heritability of this latent score indicates its genetic contribution. The results of the biometric analyses showed that environmental factors mainly contributed to mean-level personality change. These predominantly environmental effects are consistent with previous findings in adulthood (Blonigen et al., 2008; Hopwood et al., 2011; Kandler, Bleidorn, et al., 2010). Furthermore, the results of this study provide evidence of substantial genetic contributions, which agrees with previous findings in adulthood (Blonigen et al., 2008; Hopwood et al., 2011). These results about the etiology of mean-level change in personality also support the hypotheses of the present study.

4.4.1. Adolescent personality development: Results from phenotypic analyses

Although the sample size of this study was small, we obtained some phenotypic

results that offer valuable insight into prior inconsistent findings. Results of the phenotypic analyses showed that the scores of *Depression*, *Cyclic Tendency*, *Nervousness*, *Thinking Extroversion*, and *Lack of Agreeableness* changed significantly. Because these subscales were correlated to Neuroticism (r = .68 for *D*; r = .70 for *C*; r = .72 for *N*; r = –.40 for *T*; r = .20 for *Ag*) in a previous study (Shimonaka, 1996), the results indicated that the twins of this study increased their level of Neuroticism, which is consistent with preceding studies (Canals et al., 2005; Van den Akker et al., 2014). However, the levels of the other YGPI subscales related to Neuroticism did not significantly change, such as *Inferiority Feelings* and *Lack of Objectivity*. The developmental trends are different among various facets of Neuroticism (Soto, John, Gosling, & Potter, 2011), and hence, the inconsistent results of this study may be a reflection of the differences between correspondent facets.

However, it should be noted that these phenotypic results were obtained from MZ twins. Watzlawik (2009) argued that MZ twins focused more on internal differences, such as personality, during adolescence. Developmental trajectories of adolescent personality may be slightly different between twins and non-twins. We should, therefore, further investigate whether the obtained phenotypic results were

unique to twins. If this were the case, future research should examine whether personality development follows a unique pattern in twin adolescents who grow up with a siblings who is similar.

4.4.2. Heritability and environmentality of adolescent personality

The first research theme of this study was the relative contributions of genetic and environmental influences to individual differences in personality. The results indicated that both effects remained stable across adolescence. Although previous studies focusing on adult samples suggested slight but significant decreases in heritability contributions throughout the adult life span (e.g., Kandler, Bleidorn et al., 2010; Viken et al., 1994), this study did not observe a significant decrease from 12 to 17 years of age. However, it has been indicated that internalizing problems, especially depression and anxiety, change etiologic structures from childhood to young adulthood, and that genetic contributions to childhood depression are different from those of adolescent or adult depression (Waszczuk, Zavos, Gregory, & Eley, 2014). Based on these findings, it remains possible that the heritable and environmental contributions to Neuroticism related traits change from childhood to adolescence. Future research should

examine the heritability of personality traits with a younger sample to fill the gap in the literature with a longitudinal behavior genetic study of personality traits.

4.4.3. Rank-order stability in genetic influences

The causes of rank-order stability in personality were the second research theme of this study. Consistent with previous studies, the present study showed high rank-order stability of genetic factors. Indeed, we observed that the three-year stability of genetic influences was approximately $r_g = .70$, and that of environmental effects was approximately $r_e = .30$. These estimates are nearly identical to previous studies focusing on similar age groups (e.g., Bratko & Butkovic, 2007; Viken et al., 1994). These results suggest that a large part of genetic factors influencing personality traits in early adolescence also contribute to those in late adolescence. In contrast, there is a substantial change in non-shared environmental influences. These reproducible results have enormous importance for personality development research.

It is also worth noting that these results denote the same tendency of each YGPI scale. The YGPI scales cover the Neuroticism and Extraversion domains (Natsuno, 1998; Shimonaka, 1996); however, the observed genetic and environmental correlations

were very similar. For example, Bratko and Butkovic (2007) showed similar results on the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) scales, except for the lie scale. De Fruyt et al (2006) and Spengler et al. (2012) also suggested similar results on the Big Five personality traits, except for Openness. Based on these previous findings, we conclude that the genetic factors contributing to Neuroticism and Extraversion remain equally stable and that the results of this study support these findings.

However, the results of the Cholesky model analyses showed not only genetic stability in personality but also genetic influences after mid-adolescence, despite the small proportion of total variance. Previous studies revealed that genetic effects on anxiety, depression, and behavioral problems varied over the adolescent years through genetic innovation (Kendler, Gardner, & Lichtenstein, 2008; Lewis & Plomin, 2015), and the results of the present study are consistent with these findings. Although the details of genetic innovation are unclear, they may be attributable to unique physical changes during adolescence. Juvenile physical changes, including the onset of puberty or brain maturation, are highly genetically determined (e.g., Chiang et al., 2011; Silventoinen, Haukka, Dunkel, Tynelius, & Rasmussen, 2008). It has been suggested

that these physical changes may have effects on emotional instability and Extraversion (e.g., Blankstein, Chen, Mincic, McGrath, & Davis, 2009; Mensah et al., 2013). In fact, an association between personality and physical change has been shown; changes in Conscientiousness, Extraversion, and Neuroticism were significantly associated with changes in mental and physical health status (Magee, Heaven, & Miller, 2013). Therefore, future research should explore the specific genes related to this genetic innovation and investigate the mutual trajectories of personality and physical development across adolescence.

4.4.4. Genetic and environmental contributions to mean-level personality change

The results of the biometric analyses on the change score model showed that environmental factors contributed mainly to mean-level personality change, with estimates of approximately .70. Further, the results of this study provide evidence of substantial genetic contributions, with heritability estimates of approximately .30. Although preceding findings in adulthood supported the genetic contribution to mean-level personality change (Blonigen et al. 2008; Hopwood et al., 2011), the degree of genetic effects was small in these studies. In contrast, the estimated genetic effects in

the present study appeared to be larger than those in previous studies (Blonigen et al., 2008; Hopwood et al., 2011). This may be due to difference between adolescence and adulthood. Compared with adulthood, adolescence is a period in which the brain structure alters dramatically and the risk for psychopathology increases (Casey et al., 2008). For example, it was indicated that adolescent depression is associated with hippocampal and amygdala volumes in cross-sectional (Hulvershorn, Cullen, & Anand, 2011) and longitudinal (Whittle et al., 2014) studies. It was also shown that the allelic variants of some specific genes affect volumes of the hippocampus (e.g., Honea et al., 2009) and amygdala (e.g., Stjepanović, Lorenzetti, Yücel, Hawi, & Bellgrove, 2013). Therefore, we assume that these gene variants affect adolescent brain structures and, subsequently, mean-level changes in Neuroticism related traits, such as *Depression*, *Cyclic Tendency*, *Nervousness*, and *Thinking Extroversion*.

The other interpretation of this genetic contribution to mean-level personality change is that individuals with specific alleles of genes related to susceptibility are more likely to show an increase or decline of personality trait scores through various life experiences. Previous findings showed that personality change is mainly caused by environmental factors (Bleidorn et al., 2009; Blonigen et al., 2008; Hopwood et al.,

2011; Kandler, Bleidorn, et al., 2010), which is also supported by the results of this study. There are suggestions that environmental effects may impact individuals differently and even serve to accentuate individual differences (e.g., Belsky, 1997b, 2005; Ellis et al., 2011). That is, individuals with specific characteristics are likely not only negatively influenced by adversity but also benefit from a positive environment. Belsky (1997, 2005) and Ellis et al. (2011) called this characteristic differential susceptibility, which is underpinned by genetic factors. Because the analyzed model in this study took it as given that there were no correlations and interactions between genetic and environmental factors, the gene-environment interaction (G × E) assumed in differential susceptibility theory may be obtained as an additive genetic effect. In future research, we should examine this G × E interaction in mean-level change in personality with an appropriate model.

4.5. Conclusion and Suggestion

The results in this chapter demonstrate the genetic and environmental underpinnings of adolescent personality stability and change. Environmental factors mainly contribute to mean-level and rank-order change of personality trait levels, and

genetic factors mainly contribute to rank-order stability of personality trait levels. These findings suggest that personality change is derived from environmental effects such as influential life events and various everyday experiences. However, novel genetic factors unique to the personality at Time 2 were also observed (cf. genetic innovation). This denotes that the genetic structure of Neuroticism and Extraversion may differ across development. The results of genetic innovation in personality development offer implications for taxonomy and clinical practice. Personality structures in adolescence should be revised with a focus on the genetic underpinnings. The use of personality taxonomy designed for adulthood may preclude the emergence of deviating or new major trait factors or facets that may be valid for children and adolescents (De Fruyt & De Clercq, 2013). Maladaptive and adaptive personality traits that are unique to childhood and adolescence are associated with externalizing and internalizing problems (De Clercq, Van Leeuwen, De Fruyt, Van Hiel, & Mervielde, 2008; De Fruyt, Mervielde, & Van Leeuwen, 2002). Since these specific personality traits may be childhood and adolescent precipitants of mental disorders, personality taxonomy in these developmental stages and its future outcome should be further investigated.

In addition, the results in this chapter show the genetic contributions to mean-

level change in personality. Though personality change is mainly due to environmental factors, genetic factors significantly affect mean-level change in personality. This denotes that some genes additively affect the levels of Neuroticism and Extraversion. However, this does not deny the possibility of gene-environment interaction. Because it is hypothesized that there are no gene-environmental interactions and correlations in the analyzed models, we cannot rule out the possibility of their existence, which provides implications for developmental mechanism. It has been suggested that complex gene-environment interaction are likely to play a role in personality development (Bleidorn et al., 2014; Johnson, 2007). There are many studies investigating gene-environmental interactions in lifelong development (e.g., Caspi et al., 2002, 2003). Hence, this issue will be examined with focus on specific SNPs. As preliminary steps for future investigations, the interplay between genetically determined psychological traits and environmental factors in personality development should be investigated.

Table 4.1

Twin correlations for the YGPI traits and two time points

	Monozygotic twins			Dizygotic twins		
YGPI Scales	Time 1 Twin 1	Time 1 Twin 2	Time 2 Twin 1	Time 1 Twin 1	Time 1 Twin 2	Time 2 Twin 1
Depression						
Time 1 Twin 2	.35 [.23, .45]			.12 [−.17, .40]		
Time 2 Twin 1	**.47 [.31, .60]**	.27 [.09, .43]		**.36 [−.05, .67]**	.09 [−.33, .47]	
Time 2 Twin 2	.40 [.23, .54]	**.55 [.41, .67]**	.53 [.38, .65]	−.08 [−.48, .34]	**.43 [.03, .71]**	.15 [−.28, .53]
Cyclic Tendency						
Time 1 Twin 2	.31 [.19, .41]			.16 [−.13, .43]		
Time 2 Twin 1	**.47 [.32, .60]**	.39 [.23, .54]		**.31 [−.11, .63]**	.28 [−.14, .62]	
Time 2 Twin 2	.33 [.16, .49]	**.58 [.44, .69]**	.46 [.31, .60]	.10 [−.32, .49]	**.80 [.59, .91]**	.41 [.00, .71]
Inferiority Feelings						
Time 1 Twin 2	.38 [.27, .48]			.25 [−.04, .50]		
Time 2 Twin 1	**.51 [.36, .63]**	.45 [.29, .58]		**.67 [.36, .84]**	.35 [−.06, .66]	
Time 2 Twin 2	.42 [.25, .56]	**.63 [.51, .73]**	.59 [.45, .69]	.37 [−.05, .68]	**.55 [.18, .78]**	.29 [−.14, .63]
Nervousness						
Time 1 Twin 2	.32 [.21, .43]			.11 [−.18, .38]		
Time 2 Twin 1	**.52 [.37, .64]**	.40 [.23, .54]		**.39 [−.01, .69]**	.17 [−.25, .54]	
Time 2 Twin 2	.39 [.22, .54]	**.55 [.41, .67]**	.52 [.38, .65]	−.12 [−.51, .31]	**.58 [.24, .80]**	.05 [−.37, .45]
Lack of Objectivity						
Time 1 Twin 2	.33 [.21, .43]			.09 [−.21, .36]		
Time 2 Twin 1	**.48 [.32, .61]**	.30 [.12, .46]		**.62 [.29, .82]**	.19 [−.23, .55]	
Time 2 Twin 2	.33 [.16, .49]	**.58 [.45, .69]**	.44 [.28, .58]	.21 [−.22, .57]	**.35 [−.06, .66]**	.10 [−.33, .49]
Lack of Cooperativeness						
Time 1 Twin 2	.45 [.35, .54]			.36 [.08, .58]		
Time 2 Twin 1	**.56 [.42, .67]**	.38 [.21, .52]		**.44 [.04, .72]**	.05 [−.36, .45]	
Time 2 Twin 2	.26 [.08, .42]	**.36 [.19, .51]**	.43 [.27, .57]	.40 [−.02, .70]	**.53 [.16, .77]**	.33 [−.10, .65]
Lack of Agreeableness						
Time 1 Twin 2	.31 [.19, .41]			.19 [−.10, .45]		
Time 2 Twin 1	**.47 [.31, .60]**	.21 [.03, .38]		**.68 [.38, .85]**	.11 [−.30, .49]	
Time 2 Twin 2	.21 [.02, .38]	**.41 [.24, .55]**	.40 [.24, .55]	.14 [−.29, .52]	**.29 [−.13, .62]**	.22 [−.21, .58]
General Activity						
Time 1 Twin 2	.35 [.24, .45]			.13 [−.16, .40]		
Time 2 Twin 1	**.49 [.34, .62]**	.29 [.11, .45]		**.63 [.30, .82]**	.20 [−.22, .56]	
Time 2 Twin 2	.40 [.23, .55]	**.59 [.46, .70]**	.34 [.16, .49]	.06 [−.36, .46]	**.49 [.11, .74]**	.26 [−.17, .61]
Rhathymia						
Time 1 Twin 2	.42 [.31, .52]			.11 [−.18, .39]		
Time 2 Twin 1	**.47 [.31, .60]**	.25 [.07, .41]		**.79 [.57, .90]**	−.20 [−.49, .20]	
Time 2 Twin 2	.17 [−.01, .34]	**.45 [.29, .59]**	.31 [.14, .47]	.07 [−.35, .47]	**.42 [.02, .70]**	.13 [−.30, .51]
Thinking Extroversion						
Time 1 Twin 2	.29 [.17, .39]			.23 [−.06, .49]		
Time 2 Twin 1	**.44 [.28, .57]**	.19 [.01, .36]		**.26 [−.16, .60]**	−.18 [−.55, .24]	
Time 2 Twin 2	.09 [−.10, .27]	**.32 [.15, .48]**	.21 [.02, .38]	.36 [−.07, .67]	**.51 [.14, .76]**	.35 [−.08, .66]
Ascendance						
Time 1 Twin 2	.55 [.45, .63]			.16 [−.13, .43]		
Time 2 Twin 1	**.57 [.43, .68]**	.45 [.29, .58]		**.73 [.46, .87]**	.04 [−.37, .43]	
Time 2 Twin 2	.43 [.27, .57]	**.66 [.54, .75]**	.56 [.42, .67]	−.10 [−.49, .33]	**.71 [.42, .86]**	.28 [−.15, .62]
Social Extroversion						
Time 1 Twin 2	.53 [.43, .61]			.29 [.00, .53]		
Time 2 Twin 1	**.59 [.46, .70]**	.35 [.18, .50]		**.77 [.54, .90]**	.20 [−.23, .55]	
Time 2 Twin 2	.44 [.28, .58]	**.60 [.47, .71]**	.48 [.32, .61]	.21 [−.22, .57]	**.49 [.11, .75]**	.47 [.07, .74]

Note. 95% confidence intervals are shown in parentheses. Rank-order stability coefficients are presented in bold. YGPI = Yatabe-Guilford Personality Inventory.

Table 4.2

Means and variances of latent difference scores of each YGPI scale

YGPI scales	Latent Difference Score			
	Mean	*p*	*Variance*	*p*
Depression	**3.35**	**0.00**	**101.93**	**0.00**
Cyclic Tendency	**2.10**	**0.00**	**93.26**	**0.00**
Inferiority Feelings	0.80	0.11	**83.03**	**0.00**
Nervousness	**1.86**	**0.00**	**94.20**	**0.00**
Lack of Objectivity	–0.04	0.94	**96.98**	**0.00**
Lack of Cooperativeness	–0.20	0.68	**106.87**	**0.00**
Thinking Extroversion	**–2.36**	**0.00**	**117.75**	**0.00**
General Activity	1.02	0.05	**92.84**	**0.00**
Rhathymia	0.48	0.38	**103.81**	**0.00**
Ascendance	–0.68	0.15	**73.70**	**0.00**
Social Extroversion	–0.38	0.43	**79.07**	**0.00**
Lack of Agreeableness	**2.88**	**0.00**	**106.82**	**0.00**

Note. YGPI = Yatabe-Guilford Personality Inventory. Estimates that were statistically significant at $p < .004$ are presented in bold.

Table 4.3

Results of longitudinal Cholesky decomposition model fitting for the YGPI scales

YGPI Scales		–2lnL	$\Delta\chi^2$	Δdf	p	AIC	BIC	RMSEA	90%CI
Depression									
	Full Model	7147.07							
	ACE	7171.10	24.03	17	.12	7193.10	7234.58	0.05	[0.00, 0.09]
	AE	7171.10	0.00	3	1.00	7187.10	7217.27	0.04	[0.00, 0.08]
	CE	7179.13	8.03	3	.05	7195.13	7225.30	0.06	[0.01, 0.10]
Cyclic Tendency									
	Full Model	6766.91							
	ACE	6789.39	22.49	17	.17	6811.40	6852.88	0.05	[0.00, 0.09]
	AE	6790.78	1.39	3	.71	6806.78	6836.95	0.04	[0.00, 0.08]
	CE	6791.30	1.90	3	.59	6807.30	6837.47	0.04	[0.00, 0.08]
Inferiority Feelings									
	Full Model	6339.74							
	ACE	6353.80	14.06	17	.66	6375.80	6417.28	0.00	[0.00, 0.06]
	AE	6354.58	0.78	3	.85	6370.58	6400.75	0.00	[0.00, 0.05]
	CE	6356.23	2.44	3	.49	6372.23	6402.40	0.00	[0.00, 0.05]
Nervousness									
	Full Model	6763.01							
	ACE	6782.06	19.05	17	.33	6804.06	6845.55	0.03	[0.00, 0.08]
	AE	6782.31	0.25	3	.97	6798.31	6828.48	0.00	[0.00, 0.07]
	CE	6794.94	12.88	3	.00	6810.94	6841.11	0.06	[0.01, 0.10]
Lack of Objectivity									
	Full Model	6795.35							
	ACE	6808.78	13.44	17	.71	6830.79	6872.27	0.00	[0.00, 0.06]
	AE	6808.78	0.00	3	1.00	6824.79	6854.96	0.00	[0.00, 0.04]
	CE	6814.97	6.18	3	.10	6830.97	6861.14	0.00	[0.00, 0.07]
Lack of Cooperativeness									
	Full Model	6712.24							
	ACE	6736.05	23.82	17	.12	6758.05	6799.54	0.05	[0.00, 0.09]
	AE	6736.06	0.01	3	1.00	6752.06	6782.24	0.04	[0.00, 0.08]
	CE	6748.79	12.73	3	.01	6764.79	6794.96	0.07	[0.03, 0.11]
Lack of Agreeableness									
	Full Model	6795.95							
	ACE	6810.40	14.45	17	.63	6832.40	6873.89	0.00	[0.00, 0.06]
	AE	6810.63	0.23	3	.97	6826.63	6856.80	0.00	[0.00, 0.05]
	CE	6811.62	1.22	3	.75	6827.62	6857.80	0.00	[0.00, 0.05]
General Activity									
	Full Model	6802.40							
	ACE	6809.53	7.13	17	.98	6831.53	6873.01	0.00	[0.00, 0.00]
	AE	6810.65	1.12	3	.77	6826.65	6856.82	0.00	[0.00, 0.00]
	CE	6813.06	3.54	3	.32	6829.06	6859.23	0.00	[0.00, 0.00]
Rhathymia									
	Full Model	7171.02							
	ACE	7201.03	30.01	17	.03	7223.03	7264.52	0.07	[0.02, 0.11]
	AE	7201.93	0.90	3	.83	7217.93	7248.10	0.06	[0.00, 0.10]
	CE	7211.92	10.89	3	.01	7227.92	7258.09	0.08	[0.05, 0.12]
Thinking Extroversion									
	Full Model	6417.67							
	ACE	6452.60	34.93	17	.01	6474.60	6516.09	0.08	[0.04, 0.12]
	AE	6453.28	0.68	3	.88	6469.29	6499.46	0.07	[0.03, 0.11]
	CE	6460.94	8.34	3	.04	6476.94	6507.11	0.09	[0.05, 0.13]
Ascendance									
	Full Model	7040.70							
	ACE	7063.76	23.07	17	.15	7085.76	7127.25	0.05	[0.00, 0.09]
	AE	7066.20	2.44	3	.49	7082.20	7112.38	0.04	[0.00, 0.08]
	CE	7076.73	12.96	3	.00	7092.73	7122.90	0.07	[0.03, 0.11]
Social Extroversion									
	Full Model	6292.99							
	ACE	6307.87	14.88	17	.60	6329.88	6371.36	0.00	[0.00, 0.06]
	AE	6310.22	2.34	3	.50	6326.22	6356.39	0.00	[0.00, 0.06]
	CE	6315.03	7.15	3	.07	6331.03	6361.20	0.03	[0.00, 0.07]

Table 4.4

Parameter estimates for the longitudinal Cholesky decomposition model

YGPI Scales		Estamates							
		A at Time 1	A at Time 2	E at Time 1	E at Time 2	A^2	E^2	r_g	r_e
Depression	Time 1	0.63		0.78		0.40	0.61		
		[0.54, 0.72]		[0.71, 0.85]		[0.28, 0.51]	[0.49, 0.72]		
	Time 2	0.43	0.52	0.25	0.69	0.46	0.54	0.64	0.34
		[0.26, 0.60]	[0.39, 0.66]	[0.12, 0.38]	[0.61, 0.77]	[0.34, 0.58]	[0.43, 0.66]	[0.41, 0.86]	[0.17, 0.50]
Cyclic Tendency	Time 1	0.61		0.79		0.38	0.62		
		[0.52, 0.71]		[0.72, 0.86]		[0.27, 0.49]	[0.51, 0.73]		
	Time 2	0.53	0.37	0.20	0.74	0.42	0.58	0.82	0.26
		[0.37, 0.69]	[0.17, 0.58]	[0.06, 0.34]	[0.66, 0.81]	[0.30, 0.54]	[0.46, 0.70]	[0.60, 1.00]	[0.08, 0.44]
Inferiority Feelings	Time 1	0.62		0.79		0.38	0.62		
		[0.53, 0.71]		[0.72, 0.85]		[0.28, 0.49]	[0.51, 0.72]		
	Time 2	0.58	0.45	0.23	0.64	0.54	0.46	0.79	0.34
		[0.44, 0.73]	[0.29, 0.61]	[0.11, 0.35]	[0.57, 0.71]	[0.44, 0.64]	[0.36, 0.56]	[0.62, 0.96]	[0.17, 0.50]
Nervousness	Time 1	0.59		0.81		0.35	0.66		
		[0.49, 0.68]		[0.74, 0.88]		[0.23, 0.46]	[0.54, 0.77]		
	Time 2	0.59	0.40	0.20	0.67	0.51	0.50	0.83	0.28
		[0.43, 0.75]	[0.19, 0.61]	[0.08, 0.32]	[0.59, 0.75]	[0.39, 0.62]	[0.38, 0.61]	[0.63, 1.00]	[0.12, 0.45]
Lack of Objectivity	Time 1	0.61		0.79		0.37	0.63		
		[0.52, 0.70]		[0.72, 0.86]		[0.26, 0.48]	[0.52, 0.74]		
	Time 2	0.47	0.46	0.24	0.72	0.43	0.58	0.72	0.31
		[0.31, 0.62]	[0.30, 0.61]	[0.12, 0.36]	[0.64, 0.80]	[0.31, 0.54]	[0.46, 0.69]	[0.50, 0.93]	[0.16, 0.46]
Lack of Cooperativeness	Time 1	0.74		0.67		0.55	0.45		
		[0.68, 0.80]		[0.60, 0.74]		[0.46, 0.64]	[0.36, 0.54]		
	Time 2	0.39	0.50	0.21	0.75	0.40	0.60	0.62	0.26
		[0.25, 0.53]	[0.37, 0.62]	[0.07, 0.34]	[0.67, 0.83]	[0.28, 0.52]	[0.48, 0.72]	[0.42, 0.82]	[0.10, 0.43]
Lack of Agreeableness	Time 1	0.59		0.81		0.35	0.65		
		[0.49, 0.68]		[0.74, 0.88]		[0.23, 0.46]	[0.54, 0.77]		
	Time 2	0.39	0.49	0.24	0.74	0.39	0.61	0.63	0.30
		[0.22, 0.57]	[0.34, 0.63]	[0.11, 0.36]	[0.67, 0.82]	[0.27, 0.51]	[0.49, 0.73]	[0.38, 0.88]	[0.15, 0.46]
General Activity	Time 1	0.63		0.77		0.40	0.60		
		[0.55, 0.72]		[0.70, 0.84]		[0.29, 0.51]	[0.49, 0.71]		
	Time 2	0.51	0.36	0.22	0.75	0.39	0.61	0.82	0.28
		[0.36, 0.66]	[0.17, 0.56]	[0.09, 0.34]	[0.67, 0.83]	[0.27, 0.51]	[0.49, 0.73]	[0.61, 1.00]	[0.12, 0.43]
Rhathymia	Time 1	0.65		0.76		0.42	0.58		
		[0.57, 0.74]		[0.69, 0.83]		[0.31, 0.53]	[0.47, 0.69]		
	Time 2	0.44	0.49	0.27	0.71	0.43	0.57	0.67	0.35
		[0.28, 0.59]	[0.36, 0.62]	[0.15, 0.38]	[0.63, 0.79]	[0.31, 0.55]	[0.46, 0.69]	[0.46, 0.87]	[0.21, 0.49]
Thinking Extroversion	Time 1	0.52		0.86		0.27	0.74		
		[0.40, 0.63]		[0.79, 0.93]		[0.11, 0.39]	[0.58, 0.86]		
	Time 2	0.36	0.46	0.22	0.78	0.35	0.65	0.62	0.27
		[0.14, 0.58]	[0.29, 0.64]	[0.09, 0.35]	[0.70, 0.86]	[0.22, 0.48]	[0.52, 0.78]	[0.27, 0.97]	[0.11, 0.42]
Ascendance	Time 1	0.74		0.67		0.55	0.45		
		[0.68, 0.80]		[0.61, 0.74]		[0.46, 0.64]	[0.36, 0.54]		
	Time 2	0.61	0.49	0.21	0.59	0.62	0.38	0.78	0.33
		[0.50, 0.72]	[0.38, 0.61]	[0.11, 0.31]	[0.52, 0.65]	[0.53, 0.71]	[0.30, 0.47]	[0.66, 0.90]	[0.18, 0.48]
Social Extroversion	Time 1	0.74		0.67		0.55	0.45		
		[0.68, 0.80]		[0.60, 0.74]		[0.46, 0.64]	[0.36, 0.54]		
	Time 2	0.56	0.48	0.22	0.63	0.55	0.45	0.76	0.33
		[0.45, 0.68]	[0.36, 0.60]	[0.12, 0.33]	[0.56, 0.71]	[0.45, 0.65]	[0.35, 0.55]	[0.63, 0.90]	[0.18, 0.48]

Note. A = additive genetic effect, E = nonshared environmental effect, r_g = genetic correlation between two time points, r_e = environmental correlation between two time points, 95% confidence intervals are shown in parentheses.

Table 4.5

Results of longitudinal Cholesky decomposition model fitting for the YGPI scales

YGPI Scales		–2lnL	$\Delta\chi^2$	Δdf	p	BIC	RMSEA
Depression							
	Full-Model	7147.07					
	ACE	7188.93	41.86	17	0.00	7252.42	0.095
	AE	7188.93	0.00	3	1.00	7235.10	0.083
	CE	7197.99	9.06	3	0.03	7244.16	0.098
Cyclic Tendency							
	Full-Model	6766.91					
	ACE	6796.88	29.97	17	0.03	6860.36	0.069
	AE	6798.31	1.44	3	0.70	6844.49	0.060
	CE	6798.83	1.95	3	0.58	6845.00	0.061
Inferiority Feelings							
	Full-Model	6339.74					
	ACE	6354.62	14.88	17	0.60	6418.10	0.000
	AE	6355.39	0.77	3	0.86	6401.56	0.000
	CE	6357.16	2.54	3	0.47	6403.33	0.000
Nervousness							
	Full-Model	6763.01					
	ACE	6788.97	25.97	17	0.08	6852.46	0.057
	AE	6789.15	0.18	3	0.98	6835.32	0.044
	CE	6802.04	13.06	3	0.00	6848.21	0.077
Lack of Objectivity							
	Full-Model	6795.35					
	ACE	6808.92	13.58	17	0.70	6872.41	0.000
	AE	6808.92	0.00	3	1.00	6855.10	0.000
	CE	6815.09	6.16	3	0.10	6861.26	0.000
Lack of Cooperativeness							
	Full-Model	6712.24					
	ACE	6736.05	23.81	17	0.12	6799.54	0.050
	AE	6736.06	0.01	3	1.00	6782.23	0.035
	CE	6748.77	12.72	3	0.01	6794.94	0.072
Thinking Extroversion							
	Full-Model	6417.67					
	ACE	6459.67	41.99	17	0.00	6523.15	0.082
	AE	6459.78	0.11	3	0.99	6505.95	0.070
	CE	6460.08	0.42	3	0.94	6506.25	0.072
General Activity							
	Full-Model	6802.40					
	ACE	6814.48	12.09	17	0.79	6877.97	0.000
	AE	6815.51	1.03	3	0.79	6861.69	0.000
	CE	6818.02	3.53	3	0.32	6864.19	0.000
Rhathymia							
	Full-Model	7171.02					
	ACE	7201.11	30.09	17	0.03	7264.60	0.069
	AE	7201.93	0.82	3	0.84	7248.10	0.058
	CE	7212.00	10.89	3	0.01	7258.17	0.081
Ascendance							
	Full-Model	7040.70					
	ACE	7064.25	23.55	17	0.13	7127.73	0.096
	AE	7066.60	2.36	3	0.50	7112.77	0.083
	CE	7077.27	13.03	3	0.00	7123.45	0.084
Social Extroversion							
	Full-Model	6292.99					
	ACE	6308.01	15.01	17	0.59	6371.49	0.049
	AE	6310.29	2.29	3	0.51	6356.47	0.043
	CE	6315.18	7.17	3	0.07	6361.35	0.072
Lack of Agreeableness							
	Full-Model	6795.95					
	ACE	6831.25	35.30	17	0.01	6894.74	0.000
	AE	6831.51	0.26	3	0.97	6877.68	0.000
	CE	6832.63	1.38	3	0.71	6878.80	0.026

Table 4.6

Results of Cholesky decomposition model fitting on change score model for the YGPI scales

YGPI Scales		Time1		Latent Difference		Heritability	Environmentality
		A	E	A	E		
Depression							
	Time 1	0.60***	0.80***			0.36***	0.64***
	Difference	–0.12	–0.51***	0.56***	0.64***	0.33***	0.67***
Cyclic Tendency							
	Time 1	0.60***	0.80***			0.36***	0.64***
	Difference	0.00	–0.58***	0.44***	0.69***	0.19*	0.81***
Inferiority Feelings							
	Time 1	0.63***	0.77***			0.40***	0.60***
	Difference	–0.06	–0.53***	0.54***	0.65***	0.29***	0.71***
Nervousness							
	Time 1	0.59***	0.81***			0.35***	0.66***
	Difference	–0.01	–0.61***	0.43***	0.67***	0.18*	0.82***
Lack of Objectivity							
	Time 1	0.63***	0.78***			0.39***	0.61***
	Difference	–0.19*	–0.55***	0.47***	0.66***	0.26***	0.75***
Lack of Cooperativeness							
	Time 1	0.77***	0.64***			0.60***	0.41***
	Difference	–0.34***	–0.38***	0.61***	0.61***	0.49***	0.51***
Thinking Extroversion							
	Time 1	0.51***	0.86***			0.27***	0.74***
	Difference	–0.23*	–0.54***	0.38***	0.72***	0.35***	0.65***
General Activity							
	Time 1	0.63***	0.77***			0.40***	0.60***
	Difference	–0.09	–0.50***	0.40***	0.77***	0.17*	0.84***
Rhathymia							
	Time 1	0.65***	0.76***			0.42***	0.58***
	Difference	–0.11	–0.49***	0.56***	0.66***	0.33***	0.67***
Ascendance							
	Time 1	0.73***	0.68***			0.54***	0.46***
	Difference	–0.02	–0.50***	0.51***	0.70***	0.26***	0.74***
Social Extroversion							
	Time 1	0.74***	0.67***			0.55***	0.45***
	Difference	–0.19*	–0.43***	0.54***	0.70***	0.33***	0.67***
Lack of Agreeableness							
	Time 1	0.60***	0.80***			0.36***	0.64***
	Difference	–0.25**	–0.54***	0.47***	0.65***	0.28***	0.72***

Note. A = additive genetic effect; E = nonshared environmental effect; YGPI = Yatabe-Guilford Personality Inventory. 95% confidence intervals are given in parentheses.

* $p < .05$, ** $p < .01$, *** $p < .001$.

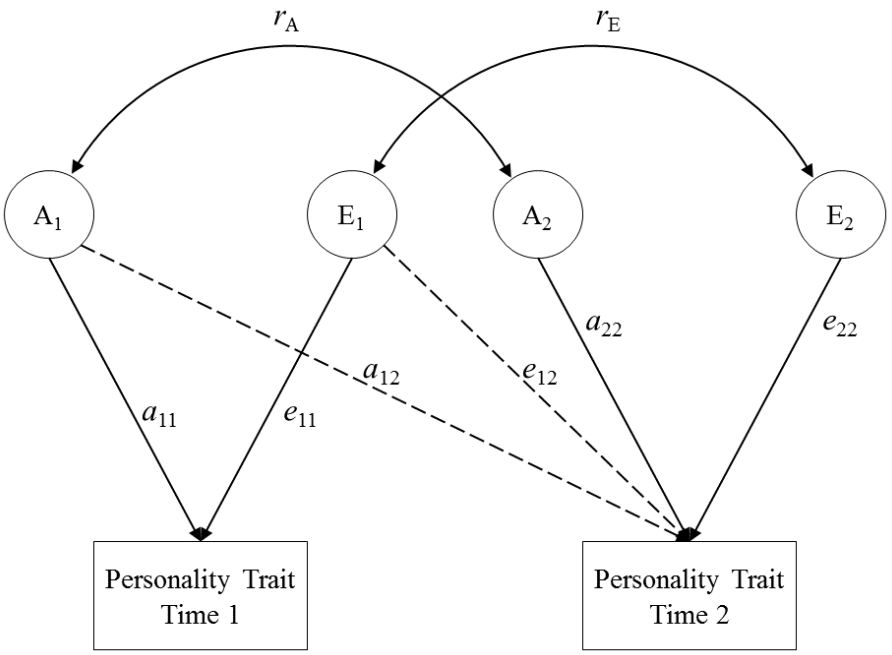

Figure 4.1. Path diagram of the Cholesky decomposition model. The variance of personality at each assessment is decomposed into additive genetic effects (A_1 and A_2) and nonshared environmental effects (E_1 and E_2). This path diagram represents only one twin in a pair (results are identical for the co-twin).

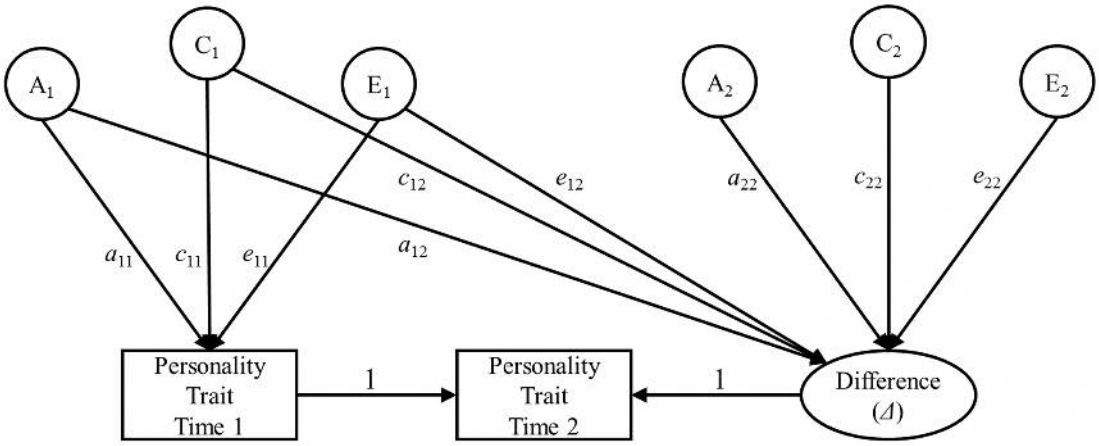

Figure 4.2. Path diagram of the Cholesky decomposition model. The variance of personality at each assessment is decomposed into additive genetic effects (A_1 and A_2), shared environmental effects (C_1 and C_2), and nonshared environmental effects (E_1 and E_2). This path diagram represents only one twin in a pair (results are identical for the co-twin).

Chapter 5.

Personality Change from Life Events: From the Viewpoint of Susceptibility

5.1. Introduction

The preceding chapter investigated the etiology of personality stability and change. The results showed that genetic factors mainly contribute to personality stability and environmental factors mainly contribute to personality change. However, the results also indicated that genetic factors substantially affect mean-level and rank-order change of personality traits. Though previous phenotypic findings showed that personality change is chiefly due to environmental conditions (Lüdtke et al., 2011; Vaidya et al., 2002), the findings of this study revealed that it also requires genetic foundations to some extent. The reason for this can be found in the gene-environment or person-environment interaction of personality change (Bleidorn et al., 2014; Johnson, 2007). Therefore, this chapter investigates whether individuals with specific characteristics are predisposed to experience personality change from environmental factors.

5.1.1. Personality change from life experiences

Previous research on personality development has revealed the normative trajectories and lifelong malleability of human personality (for a meta-analytic review, see Roberts et al., 2006). During life-span development, our personality is influenced by

various environmental factors and shows stability and change. Previous studies examining personality change from environmental factors offered significant findings. For example, work involvement and investment are associated with personality change in adulthood (Hudson et al., 2012; Le et al., 2014; Roberts et al., 2003), and international mobility and overseas study affect personality change in adolescence (Eby, 2005; Zimmermann & Neyer, 2013). Moreover, various events during people's life can cause personality change (Kandler et al., 2012; Lüdtke et al., 2011; Vaidya et al., 2002). These findings are generally consistent with an evolutionary perspective of personality change (Lewis, 2015).

As for the occurrence of life experiences, Roberts and Wood (2006) suggested that individuals with a specific personality tend to undergo certain types of life experiences. This association between personality and life experiences is the selection effect; on the other hand, life experiences can affect personality change, which is called the socialization effect (Roberts & Wood, 2006). Lüdtke et al. (2011) showed that university students' personality selected certain life experiences, which in turn influenced personality change. In addition, Kandler et al. (2012) showed that similar reciprocal effects were observed in an adult sample and that the selection effect was

partly caused by gene-environment correlation. These findings indicate that individual differences in life experiences can partly account for those in personality stability and change. However, these previous studies did not consider individual differences in susceptibility to life experiences. As noted in Chapter 2, this perspective is thought of as a key concept.

5.1.2. Person-environment interaction in personality change

Person-environment or gene-environment interaction is crucial for personality change (Bleidorn et al., 2014; Johnson, 2007). Belsky (1997, 2005) noted that susceptible individuals are likely not only negatively influenced by adversity but also benefit from a positive environment; thus, we can expect that susceptible individuals are more likely to show increases and declines of personality trait levels through positive and negative life experiences. Then, which individual characteristics make them susceptible to environmental factors? As noted in Chapter 2, the strategic differentiation-integration effort (SD-IE) hypothesis (Figueredo et al., 2013), which is based on life history (LH) theory, offers a constructive suggestion.

The SD-IE hypothesis explains strategic differentiation and integration of LH

traits. Variabilities in human LH strategies are captured by unidimensional individual differences in the level of the *K*-factor (Figueredo et al., 2005). According to the SD-IE hypothesis, individuals with high-*K* LH strategies strategically differentiate their LH traits to adapt to their micro-niches; hence their LH traits are temporarily stable. Conversely, individuals with low-*K* LH strategies strategically integrate their LH traits to adapt to a changing, unstable, and unpredictable environment; hence their LH traits are temporarily less stable. This phenotype of low-*K* individuals is considered to function as susceptibility. Therefore, we can expect that when facing various life events, low-*K* individuals undergo more changes in their personality traits, while those of high-*K* individuals remain stable.

5.1.3. Life events regarding life history related domains and the significance of focusing on middle adulthood

Based on the SD-IE hypothesis, low-*K* individuals are predisposed to show increases or declines of their personality trait levels in response to various life events. However, what kinds of events exert greater effects on personality change? LH denotes manners of survivorship and reproduction of organisms in evolutionary biology and

ecology, and LH strategy refers to planned composites of LH traits including some characteristics related with growth, reproduction, and survivorship of organisms. LH theory explains how organisms allocate their total bioenergetic and material resources between the somatic and reproductive effort, which is directly related to fitness, in response to environmental fitness-related quests. Hence, it is thought that life events related to fitness affect low-*K* individuals' traits. Fitness-related life events include marriage and divorce, delivery, mating, disease, and so on. Because these life events become major issues in middle adulthood (Brim, Ryff, & Kessler 2004; Lachman, 2004), this chapter focuses on this developmental stage.

Moreover, though personality change during young or emerging adulthood has received much attention (e.g., Bleidorn, 2012; Hudson & Roberts, 2014; Le et al., 2014), the question of whether and how human personality changes in middle adulthood has received little attention (Helson, Soto, & Cate, 2006). This is partly due to the traditional view that middle age is a time of relative stability in many aspects of life. The meta-analytic review by Roberts and DelVecchio (2000) showed that rank-order stability of personality traits increases with age, and recent empirical research showed that rank-order stability of personality traits during middle age is higher than during

other stages (Milojev & Sibley, 2014). However, despite the view that middle age is a stable period of life, it was pointed that middle adulthood is associated with stress and considered a period characterized by diverse biosocial changes (Brim et al., 2004; Lachman, 2004). Indeed, the levels of some personality traits significantly change through adulthood with substantial variances (Helson et al., 2002) and personality change during midlife is associated with work involvement and physical health (Helson & Soto, 2005). Thus, midlife is not a stable period, it is rather considered a period with the possibility for change.

5.1.4. Present study

The purpose of this chapter is to investigate individual differences in personality stability and change from the viewpoint of differential susceptibility. Based on the SD-IE hypothesis (Figueredo et al., 2013), we predict that low-*K* individuals are more likely to change on measures of personality traits due to various fitness-related life events. Conversely, we expect that high-*K* individuals tend to remain stable despite experiencing various life events.

5.2. Material and Methods

5.2.1. Participants and procedures

The first survey of this study was conducted in a web-based questionnaire format. All participants were members of an online research panel service provided by MyVoice Communications (http://www.myvoice.co.jp/index.html). People in the panel were Japanese residents who had provided their participation consent. An invitation for the present study was emailed to panel registrants who were 30–50 years old on July 11, 2014. The age restriction was imposed since this study focused on people in middle adulthood who were likely to face various fitness-related life events. The email contained information about informed consent, reward for participation, and a hyperlink to the web-based survey. MyVoice awarded reward points corresponding to approximately 40 JPY (about $0.40 US) for the completion of the questionnaire. The company collected data for 2000 participants (1000 female) during July 11–15, 2014 and sent the data to me without any identifying information. The mean age of all participants was 40.94 years (SD = 5.35, range 30–49; M = 41.67, SD = 5.07 for male; M = 40.21, SD = 5.52 for female).

The second survey was also conducted in a web-based questionnaire format. An

invitation was emailed January 9, 2015 to the people who had participated in the first survey. The assessment interval was 6 months. As with the first survey, this invitation email contained information about informed consent, reward for participation, and a hyperlink to the web-based survey. MyVoice awarded reward points corresponding to approximately 40 JPY (about $0.40 US) for the completion of the questionnaire. The company collected data for 1273 participants (606 female) during January 9–14, 2015 and sent the data to me without any identifying information. Because some participants answered the questionnaire in a very perfunctory manner, their data were excluded from the analysis. Thus, data from the remaining 1051 participants (534 female) were analyzed. The mean age of these participants was 41.61 years (SD = 5.31, range 30–50; M = 42.32, SD = 5.01 for male; M = 40.92, SD = 5.51 for female).

5.2.2. Measures

5.2.2.1. First survey

The questionnaire used in the first survey (Time 1) comprised the following three sections: personality traits, human LH strategies, and demographic information.

A) Personality traits were measured with the Japanese version of the 60-item

HEXACO Personality Inventory-Revised (HEXACO-PI-R; Ashton & Lee, 2009; Wakabayashi, 2014). This scale measures six domains of personality, Extraversion, Agreeableness, Conscientiousness, Emotionality, Openness to experiences, and Honesty-Humility, with 10 items for each domain. The answer format is a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Internal reliability was acceptable ($\alpha = .79$, $\omega = .83$ for Extraversion; $\alpha = .66$, $\omega = .72$ for Agreeableness; $\alpha = .68$, $\omega = .74$ for Conscientiousness; $\alpha = .70$, $\omega = .76$ for Emotionality; $\alpha = .72$, $\omega = .78$ for Openness to experiences; $\alpha = .66$, $\omega = .74$ for Honesty-Humility).

B) Human LH strategy was measured with the Japanese version of the Mini-K (Mini-K-J; Figueredo et al., 2006; Kawamoto, 2015). Item examples of the Mini-K-J are, “I have a close and warm romantic relationship with my sexual partner,” and “I often find the bright side to a bad situation.” The Mini-K-J contains 20 items, and the answer format is a seven-point Likert scale that ranges from disagree strongly (−3) to agree strongly (3). Internal reliability was adequate ($\alpha = .83$, $\omega = .86$).

C) Demographic information asked about the participants’ age and sex (i.e., 0: Male, 1: Female).

5.2.2.2. Second survey

The questionnaire used in the second survey (Time 2) comprised the following two sections: personality traits and life events check list.

A) Personality traits were measured with the HEXACO-PI-R (Ashton & Lee, 2009; Wakabayashi, 2014), which is the same measure as for the first survey. Internal reliability was acceptable (α = .80, ω = .84 for Extraversion; α = .68, ω = .73 for Agreeableness; α = .70, ω = .76 for Conscientiousness; α = .68, ω = .74 for Emotionality; α = .72, ω = .79 for Openness to experiences; α = .67, ω = .75 for Honesty-Humility).

B) The occurrence of life events was measured by the 30-item life event checklist (Table 5.1) similar to that used by Plomin, Lichtenstein, Pedersen, McClearn, and Nesselroade (1990) and Kandler et al. (2012). Response categories were (–3) very negative, (–2) negative, (–1) rather negative, (0) nor, (1) rather positive, (2) positive, (3) very positive, and (9) inexperienced. The participants rated the items that had happened within the last 6 months on the –3 to 3 scale, and rated the items that had not happened within the last 6 months with 9. In the analyses of the current study, these two categories were reduced to never (0) and experienced at least one-time (1).

In accordance with previous studies (e.g., Kandler et al., 2012), mean values of each life event item valence were linearly transformed to range from 0 to 1. Based on the transformed valence scores, the 30 life events were classified into two clusters (cutoff = .50): positive life events (PLE: items 3, 6, 10, 13, 21, 25, 27, 28, 29, 30), and negative life events (NLE: items 1, 2, 4, 5, 7, 8, 9, 11, 12, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 26). The averaged frequency of occurrence of PLE and NLE were *Mean* = 0.60 (*SD* = 0.94, *Median* = 0) and *Mean* = 2.24 (*SD* = 2.28, *Median* = 2), respectively, in the second survey (i.e., the retrospective number of life event occurrences between time 1 and 2).

5.2.3. Data Analyses

In order to examine mean-level change in personality and individual differences in personality change, the latent change score model (McArdle, 2009) was applied to each HEXACO-PI-R score (see Figure 5.1). I estimated the means and variances of the scale score changes, and tested whether these estimates were statistically significant with this model.

Then, the latent change score model was estimated as a multi-group model to

test for differences in the path coefficients between high-*K* and low-*K* groups. Analyses began with a baseline model that allowed all paths to vary freely across the groups, which is similar to what would be obtained if separate models were conducted for each group, except that one group was examined simultaneously in a single model. Then, equality constraints were imposed to determine whether constraining the coefficients to be equal across the moderator subgroups would degrade the fit of the multi-group model as indicated by an increase in chi-square over that of the baseline model, with degrees of freedom equal to the number of parameters constrained. A significant difference in chi-square would indicate a moderation effect. These analyses were conducted with Mplus ver. 7 (Muthén & Muthén, 2012).

5.3. Results

5.3.1. Attrition analyses

Approximately 64% of the Time 1 participants completed the questionnaires at Time 2. Attrition effects were inspected for split samples by comparing mean age, gender, personality scores at Time 1, and the Mini-K-J score at Time 1 between participants who completed the questionnaires at both assessments and those who

completed Time 1 assessment but did not take part in the next assessment. For demographic variables, we found no differences in age (t = 1.51, df = 1968.3, p = .13) and gender (χ^2 = 0.51, df = 1, p = .47). Uncorrected for multiple testing effects, no differences were revealed in 4 personality trait scores and the Mini-K-J score (t = 1.01, df = 1991.6, p = .31 for Extraversion; t = 0.46, df = 1995.1, p = .64 for Agreeableness; t = 0.78, df = 1997.2, p = .43 for Emotionality; t = 0.13, df = 1980.4, p = .89 for Openness; t = 1.29, df = 1970.8, p = .20 for the Mini-K-J score). However, statistically significant differences were observed in the remaining personality traits (t = 4.26, df = 1991.8, p < .001, Cohen's d = 0.19 for Conscientiousness; t = 2.72, df = 1991.7, p = .01, Cohen's d = 0.12 for Honesty-Humility). Therefore, the participants who participated in both assessments had slightly higher levels of Conscientiousness and Honesty-Humility. However, the effect sizes of these two traits were not large; hence, the differences between the two participant groups were deemed not substantial.

5.3.2. Correlations among variables in the present study

Before conducting statistical analyses, correlation coefficients among variables were calculated. The results showed high rank-order stability of the HEXACO-PI-R (rs

= .75−.82, *p*s < .001). The correlations between personality traits at Time 1 and the Mini-K-J score were statistically significant except for Emotionality. The detailed correlation coefficients are given in Table 5.2.

5.3.3. Mean-level changes in the HEXACO-PI-R with latent change score model

For an illustration of mean-level changes of the HEXACO-PI-R scales, I fitted the latent change score model to the 2-wave longitudinal data (see Figure 5.1). The latent scores of Agreeableness and Honesty-Humility significantly declined over the interval. The remaining trait scores remained stable. The variances of the latent difference scores of all HEXACO-PI-R scales were statistically significant, which indicates their broad individual differences. The detailed results are given in Table 5.3.

5.3.4. Life events and personality development: Selection and socialization

Before turning to the analyses of the interactions between life events and latent life history construct on change in personality traits, I briefly examined the association of change in personality with aggregated and individual life events and the associations of initial levels of personality with aggregated and individual life events (see Figure

5.2). As mentioned above, life events were rated at Time 2 for the period between the first and second assessments. Table 5.1 shows the frequency with which participants experienced the different life events at some time during the study. It is not surprising that some events were much more common than others. For instance, approximately 35% of participants reported that they had major deterioration in financial status since the first assessment. On the other hand, only 1% of participants reported unintentional pregnancy.

5.3.4.1. Extraversion

In the first step, aggregated positive and negative life events were included in the latent change score model. These indices were calculated by summing the number of items that participants experienced during the assessment interval. Consistent with previous research (Lüdtke et al., 2011; Vaidya et al., 2002), individuals who experienced more positive life events scored higher on initial level of Extraversion ($B = 0.29$, $B\ SE = 0.06$, $p < .01$), and those who experienced more negative life events scored lower on initial level of Extraversion ($B = -0.14$, $B\ SE = 0.06$, $p < .01$). However, aggregated positive and negative life events did not significantly predict individual differences in

change in Extraversion. The detailed results are given in Table 5.4.

Next, to better understand the association between change in personality and individual life events, I also examined how single life events were associated with initial level and change in personality. The results showed several statistically significant associations between the initial level and change in Extraversion and the occurrence of positive and negative life events. As could be expected from the analyses of the aggregated life events, the initial level of Extraversion was negatively linked to the occurrence of several negative life events and positively linked to positive life events. Specifically, people who developed mental health problems scored lower on initial level of Extraversion ($B = -1.09$, $B\ SE = 0.14$, $p < .01$), and people who had major deterioration in financial status scored lower on initial level of Extraversion ($B = -0.87$, $B\ SE = 0.14$, $p < .01$). Conversely, people who attained promotion in the work place scored higher on initial level of Extraversion ($B = 1.24$, $B\ SE = 0.30$, $p < .01$), and people who had major improvement in financial status scored higher on initial level of Extraversion ($B = 0.80$, $B\ SE = 0.17$, $p < .01$). As for socialization associations, some negative life events were significantly associated with declines in Extraversion. For example, in people who had a traffic or job-related accident, the level of Extraversion

declined ($B = -0.33$, $B\ SE = 0.13$, $p = .01$); and in people who had major conflict with their neighbors, the level of Extraversion declined ($B = -0.42$, $B\ SE = 0.13$, $p = .01$). The detailed results are shown in Table 5.5.

5.3.4.2. Agreeableness

As with Extraversion, aggregated positive and negative life events were included in the latent change score model in the first step. The results showed that aggregated positive life events did not significantly predict initial level of and individual differences in change in Agreeableness. In terms of negative life events, individuals who experienced more negative life events scored slightly lower on the later level of Agreeableness ($B = -0.02$, $B\ SE = 0.01$, $p = .05$). However, initial level of Agreeableness was not associated with aggregated negative events. The detailed results are given in Table 5.4.

Next, I examined how single life events were associated with initial level and change in personality. The results showed several statistically significant associations between the initial level and change in Agreeableness and the occurrence of positive and negative life events. The initial level of Agreeableness was negatively linked to the

occurrence of several negative life events and positively linked to positive life events. For example, people who developed mental health problems scored lower on initial level of Agreeableness ($B = -0.13$, $B\ SE = 0.06$, $p = .03$). In contrast, people who changed to a new work place scored higher on initial level of Agreeableness ($B = 0.27$, $B\ SE = 0.14$, $p = .04$). In terms of socialization associations, some negative life events were significantly associated with declines in Agreeableness. For example, for people who were separated from their spouse or romantic partner for an extended period, the level of Agreeableness significantly declined ($B = -0.20$, $B\ SE = 0.09$, $p = .03$); and, as with the case of Extraversion, in people who had major conflict with their neighbors, the level of Agreeableness declined ($B = -0.15$, $B\ SE = 0.08$, $p = .05$). However, some positive life events were also significantly associated with declines in Agreeableness. For example, for people who engaged in sexual relations without emotional commitment, the level of Agreeableness significantly declined ($B = -0.25$, $B\ SE = 0.13$, $p = .05$). The detailed results are shown in Table 5.6.

5.3.4.3. Conscientiousness

First, associations of aggregated positive and negative life events with initial

level of and individual differences in change in Conscientiousness were investigated. The results showed that aggregated positive and negative life events did not significantly predict initial level of and individual differences in change in Conscientiousness.

Subsequently, I examined whether any single life events were associated with initial level and change in personality. The result showed a significant association between change in Conscientiousness and the occurrence of one negative life event. People who had major conflict with their neighbors showed a decline in the level of Conscientiousness ($B = -0.25$, $B\ SE = 0.11$, $p = .02$). However, other positive and negative life events were not significantly associated with initial level of and change in Conscientiousness (see Table 5.7).

5.3.4.4. Emotionality

As with other personality traits, aggregated positive and negative life events were included in the latent change score model in the first step. The results showed that only aggregated negative life events significantly predicted initial level of Emotionality. Individuals who experienced more negative life events scored higher on initial level of

Emotionality ($B = 0.10$, $B\ SE = 0.02$, $p < .01$). The detailed results are given in Table 5.4.

Next, I examined associations between the initial level and change in Emotionality and the occurrence of positive and negative life events. The initial level of Emotionality was positively linked to the occurrence of several negative life events and negatively linked to positive life events. Individuals who had major conflict with their neighbors scored higher on initial level of Emotionality ($B = 0.55$, $B\ SE = 0.21$, $p < .01$), and individuals who developed mental health problems scored higher on initial level of Emotionality ($B = 0.61$, $B\ SE = 0.12$, $p < .01$). In terms of positive life events, individuals who changed their living place scored lower on initial level of Emotionality ($B = -0.55$, $B\ SE = 0.23$, $p = .02$). However, some negative life events were negatively associated with initial level of Emotionality. For example, people who were separated from their spouse or romantic partner for an extended period scored lower on initial level of Emotionality ($B = -0.51$, $B\ SE = 0.25$, $p = .05$), and people who ended their romantic relationships scored lower on initial level of Emotionality ($B = -0.83$, $B\ SE = 0.38$, $p = .03$).

With respect to socialization associations, some negative life events were

significantly associated with increases in Emotionality. For example, people who were separated from their spouse or romantic partner for an extended period significantly increased the level of Emotionality ($B = 0.59$, $B\ SE = 0.18$, $p < .01$), and people who were laid off by their employer increased the level of Emotionality ($B = 0.53$, $B\ SE = 0.21$, $p < .01$). The detailed results are shown in Table 5.8.

5.3.4.5. Openness

With respect to Openness, aggregated positive and negative life events significantly predicted the initial level of Openness. Individuals who experienced more negative life events scored higher on initial level of Openness ($B = 0.06$, $B\ SE = 0.02$, $p < .01$), and those who experienced more positive life events also scored higher on initial level of Openness ($B = 0.24$, $B\ SE = 0.05$, $p < .01$). In contrast, aggregated positive and negative life events were not significantly associated with individual differences in change in Openness. The detailed results are given in Table 5.4.

Subsequently, I examined associations between the initial level and change in Openness and the occurrence of positive and negative life events. The initial level of Openness was positively linked to the occurrence of both negative and positive life

events. For example, individuals who had a traffic or job-related accident scored higher on initial level of Openness (B = 0.39, $B\ SE$ = 0.17, p = .02), and individuals who excessively consumed cigarettes or alcohol scored higher on initial level of Openness (B = 0.34, $B\ SE$ = 0.14, p = .02). In terms of positive life events, individuals who attained promotion in the work place scored higher on initial level of Openness (B = 0.83, $B\ SE$ = 0.25, p < .01), and individuals who engaged in sexual relations without emotional commitment scored higher on initial level of Openness (B = 0.85, $B\ SE$ = 0.33, p < .01). As for socialization associations, only one negative life event was significantly associated with decline in Openness. In people who developed mental health problems, the level of Openness significantly decreased (B = −0.15, $B\ SE$ = 0.06, p = .02). The detailed results are shown in Table 5.9.

5.3.4.6. Honesty-Humility

As with other personality traits, aggregated positive and negative life events were included in the latent change score model. The results showed that only aggregated negative life events significantly predicted initial level of Honesty-Humility. Individuals who experienced more negative life events scored lower on initial level of Honesty-

Humility ($B = -0.03$, $B\ SE = 0.01$, $p = .02$). The detailed results are given in Table 5.4.

Next, I examined associations between the initial level and change in Honesty-Humility and the occurrence of positive and negative life events. The initial level of Honesty-Humility was negatively linked to the occurrence of several negative life events and positively linked to one positive life event. Individuals who had major conflict with their neighbors scored lower on initial level of Honesty-Humility ($B = -0.33$, $B\ SE = 0.13$, $p = .01$), and individuals who excessively consumed cigarettes or alcohol scored lower on initial level of Honesty-Humility ($B = -0.38$, $B\ SE = 0.10$, $p < .01$). In terms of positive life events, individuals who became a morning person scored higher on initial level of Honesty-Humility ($B = 0.20$, $B\ SE = 0.10$, $p = .05$).

With respect to socialization associations, some negative life events were significantly associated with declines in Honesty-Humility. For example, in people who were separated from their spouse or romantic partner for an extended period, the level of Honesty-Humility significantly declined ($B = -0.27$, $B\ SE = 0.12$, $p = .02$), and for people who ended their romantic relationships, the level of Honesty-Humility declined ($B = -0.40$, $B\ SE = 0.17$, $p = .02$). However, one negative life event was positively associated with increase in Honesty-Humility. The level of Honesty-Humility

significantly increased in people who had major deterioration in financial status (B = 0.16, B SE = 0.06, $p < .01$). The detailed results are shown in Table 5.10.

5.3.5. Moderation effects of latent life history construct on life events

The preceding analyses showed statistically significant individual differences in personality change. Thus, in order to investigate the moderation effects of latent life history construct on life events, I conducted multi-group latent change score model analyses. The participants were divided into two groups: high-*K* and low-*K* group. The cut-off was the mean Mini-K-J score.

5.3.5.1. Extraversion

The effects of three life events on the latent change scores significantly differed between high-*K* and low-*K* groups. The three life events consisted of item 7 ("traffic or job-related accident": $\Delta\chi^2 = 5.33$, $df = 1$, $p = .02$), item 10 ("starting a new hobby or sport": $\Delta\chi^2 = 4.52$, $df = 1$, $p = .03$), and item 25 ("engaging in sexual relations without emotional commitment": $\Delta\chi^2 = 5.32$, $df = 1$, $p = .02$). Among the three, item 7 was rated as a negative life event. With respect to the two positive items (item 10 and 25), low-*K*

individuals increased the levels of Extraversion by experiencing these life events. In contrast, low-*K* individuals slightly decreased the level of Extraversion after having traffic or job-related accidents. The detailed results are given in Table 5.11.

5.3.5.2. Agreeableness

The effect of one life event on the latent change score was significantly moderated by the Mini-K-J score. The life event consisted of item 20 ("child in trouble": $\Delta\chi^2 = 4.56$, $df = 1$, $p = .03$). This item was rated as a negative life event. The result showed that levels of Agreeableness declined in low-*K* individuals after having trouble related to their children. The regression coefficients are given in Table 5.12.

5.3.5.3. Conscientiousness

With respect to Conscientiousness, differences in chi-square for each life event were not statistically significant; that is, there were no interaction effects. The selection effects of Conscientiousness were not statistically significant, and the socialization effects were barely significant. The possible reason will be addressed in the discussion.

5.3.5.4. Emotionality

The effects of two life events on the latent change scores significantly differed between high-*K* and low-*K* groups. The two life events consisted of item 3 ("change of address": $\Delta\chi^2 = 4.37$, $df = 1$, $p = .04$) and item 18 ("increase of snacking and meal size": $\Delta\chi^2 = 6.49$, $df = 1$, $p = .01$). Item 3 was rated as a positive life event and item 18 was rated as a negative life event. The results indicated that levels of Emotionality increased in low-*K* individuals after experiencing these life events. The detailed results are given in Table 5.13.

5.3.5.5. Openness

The effects of three life events on the latent change scores significantly differed between high-*K* and low-*K* groups. The three life events consisted of item 7 ("traffic or job-related accident": $\Delta\chi^2 = 6.00$, $df = 1$, $p = .01$), item 14 ("serious illness or injury (self)": $\Delta\chi^2 = 5.23$, $df = 1$, $p = .02$), and item 27 ("entering into a serious new romantic relationship": $\Delta\chi^2 = 4.94$, $df = 1$, $p = .03$). Among the three life events, item 27 was rated as a positive life event. With respect to the two negative items, the level of Openness declined in low-*K* individuals after experiencing these events. In contrast, the

level of Extraversion increased in low-*K* individuals after entering a serious new romantic relationship. The detailed results are shown in Table 5.14.

5.3.5.6. Honesty-Humility

The effects of three life events on the latent change scores were significantly moderated by the Mini-K-J score. The three life events comprised item 5 ("separation from spouse for an extended period": $\Delta\chi^2 = 5.06$, $df = 1$, $p = .02$), item 8 ("major deterioration in financial status": $\Delta\chi^2 = 5.87$, $df = 1$, $p = .02$), and item 25 ("engaging in sexual relations without emotional commitment": $\Delta\chi^2 = 5.89$, $df = 1$, $p = .02$). Among the three life events, item 5 and item 8 were rated as negative life events. The level of Honesty-Humility declined in low-*K* individuals after separation from their spouses for an extended period (item 5) and after engaging in sexual relations without emotional commitment (item 25). However, with respect to item 8, the level of Honesty-Humility in high-*K* individuals significantly increased after major deterioration in financial status. The detailed results are given in Table 5.15.

5.4. Discussion

The present study investigated short-term personality stability and change in middle adulthood. First, I examined rank-order stability and mean-level change in personality traits. The results showed relatively high rank-order stability of HEXACO personality traits and small mean-level declines in Agreeableness and Honesty-Humility. Moreover, the analysis also showed that all latent change scores included substantial between-individual variances, which refer to individual differences in personality change. The present study further examined the association of initial levels of and change in personality with positive and negative life events. The results showed some selection and socialization effects of personality. Finally, this study investigated whether LH tendencies (*K*-factor) amplify or suppress the effects of fitness-related life events based on the SD-IE hypothesis (Figueredo et al., 2013). The results indicated that some effects from positive and negative life events were moderated by the Mini-K-J score that reflects the latent LH construct. The findings regarding life event effects are generally concordant with previous studies (Lüdtke et al., 2011; Vaidya et al., 2002). Furthermore, the findings regarding the moderation effects of the LH construct are vital and unique points of the present study.

5.4.1. Rank-order stability and mean-level change in HEXACO personality

The general patterns of rank-order personality stability found in this study were consistent with the cumulative continuity principles (Roberts et al., 2008). The stability coefficient estimates in this study were approximately .80. The estimates are similar to the result of a recent meta-analysis (Ferguson, 2010) but relatively higher than that of other meta-analytic studies (e.g., Roberts & DelVecchio, 2000). This could be because the assessment interval was relatively short. According to Ardelt (2000), stability coefficients are negatively associated with retest intervals. Therefore, this study obtained relatively high coefficients.

In terms of mean-level change in personality, these middle-aged adults from Japan became less agreeable and less honest. According to the maturity principle (Roberts et al., 2008), people gradually acquire desirable qualities that serve to facilitate functioning in society. In other words, people tend to become nicer, more responsible, more self-disciplined, and more emotionally stable with age. A meta-analytic study showed that people increased on measures of social dominance, Conscientiousness, and emotional stability after age 30 (Roberts et al., 2006). Other empirical studies also indicated increases in emotional stability (Allemand, Zimprich, & Hertzog, 2007;

Helson & Soto, 2005; Helson et al., 2002; Mroczek & Spiro, 2003; van Aken et al., 2006), Agreeableness (Allemand et al., 2007), and social-dominance (Helson & Soto, 2005; Helson et al., 2002), and a decline in social vitality (Helson et al., 2002). Thus, the current results are inconsistent with these studies.

One possible explanation for this inconsistency is scale specificity. The present study used the HEXACO-PI-R (Ashton & Lee, 2009; Wakabayashi, 2014), which suggests that human personality is composed of six basic domains. Because the HEXACO model added the sixth personality trait, Honesty-Humility, to the Big Five model, each domain in the HEXACO model may be slightly different from that in the Big Five model. Especially Agreeableness in the HEXACO personality inventory correlates with Agreeableness assessed by the NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992), a well-established questionnaire based on the Five-Factor Model of personality, but the correlation coefficients are smaller than for other corresponding domains (Wakabayashi, 2014). Agreeableness in the HEXACO model may be slightly different from that in the Big Five.

Sample specificity is also thought to be a possible cause. All previous related studies were conducted in Western countries. As noted in earlier discussions, personality

development is canalized by the contextual demands in our circumstances (Roberts et al., 2008; Turner et al., 2006; Wood & Denissen, 2015). If the circumstances change, the contextual demands change concordantly. For example, the work life environment is very close to adults and influences their well-being and health (Helson & Soto, 2005). Because the work life environment in Japan differs drastically from that in Western countries (Hobson, 2013), normative trajectories of personality development in Japan may differ from those in Western countries.

5.4.2. Life events and personality trait development

5.4.2.1. Selection effect

The present study examined selection and socialization effects of life events. With respect to selection effect, the general pattern obtained in this study is consistent with previous studies (Lüdtke et al., 2011; Vaidya et al., 2002). Especially associations between aggregated positive life events and initial level of Extraversion and between aggregated negative life events and initial level of Emotionality were consistently observed in these two studies (Lüdtke et al., 2011; Vaidya et al., 2002). Moreover, Lüdtke et al. (2011) showed that initial level of Openness was positively associated with

both positive and negative life events, which is consistent with the results of this study.

However, the results regarding Agreeableness and Conscientiousness did not conform to previous studies. Especially Vaidya et al. (2002) indicated the robust associations between initial levels of Agreeableness and Conscientiousness and positive and negative life events, part of which was further supported by the other study (Lüdtke et al., 2011). This discrepancy may be also due to scale specificity. Each personality domain in the HEXACO model may be slightly different from that of the Big Five model. In addition, the age range of this sample differed from that of the two previous studies, which included participants in emerging adulthood around age 20. This difference in age could have caused the inconsistent results.

Turning to single life events, the obtained general pattern is consistent with the results using aggregated life events. As a whole, positive life events were positively associated with initial levels of Extraversion, Agreeableness, Openness, and Honesty-Humility and negatively associated with Emotionality. Negative life events were negatively associated with initial levels of Extraversion, Agreeableness, and Honesty-Humility and positively associated with Emotionality and Openness. More interesting is that initial level of Openness was positively associated with both positive and negative

life events. Openness refers to the breadth, depth, and originality of an individual's mental and experiential life, and includes traits such as aesthetic appreciation, inquisitiveness, creativity, and unconventionality. Individuals with higher level of Openness tend to actively try new activities, which results in experiencing various life events.

In addition, the present study observed specificity of certain life events. For example, items 5 ("separation from spouse for an extended period") and 19 ("end of a romantic relationship") were rated as negative life events but were negatively associated with initial level of Emotionality. These items are thought to reversely reflect mate retention tactics, which denote maintenance of a mating relationship over an extended period. Neuroticism, which corresponds to Emotionality in the HEXACO model, also correlates with mate retention tactics (de Miguel & Buss, 2011). These authors empirically showed that people scoring high on Neuroticism engage in heavier usage of mate retention tactics. Based on this finding, Emotionality should decrease the probability of separation from the spouse for an extended period or end of a romantic relationship, which is supported by the result of this study.

5.4.2.2. Socialization effect

Though previous studies indicated substantial socialization effects of aggregated life events (Lüdtke et al., 2011, Vaidya et al., 2002), they did not significantly influence the change in personality except for Agreeableness. Moreover, the significant association of negative events with change in Agreeableness was very small. However, single life events affected change in personality. In general, negative life events decreased the levels of Extraversion, Agreeableness, Conscientiousness, Openness, and Honesty-Humility and increased the level of Emotionality. Conversely, positive life events had little influence on change in personality except for Agreeableness. This general pattern was consistent with a previous study (Lüdtke et al., 2011).

Two positive life events, items 10 ("starting a new hobby or sport") and item 25 ("engaging in sexual relations without emotional commitment"), had negative influences on change in Agreeableness, similar to negative events. These effects are thought to be specific to these items. As for item 10, we expect that people who started a new hobby or sport get involved in these activities, which results in decline in agreeable behaviors. The other event is related to sociosexuality, which denotes one's willingness to engage in sexual relations without closeness or commitment. Sociosexuality is

strongly negatively associated with Agreeableness (e.g., Holtzman & Strube, 2013). In an experimental study, it was suggested that individuals who had been primed with disease cues tended to respond by acting in a more conformist way (Murray & Schaller, 2012). This finding tells us that people can conform to environmental conditions, which is consistent with the condition-dependent model of personality (Lewis, 2015). Based on this suggestion, people who engaged in sexual relations without emotional commitment may decrease the level of Agreeableness in accordance with the behavior. A more detailed, closer survey in the future will further disclose this mechanism.

5.4.3. Moderation effect of latent life history construct

The principal purpose of this study was to investigate the moderation effect of the latent life history construct. The preceding section discussed socialization effects of certain life events. However, the effects merely represented mean levels. Based-on the SD-IE hypothesis (Figueredo et al., 2013), we expect that low-*K* people (susceptible people) are more affected by positive and negative life events for better or for worse. The results revealed significant differences in life event effects between low-*K* and high-*K* individuals. For example, if low-*K* people experienced a traffic or job-related

accident (item 7), they were more negatively affected and their level of Extraversion and Openness declined; however, if high-*K* people experienced this event, they were less affected by it. Further, if low-*K* people engaged in sexual relations without emotional commitment (item 25), they were more affected and their level of Extraversion increased and level of Honesty-Humility decreased; however, if high-*K* people experienced this event, they were less affected by it. These findings support the hypotheses of this study.

As for the effect of major deterioration in financial status (item 8) on the level of Honesty-Humility, high-*K* individuals were more affected by this life event, which is not consistent with the hypothesis. When people experience deterioration in financial status, they should become more careful and moderate in their spending and work more. These behaviors are future-oriented and applicable to high-*K* strategies. Because high-*K* individuals are more familiar with these behaviors, their behavioral tendency becomes stronger when facing deterioration in financial status. In contrast, low-*K* strategies are intrinsically adaptive to an unstable, unpredictable environment. Hence, a negative environment such as deterioration in financial status might not have influenced them.

Does the life history construct interact with any life event as differential

susceptibility theory predicts? The answer to this question should be "No." For example, items 4 ("death of a close person") and 23 ("serious illness or injury of a close person"), which seem to be influential and impactful, did not interact with the LH construct. It is deemed important for an interaction with the LH construct that the events are directly related to the participants' fitness. The LH construct denotes the tendencies that explain how organisms allocate their energy, time, and effort to somatic and reproductive effort depending on life circumstances. Hence, when the events straightforwardly affect the participants' circumstances, they modify the strategies that are most adaptive to the alternative circumstances. In contrast, the participants' circumstances may not be influenced by life events that do not strongly affect them. Future research should consider more detailed characteristics of each environmental event.

In addition, there were no significant interactions with Conscientiousness. A possible reason could be scale specificity. Selection and socialization effects of Conscientiousness were not observed in this study, though previous studies consistently obtained such effects.

5.4.4. Limitations and future directions

The strengths of this study include the relatively large sample size, the use of a rare sample of Japanese middle-age adults, and the unique viewpoint of the latent LH construct as individual susceptibility. Conversely, some limitations remained that should be taken into consideration. First, this study used a single, self-report questionnaire to measure participants' personality. Mono-rater measures of personality constructs are easily influenced by random and systematic error components (Campbell & Fiske, 1959). To avoid these biases, it is effective to concurrently administer additional measurement methods or independent ratings by well-informed observers (Hofstee, 1994; Kandler, Riemann, et al., 2010). Future research should measure multiple-method or multiple-rater personality data to eliminate random and systematic error effects for investigating stability and change in personality. Especially when focusing on middle adulthood, it might be useful to conduct an investigation at the couple level as well.

Second, the short assessment interval was also a limitation of the present study. Many previous studies have examined stability and change in personality with a relatively long assessment interval, which provides useful evidence regarding normative life-long trajectories of personality. Nonetheless, this study provided mean-level

changes in personality and examined individual differences in personality change with focus on person-environment interaction despite the short-term retest interval. Third, the present study omitted the relatively small daily life experiences. Personality change may be induced not only by major, high-impact life events but also by the many everyday experiences. Future research should examine this point. Finally, this study did not directly measure the susceptibility concept, because its definition is still under discussion and a measurement scale has not been developed yet. For further investigation, we should clearly define the susceptibility concept and develop a corresponding assessment instrument.

5.5. Conclusion and Suggestion

The present chapter investigated personality change from life events with a sample of Japanese mid-adults. According to the results, the occurrence of various life events is associated with participants' personality traits, and some of these events affect the level of personality traits. In addition, the effects of some life events are moderated by participants' latent life history construct. As a result of this moderation effect, low-*K* individuals, who are considered more susceptible, are more affected by life events.

These findings offer some implications for the mechanism of personality change and availability of evolutionary perspectives.

As for the mechanism of personality change, the findings in this chapter offer two important points. First, personality change in mid-adulthood is also derived from life events as is the case with university student samples. This supports the findings from behavioral genetic studies (cf. Chapter 4) and raises further questions: What is the difference between influential life events and those that do not affect personality, and how do life events affect the levels of personality traits? Second, some susceptible people are more affected by life events for better or for worse, which causes large variances of personality change. The individual susceptibility is reflected by the latent life history construct. This finding supports the validity of differential susceptibility theory in personality development. In future research, the occurrence of developmental outcomes, such as pathological symptoms and academic achievements, should be examined with a focus on individual susceptibility to environmental factors.

In addition, the results in this chapter suggest that evolutionary perspectives contribute ample information to human development studies. The evolutionary framework has gained more recognition for understanding human personality (Buss,

2008; Buss & Hawley, 2010; Buss & Penke, 2015), and new research areas taking evolutionary perspective into account have emerged. For example, “evolutionary medicine” is one of the new branches of medical science, which applies modern evolutionary theory to understanding health and disease. The evolutionary framework has fostered our understanding of physical diseases, such as cancer, type 2 diabetes mellitus, and obesity (Merlo, Pepper, Reid, & Maley, 2006; Okin & Medzhitov, 2012; Sellayah, Cagampang, & Cox, 2014), and mental diseases (Del Giudice, 2014; Glover, 2011). We can create a new hypothesis about various human phenotypes with focus on evolutionary perspectives.

Table 5.1

Percentage of individuals for whom an event occurred and valence of each life event

	Life events	Frequency in %	Positive valence
1	Becoming an evening person	34.06	0.40
2	Losing appetite	29.21	0.50
3	Change of address	6.18	**0.58**
4	Death of a close person	10.94	0.18
5	Separation from spouse for an extended period	6.28	0.30
6	Major improvement in financial status	25.50	**0.61**
7	Traffic or job related accident	11.42	0.22
8	Major deterioration in financial status	34.92	0.23
9	Major conflict with neighbors	9.61	0.29
10	Starting a new hobby or sport	16.65	**0.73**
11	Unfulfilled wish to have children	7.14	0.26
12	Major conflict with close relatives	6.47	0.26
13	Changing to a new work place	4.66	**0.55**
14	Serious illness or injury (self)	7.33	0.20
15	Quitting a hobby or sport	17.60	0.31
16	Development of mental health problem	32.83	0.24
17	Excessive consumption of cigarettes or alcohol	16.75	0.36
18	Increase of snack and meal	31.97	0.36
19	End of a romantic relationship	2.66	0.25
20	Child in trouble	1.81	0.30
21	Promotion in the work place	5.80	**0.69**
22	Major happenings in the neighborhood	3.04	0.28
23	Serious illness or injury of a close person	9.80	0.15
24	Lay-off by employer	4.19	0.45
25	Engaging in sexual relations without emotional commitment	2.47	**0.62**
26	Unintentional pregnancy	0.76	0.31
27	Entering into a serious new romantic relationship	3.62	**0.75**
28	Getting married	1.43	**0.84**
29	Becoming a morning person	14.08	**0.67**
30	Birth of own child	1.81	**0.89**

Notes. Self-rated valence was adapted to take values between 0 and 1. Higher values indicate more positive events. Values above .50 are shown in boldface.

Table 5.2

Correlations between the personality traits at Time 1 and other variables

Variable	EXT	AGR	CON	EMO	OPE	HON	Mini-K	Age	Gender
EXT	.82***	.14***	.18***	−.36***	.26***	−.11***	.42***	.07	−.09
AGR	.10**	.75***	−.06	−.20***	.07	.08	.14***	−.01	−.03
CON	.17***	−.08**	.75***	−.04	.26***	.11***	.32***	.05	.02
EMO	−.32***	−.20***	−.01	.76***	−.12**	−.00	.07	−.09*	.28***
OPE	.26***	.08*	.27***	−.10***	.82***	.03	.29***	−.04	.04
HON	−.14***	.05	.10***	.04	−.00	.74***	.12***	.03	.15***

Notes. EXT = Extraversion; AGR = Agreeableness; CON = Conscientiousness; EMO = Emotionality; OPE = Openness; HON = Honesty-Humility. Rank-order stability coefficients are boxed. The correlations below the rank-order stability are those among the HEXACO-PI-R domains at Time 1. The correlations above the rank-order stability are those among the HEXACO-PI-R domains at Time 2.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5.3

Results of latent change score models for the HEXACO scales

	Difference						Model Fit			
Variables	*Mean*	*Mean SE*	*p*	*Var*	*Var SE*	*p*	CFI	TLI	RMSEA	RMSEA 90%CI
EXT	−0.02	0.04	.65	0.48	0.07	<.01	0.97	0.97	0.07	[0.06, 0.08]
AGR	−0.07	0.02	<.01	0.11	0.02	<.01	0.99	0.99	0.03	[0.02, 0.04]
CON	−0.04	0.03	.09	0.20	0.04	<.01	0.97	0.96	0.06	[0.05, 0.07]
EMO	0.04	0.04	.35	0.41	0.08	<.01	0.99	0.99	0.03	[0.02, 0.05]
OPE	−0.02	0.03	.46	0.26	0.04	<.01	1.00	1.00	0.02	[0.00, 0.03]
HON	−0.08	0.03	<.01	0.15	0.04	<.01	1.00	1.00	0.01	[0.00, 0.03]

Notes. N = 1051. EXT = Extraversion; AGR = Agreeableness; CON = Conscientiousness; EMO = Emotionality; OPE = Openness; HON = Honesty-Humility; Var = Variance; SE = standard error.

Table 5.4

Regression coefficients of initial status and change in personality traits on aggregated positive and negative life events

		Positive life events			Negative life events		
Personality traits		*B*	*B SE*	*p*	*B*	*B SE*	*p*
Extraversion							
	Initial level (β_3)	0.29	0.06	<.01	−0.14	0.03	<.01
	Difference (β_6)	−0.03	0.04	.49	−0.03	0.02	.08
Agreeableness							
	Initial level (β_3)	0.01	0.03	.68	−0.02	0.01	.08
	Difference (β_6)	−0.02	0.02	.23	−0.02	0.01	.05
Conscientiousness							
	Initial level (β_3)	0.04	0.04	.28	−0.02	0.02	.37
	Difference (β_6)	−0.02	0.03	.56	−0.00	0.01	.89
Emotionality							
	Initial level (β_3)	0.02	0.06	.77	0.10	0.02	<.01
	Difference (β_6)	0.05	0.04	.23	0.02	0.02	.17
Openness							
	Initial level (β_3)	0.24	0.05	<.01	0.06	0.02	<.01
	Difference (β_6)	0.02	0.03	.77	−0.02	0.01	.09
Honesty-Humility							
	Initial level (β_3)	0.04	0.03	.27	−0.03	0.01	.02
	Difference (β_6)	−0.00	0.03	.87	0.01	0.01	.59

Note. All models include control variables for age and gender.

Table 5.5

Regression coefficients of initial status and change in Extraversion on single positive and negative life events

Selection (β_3)				Socialization (β_6)			
Item	*B*	*B SE*	*p*	Item	*B*	*B SE*	*p*
Negative events							
Becoming an evening person	−0.35	0.13	<.01	Traffic or job related accident	−0.33	0.13	.01
Major deterioration in financial status	−0.87	0.14	<.01	Major conflict with neighbors	−0.42	0.14	<.01
Quitting a hobby or sport	−0.52	0.18	<.01	Development of mental health problem	−0.24	0.08	<.01
Development of mental health problem	−1.09	0.14	<.01				
Positive events							
Major improvement in financial status	0.80	0.17	<.01				
Starting a new hobby or sport	0.38	0.18	.04				
Promotion in the work place	1.24	0.30	<.01				

Note. All models include control variables for age and gender.

Table 5.6

Regression coefficients of initial status and change in Agreeableness on single positive and negative life events

Selection (β_3)				Socialization (β_6)			
Item	*B*	*B SE*	*p*	Item	*B*	*B SE*	*p*
Negative events							
Major deterioration in financial status	−0.12	0.06	.05	Separation from spouse for an extended period	−0.20	0.09	.03
Quitting a hobby or sport	−0.26	0.08	<.01	Major conflict with neighbors	−0.15	0.08	.05
Development of mental health problem	−0.13	0.06	.03				
Positive events							
Change of address	0.24	0.12	.04	Starting a new hobby or sport	−0.12	0.06	.04
Changing to a new work place	0.27	0.14	.04	Engaging in sexual relations without emotional commitment	−0.25	0.13	.05

Note. All models include control variables for age and gender.

Table 5.7

Regression coefficients of initial status and change in Conscientiousness on single positive and negative life events

Selection (β_3)				Socialization (β_6)			
Item	*B*	*B SE*	*p*	Item	*B*	*B SE*	*p*
Negative events							
				Major conflict with neighbors	−0.25	0.11	.02

Note. All models include control variables for age and gender.

Table 5.8

Regression coefficients of initial status and change in Emotionality on single positive and negative life events

Selection (β_3)				Socialization (β_6)			
Item	*B*	*B SE*	*p*	Item	*B*	*B SE*	*p*
Negative events							
Separation from spouse for an extended period	−0.51	0.25	.05	Separation from spouse for an extended period	0.59	0.18	<.01
Major conflict with neighbors	0.55	0.21	<.01	Lay-off by employer	0.53	0.21	<.01
Quitting a hobby or sport	0.58	0.15	<.01				
Development of mental health problem	0.61	0.12	<.01				
Increase of snack and meal	0.43	0.12	<.01				
End of a romantic relationship	−0.83	0.38	.03				
Major happenings in the neighborhood	0.81	0.35	.02				
Serious illness or injury of a close person	0.36	0.18	.05				
Positive events							
Change of address	−0.55	0.23	.02				
Engaging in sexual relations without emotional commitment	−1.13	0.36	<.01				

Note. All models include control variables for age and gender.

Table 5.9

Regression coefficients of initial status and change in Openness on single positive and negative life events

Selection (β_3)				Socialization (β_6)			
Item	*B*	*B SE*	*p*	Item	*B*	*B SE*	*p*
Negative events							
Traffic or job related accident	0.39	0.17	.02	Development of mental health problem	−0.15	0.06	.02
Quitting a hobby or sport	0.28	0.14	.05				
Excessive consumption of cigarettes or alcohol	0.34	0.14	.02				
Increase of snack and meal	0.21	0.11	.05				
Positive events							
Major improvement in financial status	0.37	0.13	<.01				
Starting a new hobby or sport	0.38	0.14	<.01				
Promotion in the work place	0.83	0.25	<.01				
Engaging in sexual relations without emotional commitment	0.85	0.33	<.01				
Becoming a morning person	0.41	0.16	<.01				

Note. All models include control variables for age and gender.

Table 5.10

Regression coefficients of initial status and change in Honesty-Humility on single positive and negative life events

Selection (β_3)				Socialization (β_6)			
Item	*B*	*B SE*	*p*	Item	*B*	*B SE*	*p*
Negative events							
Major deterioration in financial status	−0.25	0.08	<.01	Separation from spouse for an extended period	−0.27	0.12	.02
Major conflict with neighbors	−0.33	0.13	.01	Major deterioration in financial status	0.16	0.06	<.01
Major conflict with close relatives	−0.34	0.16	.04	Major conflict with close relatives	−0.33	0.12	<.01
Excessive consumption of cigarettes or alcohol	−0.38	0.10	<.01	Serious illness or injury (self)	−0.24	0.10	.02
Major happenings in the neighborhood	−0.61	0.22	<.01	Excessive consumption of cigarettes or alcohol	−0.16	0.07	.02
				End of a romantic relationship	−0.40	0.17	.02
Positive events							
Becoming a morning person	0.20	0.10	.05				

Note. All models include control variables for age and gender.

Table 5.11

Results of multi group moderation analyses for Extraversion

Life event	Model	Subgroup	Path coefficient (β_6)	Model comparison
Item 7				
Traffic or job related accident	Baseline	High-*K*	−0.039	$\Delta\chi^2(1) = 5.33$
		Low-*K*	−0.597**	$p = .02$
	Constraint		−0.287*	
Item 10				
Starting a new hobby or sport	Baseline	High-*K*	−0.125	$\Delta\chi^2(1) = 4.52$
		Low-*K*	0.325*	$p = .03$
	Constraint		0.063	
Item 25				
Engaging in sexual relations without emotional commitment	Baseline	High-*K*	−0.336	$\Delta\chi^2(1) = 5.32$
		Low-*K*	0.554*	$p = .02$
	Constraint		0.123	

Note. * $p < .05$, ** $p < .01$.

Table 5.12

Results of multi group moderation analyses for Agreeableness

Life event	Model	Subgroup	Path coefficient (β_6)	Model comparison
Item 20				
Child in trouble	Baseline	High-*K*	0.363	$\Delta\chi^2(1) = 4.56$
		Low-*K*	−0.456*	$p = .03$
	Constraint		−0.283	

Note. * $p < .05$.

Table 5.13

Results of multi group moderation analyses for Emotionality

Life event	Model	Subgroup	Path coefficient (β_6)	Model comparison
Item 3				
Change of address	Baseline	High-*K*	−0.089	$\Delta\chi^2(1) = 4.37$
		Low-*K*	0.584**	$p = .04$
	Constraint		0.225	
Item 18				
Increase of snack and meal	Baseline	High-*K*	0.027	$\Delta\chi^2(1) = 6.49$
		Low-*K*	0.447***	$p = .01$
	Constraint		0.223	

Note. ** $p < .01$, *** $p < .001$.

Table 5.14

Results of multi group moderation analyses for Openness

Life event	Model	Subgroup	Path coefficient (β_6)	Model comparison
Item 7				
Traffic or job related accident	Baseline	High-*K*	0.169	$\Delta\chi^2(1) = 6.00$
		Low-*K*	−0.320*	$p = .01$
	Constraint		−0.044	
Item 14				
Serious illness or injury (self)	Baseline	High-*K*	0.010	$\Delta\chi^2(1) = 5.23$
		Low-*K*	−0.546**	$p = .02$
	Constraint		−0.221	
Item 27				
Entering into a serious new romantic relationship	Baseline	High-*K*	−0.282	$\Delta\chi^2(1) = 4.94$
		Low-*K*	0.533*	$p = .03$
	Constraint		0.019	

Note. * $p < .05$, ** $p < .01$.

Table 5.15

Results of multi group moderation analyses for Honesty-Humility

Life event	Model	Subgroup	Path coefficient (β_6)	Model comparison
Item 5				
Separation from spouse for an extended period	Baseline	High-*K*	−0.064	$\Delta\chi^2(1) = 5.06$
		Low-*K*	−0.535**	$p = .02$
	Constraint		−0.258*	
Item 8				
Major deterioration in financial status	Baseline	High-*K*	0.261***	$\Delta\chi^2(1) = 5.87$
		Low-*K*	0.023	$p = .02$
	Constraint		0.134**	
Item 25				
Engaging in sexual relations without emotional commitment	Baseline	High-*K*	0.220	$\Delta\chi^2(1) = 5.89$
		Low-*K*	−0.502*	$p = .02$
	Constraint		−0.149	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

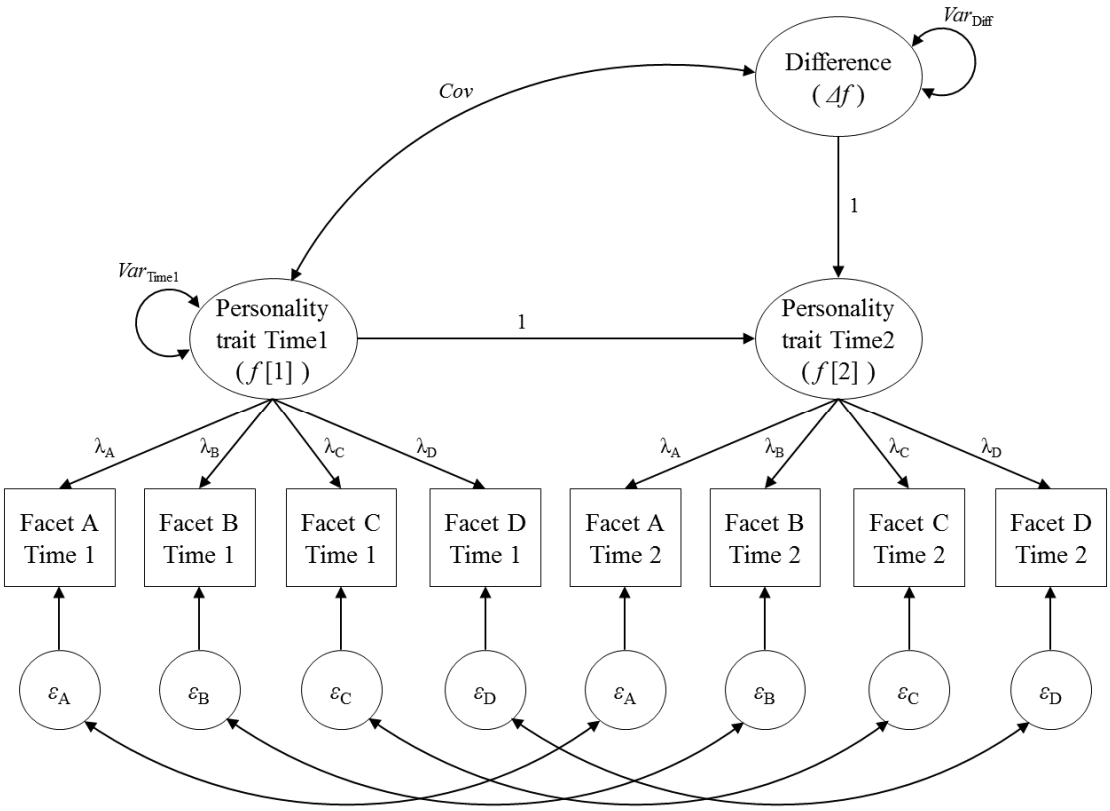

Figure 5.1.

Latent change score model for investigating mean-level change in personality and individual differences in personality change

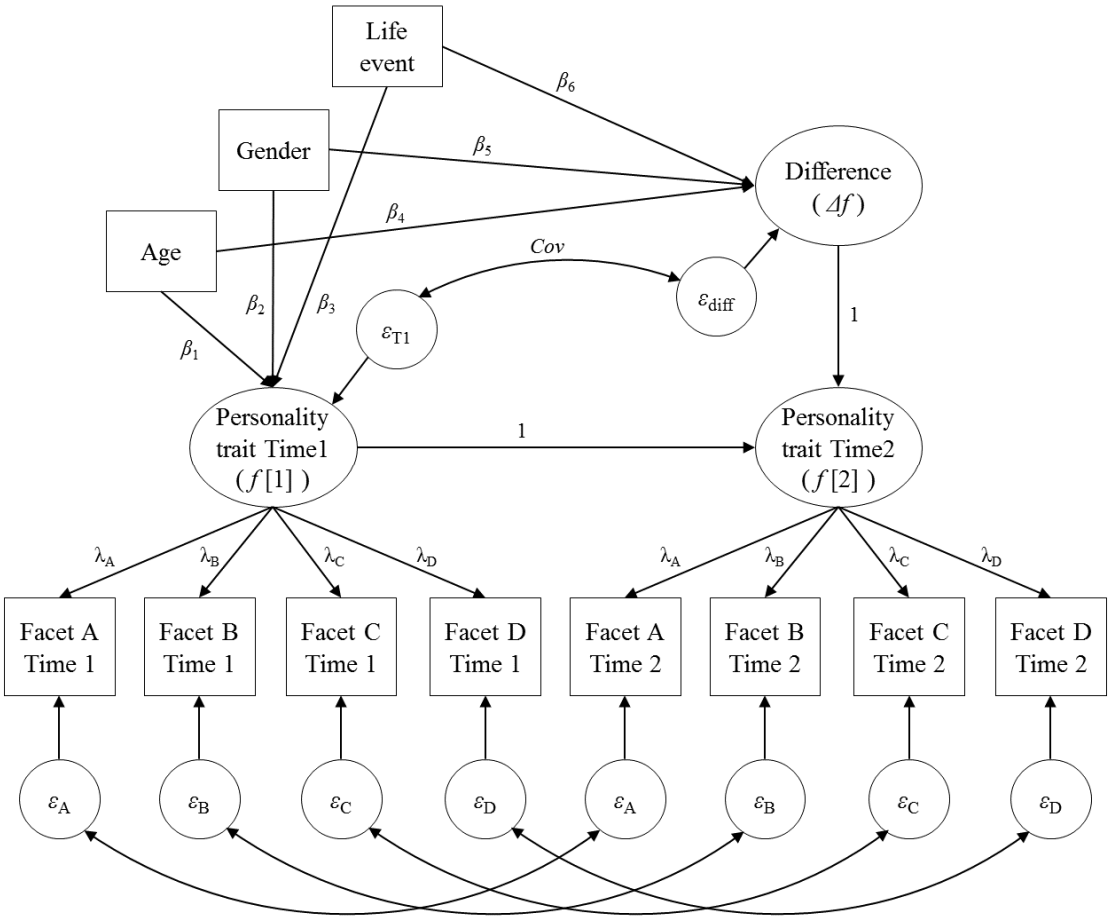

Figure 5.2.

Latent change score model for investigating selection and socialization effects of life events

Chapter 6.

Personality Stability and Change in Daily Lives

6.1. Introduction

The study in Chapter 5 examined individual differences in personality change focusing on the latent life history construct. Person-environment interaction of personality change has been considered an important perspective (Bleidorn et al., 2014; Johnson, 2007). The preceding study showed that life history constructs interact with various life events, which results in amplifying or suppressing change of personality trait levels. This finding offers significant suggestions to the research area of personality development.

This chapter focuses on effects of minor daily life experiences. Chapter 5 dealt with relatively high-impact life events and their influences on levels of personality traits. However, it was suggested that personality traits can change and develop from the accumulation of daily situations and behaviors over time (Heller, Perunovic, & Reichman, 2009). For investigating personality change, we should focus not only on large life events but also on minor daily experiences. Hence, this chapter addresses everyday experiences. Moreover, Chapter 5 focused on an abstract concept such as the LH construct (*K*-factor). However, when dealing with daily trivial experiences and for the purpose of reduction to practice, the *K*-factor as a susceptibility characteristic should

be embodied at the level of social situations. Therefore, the present chapter focused on a specific life history indicator in social life.

6.1.1. Investigations of individual differences in personality change

Much research investigating mean-level and rank-order stability and change in personality has been conducted over the past twenty years (for meta-analytic reviews, see Roberts & DelVecchio, 2000; Roberts et al., 2006). Especially the findings about mean-level stability and change have offered us useful information about developmental trajectories regarding our socioemotional dimensions.

Both longitudinal and cross-sectional studies have reported mean-level personality changes in the Big Five, which measures human personality in five domains—Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to experiences—and is widely used (John et al., 2008), across the life span. Taking particular note of mean-level personality change across the college years (18–22 years of age), the findings of the meta-analytic results by Roberts et al. (2006) indicated significant increases in social dominance, one of the facets of Extraversion, social vitality or sociability, the other facet of Extraversion, Openness to experiences, and

emotional stability, the opposite pole to Neuroticism. Moreover, when focusing on the age of young adulthood after college graduation (22–30 years of age), their findings revealed significant increases in social dominance, Conscientiousness, and emotional stability, and a significant decline in social vitality or sociability (Roberts et al., 2006). These meta-analytic findings have been supported by recent empirical studies with late adolescent or young adult samples (e.g., Bleidorn, 2012; Lüdtke et al., 2011).

However, these preceding studies also pointed out that there are broad substantial individual differences in change of personality across young or emerging adulthood. In this regard, genetically informed studies about the etiology of personality stability and change suggest that change in personality across young adulthood is associated with environmental as well as genetic factors (Bleidorn et al., 2009; Hopwood et al., 2011). Thus, researchers have paid attention to the life experiences, events, transitions, and contexts occurring during young adulthood that are particularly associated with personality development (Caspi, Roberts, & Shiner, 2005; Edmonds, Jackson, Fayard, & Roberts, 2008). Indeed, some studies explained the variability in personality change with daily life experiences or experienced life events (Kandler et al., 2012; Lüdtke et al., 2011; Vaidya et al., 2002). There are further suggestions that events

associated with these contexts may impact individuals differently and even serve to accentuate individual differences (e.g., Belsky, 1997b, 2005; Boyce & Ellis, 2005). We therefore should consider variables that moderate the effects of environmental factors on personality change.

6.1.2. Attachment security as susceptible characteristics

In the original work on attachment, Bowlby (1973) argued that individuals develop cognitive-affective representations or internal working models of their experiences in attachment relationships from infancy onwards. Individuals who received reliably sensitive care are disposed to develop generally positive representations of themselves and others, in other words, secure attachment. In contrast, individuals with a history of negative experiences in relations with attachment figures develop conditional attachment strategies, which take two fundamentally different forms: One is the hyperactivated attachment system, characterized by high anxiety and the use of excessive attempts to get attention and care from others; and the other is the deactivated attachment system, characterized by avoidance of closeness and support seeking and maintaining a strong reliance on the self (Mikulincer & Shaver, 2007, 2009).

The attachment theory by Bowlby has been built on an evolutionary perspective and is one of the few major mid-level evolutionary theories. Especially life history theory, which explains how organisms allocate their energy, time, and effort to somatic and reproductive efforts depending on life circumstances, is inseparably connected with attachment theory (Belsky, 1997a, 1999; Belsky, Steinberg, & Draper, 1991; Chisholm, 1996, 1999). The gist of life history models of attachment is that infants and toddlers use their parents' caregiving behaviors as an indicator of the stability and predictability of their local environment, which results in individual attachment security. Thus, attachment is regarded as one of the indicators of the life history construct (Figueredo et al. 2004; 2006; 2007). These studies showed the association between attachment and latent life history construct, which was also supported in a Japanese sample (Kawamoto, 2015). Therefore, this study used attachment security as a life history indicator in social life.

Previous studies have shed light on how individual differences in attachment security influence the reception of environmental effects such as life experiences, events, and social support. Collins and Feeney (2004) showed that insecure individuals were more likely than secure individuals to rate low-support messages negatively and

perceive them as more inconsiderate and upsetting. Likewise, it was indicated that insecure attachment increases susceptibility to stressful life events (Picardi et al., 2003). In general, insecure individuals were more easily influenced by various negative life events or experiences (Mikulincer & Florian, 1998). Further, highly anxious individuals were especially considered to be highly activated (Mikulincer & Shaver, 2007, 2009). For example, they realized more conflict with their romantic partners and had conflicted feelings, which negatively impacted the perceived satisfaction or closeness of relationships (Campbell, Simpson, Boldry, & Kashy, 2005). They tended to show more intense negative emotional reactions in the face of negative stimuli and to ruminate and have difficulty to stop thinking about negative experiences (Gentzler, Kerns, & Keener, 2010).

On the other hand, recent studies have focused on how the attachment system moderates reactions to positive events and stimuli. It was indicated that secure individuals experience and display more positive emotions. Highly anxious individuals find it difficult to experience positive emotions due to their preoccupation and hypervigilance for threats, while highly avoidant individuals have a tendency to perceive others' positive behaviors as signaling dependence or a sign of deception

(Shaver & Mikulincer, 2008). Indeed, preceding studies showed that insecure individuals tend to derogate and incorrectly remember aspects of positive life events, experiences, and interpersonal behaviors (Gentzler & Kerns, 2006; Gentzler et al., 2010; Gosnell & Gable, 2013; Sadikaj, Moskowitz, & Zuroff, 2011). In contrast, securely attached individuals showed greater reflection on positive experiences (Gentzler et al., 2010) and were more likely to savor their positive experiences (Gentzler, Ramsey, Yi, Palmer, & Morey, 2014).

6.1.3. Present study

As pointed out above, life experiences might cause changes in personality development (Caspi et al., 2005; Edmonds et al., 2008). Therefore, we can expect that effects of positive and negative life experiences on personality development might be modified by participants' attachment security. It was indicated that personality traits are one of the components of our personalities and that other personality aspects, including identity or autobiographical memory, also contribute to our personalities (McAdams & Pals, 2006; Roberts & Wood, 2006). Because the recognition and memories of life experiences might influence our thoughts, feelings, behaviors, and accordingly,

personality traits (McAdams & Pals, 2006; Roberts & Wood, 2006), attachment security might function as a moderator of the effects of life experiences. Though previous studies showed that positive life events promote changes of some personality traits in a positive direction while negative life events have the opposite effect (Kandler et al., 2012; Lüdtke et al., 2011; Vaidya et al., 2002), the amount of change in personality may vary across levels of attachment security. Because secure individuals experience and display more positive emotions (Shaver & Mikulincer, 2008), they are more inclined to change their personality traits in a positive direction due to positive life experiences. Insecure individuals tend to react readily to negative environmental stimuli (Mikulincer & Florian, 1998), therefore, they are expected to be more likely to be influenced by negative life experiences and to change their personality scores. Because highly anxious individuals are considered to be more susceptible to negative stimuli (Campbell et al., 2005; Gentzler et al., 2010; Mikulincer & Shaver, 2007, 2009), it is expected that they undergo greater influence of negative life experiences on personality change than highly avoidant individuals.

6.2. Material and Methods

6.2.1. Participants and procedures

Participants included students recruited from six universities in Japan. The 1,000 participants (M = 19.72; SD = 1.26; range 18–25; 679 females, 321 males) completed Time 1 questionnaires in July 2012, and among them, 323 (M = 19.83; SD = 1.37; range 18–25; 204 females, 119 males) completed Time 2 questionnaires in November 2012 (20-week interval). Participants at both time points completed the questionnaires in their lecture classes and received project folders in exchange for their participation. The attrition rate of the present study was 67.7% because participants could complete Time 2 questionnaires only if they attended the consecutive lecture during the next semester. Informed consent was obtained from all participants included in the study.

6.2.2. Measures

The Time 1 questionnaire used in this study comprised three sections: personality traits, attachment style, and demographic information. The Time 2 questionnaire comprised three sections: personality traits, life experiences, and demographic information.

6.2.2.1. Big Five personality.

The Big Five personality traits were assessed at both times using the 70-item Big-Five Personality Inventory measuring five domains of personality—Extraversion, Agreeableness, Conscientiousness, Emotional stability, and Openness—with 12 items for each domain and participants' dismissive attitude to answer with 10 items (BFPI; Murakami & Murakami, 1997). Items were rated on a three-point scale; 0 (not true of me), 1 (don't know), and 2 (true of me). Each score of the BFPI is calculated by adding every item score after dealing with the reverse items.

The BFPI has been widely used in Japan, and the correlations with the NEO-PI-R (Costa & McCrae, 1992) and the Ten Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003) were investigated. The correlations with the NEO-PI-R were moderate to high (r = .69 for Extraversion; r = −.65 for Neuroticism; r = .54 for Agreeableness; r = .77 for Conscientiousness; r = .29 for Openness; Ohnogi, 2004), while those with the TIPI were high (r = .84 for Extraversion; r = −.67 for Neuroticism; r = .45 for Agreeableness; r = .65 for Conscientiousness; r = .51 for Openness; Oshio, Abe, & Cutrone, 2012), which suggests adequate validity of the BFPI. Test-retest reliabilities for the five traits within a one-week interval ranged from .85 to .95

(Murakami & Murakami, 1997). Internal reliability was acceptable both at Time 1 (αs > .74) and at Time 2 (αs > .70).

6.2.2.2. Attachment.

Attachment at Time 1 was measured with the 36-item Japanese version of Experiences in Close Relationship inventory (ECR; Brennan et al., 1998; Nakao & Kato, 2004). This scale measures attachment avoidance and anxiety with 18 items rated on a 7-point scale from 1 (not very true of me) to 7 (very true of me). Test-retest reliabilities for the two subscales within an interval of one month were .92 for attachment anxiety and .74 for attachment avoidance (Nakao & Kato, 2004). In the current study, the reliability indexes showed good internal consistency for both anxiety (α = .90) and avoidance (α = .86).

6.2.2.3. Life experiences.

Life experiences of participants between Time 1 and Time 2 were measured by the scale of life experiences in interpersonal and achievement domains for undergraduate students (Takahira, 1998). This scale has 119 items, which

comprehensively cover most of the daily experiences that normal university students may have. The items include statements such as “I go out with my friends,” and “I am betrayed by the person whom I have trusted.” In subjective experience, the relation between valence and arousal is dynamic, and greater positive or negative valence gives rise to stronger arousal (Kuppens, Tuerlinckx, Russell, & Barrett, 2013). Therefore, this study used participants’ subjective valence for determining the psychological significance of the life experiences. The items were rated on a 4-point scale: 1 (not a good experience for me), 2 (neutral experience for me), 3 (good experience for me), and 4 (inexperienced). The participants rated the items that had happened in their lives on the 1 to 3 scale, and rated the items that had not happened with 4. Positive life experiences were calculated by summing the number of items rated with 3, and negative life experiences were calculated by summing the number of items rated with 1.

6.2.3. Data analyses

Some previous studies used a cluster analysis method to determine participants’ attachment security (e.g., Maunder et al., 2006). Thus, in this study, cross-sectional latent class analysis (LCA) was conducted on the ECR items and the number of classes

was established. To determine the number of classes, the following four criteria were set: the Bayesian information criterion (BIC; Schwarz, 1978); the bootstrap likelihood ratio test (BLRT; Nylund, Asparouhov, & Muthén, 2007); entropy, with values above .70 (Reinecke, 2006); and redundancy of an additional class.

Then, to evaluate individuals' growth trajectories, hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002) analyses were conducted on each scale score of the BFPI in Mplus ver. 7 (Muthén & Muthén, 2012) using maximum likelihood estimation. The BFPI scores were standardized as *T*-scores ($M = 50$, $SD = 10$) with the grand means and standard deviations of scores both at Time 1 and Time 2. The primary analyses were conducted in three stages. First, separate HLM for each BFPI scale examined patterns of stability and change in personality over time. In the analyzed model, intercept paths were fixed to 1 for each measurement occasion so that the intercept designates scores at the first assessment, and slope paths were fixed to 0 for the first assessment (i.e., baseline) and fixed to 1 for the second assessment.

The second stage added four predictors—age at Time 1, gender, the number of positive life experiences, and the number of negative life experiences—to the analyzed model for explaining variances of the intercepts and slopes.

In the third stage of analysis, the full HLM was estimated as a multi-group model to test for differences in path coefficients across attachment security groups. Analyses began with a baseline model that allowed all paths to vary freely across the groups, which is similar to what would be obtained if separate models were conducted for each group, except that the two groups were examined simultaneously in a single model. Then, equality constraints were imposed to determine whether constraining the coefficients to be equal across the moderator subgroups would degrade the fit of the multi-group model as indicated by an increase in chi-square over that of the baseline model with degrees of freedom equal to the number of parameters constrained. A significant difference in chi-square would indicate a moderation effect.

Listwise and pairwise deletion of missing values, which are classical methods for dealing with missing values, are the most problematic among the missing data techniques (Newman & Cottrell, 2015). Multiple imputation (MI) is superior to other missing data techniques for longitudinal data (Newman & Cottrell, 2015). Hence, all missing data were estimated by the MI method in this study. Based on the high rate of attrition cases, I created 50 imputed datasets for the full sample. The 50 imputed data sets were analyzed one after the other and combined the results of the analysis. In order

to combine the results properly reflecting the uncertainty in the imputed values, parameter estimates were averaged over the 50 sets of analyses, and standard errors were computed with the average of the standard errors over the 50 sets of analyses and the between analysis parameter estimate variation (Rubin, 1987). Owing to this reflection of the uncertainty inherent in the imputed data, the MI method offers conservative test results in accordance with the degree of attrition rates. Thus, the MI method was the best way to deal with the longitudinal data in this study despite the high attrition rate.

6.3. Results

6.3.1. Attrition analyses

Approximately 30% of the Time 1 participants completed the questionnaires at Time 2. Focusing initially on demographic variables, Welch's *t*-test revealed no significant difference in the participants' age ($t = -0.57$, $df = 646.78$, $p = .57$). However, chi-square test revealed a small distribution bias of gender ($\chi^2 = 4.40$, $df = 1$, $p = .04$), which showed that more male participants completed the questionnaires at both times. Further, no differences were found in each BFPI scale score between non-retest and

retest participants (ts < 1.44, df = 550.73−582.14, ps > .15). Therefore, the participants who completed both Time 1 and Time 2 questionnaires constituted a completely representative sample of the original participants.

6.3.2. Correlations among variables in the present study

Before conducting statistical analyses, correlation coefficients among variables were calculated. The results showed high rank-order stability of the BFPI (rs = .74−.81, ps < .001) and weak or moderate correlations among the subscales of the BFPI both at Time 1 (rs = .11−.39, ps < .001) and Time 2 (rs = .14−.38, ps < .001). The correlations between personality traits at Time 1 and the number of life experiences were weak but statistically significant. The detailed correlation coefficients are given in Table 6.1.

6.3.3. Identifying attachment security by latent class analysis

Latent class analysis was conducted on the ECR item scores to identify participants' attachment security. A series of LCA models were fit starting with a one-class model. Then, I raised the number of classes one after another. Table 6.2 includes fit information (i.e., BIC and p value for the BLRT) for LCA models with one through

six classes. Because the BIC never reached a minimum value in this application, I obtained the last relatively large decrease in the BIC value (Nylund et al., 2007), which occurred with the three-class model. None of the *p* values for the BLRT were nonsignificant, thus, this measure was not used to provide information for my decision. Entropy of the three-class model was better than that of other models (.90). From a theoretical perspective, Hazan and Shaver (1987) classified adult romantic attachment into three prototypes (i.e., secure, avoidant, and anxious). Indeed, the three-class model achieved a consummate expression of Hazan and Shaver's three prototypes (see Figure 6.1). Based on these points, the three-class model was considered the best to explain the heterogeneity in participants' ECR scores and was chosen as the final LCA model.

6.3.4. HLM analyses of mean-level changes in the BFPI

To estimate the proportion of stable variance in the BFPI personality traits, which can be computed as the proportion of between-individual variance (u_0: intercept variance) to the total variance (u_0: intercept variance + σ_0^2: within-individual variance), I used between- and within-individual variance estimates from the basic one-way ANOVA with the random effects model (Raudenbush & Bryk, 2002, p. 24). This ratio,

called *intraclass* correlation, indicates that the proportion of variance that was stable over the course of this study ranged from 73.5% for Conscientiousness to 86.1% for Extraversion (*Median* = 77.7%), and the remaining portion was within subjects. The HLM results for the final models of the BFPI scales are reported in Table 6.3.

The linear fixed effects are very important for specifying the shape of the developmental trajectory. Intercept estimates for the BFPI scales were statistically significant but slope estimates were not. These results indicated that the scores for each BFPI scale did not show statistically significant mean-level changes across the 20 weeks. Next, the random effect terms (u_0: variance) associated with the intercepts showed between-individual differences in stability of the BFPI scale scores. They were all statistically significant and larger than the residual within-individual variance (σ_0^2). Variances associated with the linear slopes were relatively small but statistically significant, indicating between-individual differences in change of the BFPI scale scores.

Variances of intercept and slope factors were explained by four predictors: participants' age at Time 1, gender, the numbers of positive life experiences, and those of negative life experiences. Age had positive effects on the intercept of

Conscientiousness and Openness and change of emotional stability. Conversely, age had an opposite effect on change of Agreeableness. Gender showed significant effects on initial levels of Agreeableness and emotional stability. After controlling for age and gender effects on intercepts and slopes, positive life experiences positively predicted initial levels of the BFPI scales and the amount of change in all of the BFPI scales except Extraversion. In contrast, negative life experiences negatively predicted initial levels of Conscientiousness and emotional stability and the amount of change in Agreeableness, Conscientiousness, and Openness.

6.3.5. Tests for moderation effects of attachment security on life experiences

This study hypothesized that influences of life experiences on personality change would be moderated by participants' attachment security. To test this hypothesis, this study conducted multi-group HLM analyses. The participants were divided via their attachment security decided by latent class analysis. In a baseline model, all paths were freely estimated across the groups. Then, I applied equality constraints to determine whether constraining the path coefficients to be equal across attachment security subgroups would reduce the fit of the multi-group model. To compare the two models,

the differences in chi-square fit statistics and Bonferroni adjustment ($p < .0025$) were used. A significant difference in chi-square would indicate a moderation effect of attachment security.

The results of multi-group analyses are shown in Table 6.4. Only the points in which significant multi-group differences were found are included in the table. The hypothesized moderation effects were observed in some BFPI scales. Attachment security moderated the effects of positive life experiences on the slope factor of emotional stability ($\Delta\chi^2(2) = 16.57$, $p < .001$), indicating that the amount of positive life experiences influenced the change of emotional stability in secure individuals but had no significant effect in insecure individuals. The effects of negative life experiences were also modified by attachment security. Path coefficients from negative life experiences to the slope factors of Extraversion, Agreeableness, emotional stability, and Openness varied by attachment security (for Extraversion, $\Delta\chi^2(2) = 43.86$, $p < .001$; for Agreeableness, $\Delta\chi^2(2) = 49.09$, $p < .001$; for emotional stability, $\Delta\chi^2(2) = 20.84$, $p < .001$; for Openness, $\Delta\chi^2(2) = 13.45$, $p < .001$). Insecure, especially highly anxious individuals tended to score lower on the BFPI scales, except for Conscientiousness, under the influence of negative life experiences. However, as for Extraversion, highly

avoidant individuals showed an increase in slope factor under the influence of negative life experiences.

Further, associations of positive life experiences with the intercept factors of Conscientiousness, emotional stability, and Openness also differed depending on attachment security (for Conscientiousness, $\Delta\chi^2(2) = 29.35$, $p < .001$; for emotional stability, $\Delta\chi^2(2) = 19.81$, $p < .001$; for Openness, $\Delta\chi^2(2) = 18.30$, $p < .001$). In secure individuals, the number of positive life experiences positively predicted the intercepts of Conscientiousness and Openness scores.

6.4. Discussion

This study verified whether change of personality can be influenced by daily life experiences, and further examined whether this influence is modified by attachment security. The results of the HLM analyses showed that although mean-level changes in the BFBI scales were not statistically significant, they included substantial between-individual variance, which was partly explained by the effects of positive and negative life experiences. This finding is concordant with previous studies (Kandler et al., 2012; Lüdtke et al., 2011; Vaidya et al., 2002). Furthermore, the influences of life experiences

on personality were moderated by participants' attachment security, which is a vital and novel point of the present study.

The individual differences in stability and change of personality were explained by the numbers of positive and negative life experiences. Overall, the results suggested that positive life experiences were positively associated with the intercepts of personality, while negative life experiences were negatively associated. Further, positive life experiences influenced changes of personality in a positive direction, while negative life experiences influenced changes of personality in a negative direction. Especially the associations of life experiences with personality indicate that personality traits predict the occurrence of life experiences, which is called *selection effect* (Roberts & Wood, 2006). In our daily lives, we tend to select social environments that are consistent with our existing dispositions and to react to similar environments. Such tendency mildly canalizes our daily life experiences. Additionally, life experiences also influenced personality change. Positive life experiences increased the slope factors of every BFPI scale except for Extraversion, and negative ones decreased the slope factors of Agreeableness, Conscientiousness, and Openness. Therefore, life experiences not only relate with personality traits but also enhance the changes in these traits, which is

consistent with the *corresponsive principle* of personality development (Caspi et al., 2005).

Previous studies investigating the association between life events and change of personality showed that negative life events especially influence personality change (Kandler et al., 2012; Lüdtke et al., 2011). However, the results of this study indicated that positive life experiences also had effects on change. This inconsistency may be due to a difference in the quality of environmental factors. Kandler et al. (2012) and Lüdtke et al. (2011) focused on relatively impactful events, for example, "death of a close person" or "changed accommodation (change of address)." However, the present study dealt with broader kinds of daily life experiences. At least with regard to positive episodes, the long succession of small daily experiences may be important for university students.

The results of the multi-group HLM analyses showed that life experience effects on change of personality were moderated by participants' attachment style. Overall, the effects of positive life experiences were reduced and those of negative experiences amplified in insecure individuals, as the hypotheses predicted. Especially secure individuals tended to show stronger associations of positive life experiences with

Conscientiousness and Openness and larger changes of emotional stability under the influence of positive life experiences. Because securely attached individuals tend to reflect on positive experiences and savor them (Gentzler et al., 2010, 2014), they may become more emotionally stable through the reflection of their daily positive experiences, similar to a positive feedback effect. On the other hand, highly anxious individuals tended to exhibit lower levels of Extraversion, Agreeableness, emotional stability, and Openness under the influence of negative life experiences. Many studies pointed out that such individuals are more susceptible to negative stimuli than secure or highly avoidant people (Campbell et al., 2005; Gentzler et al., 2010; Mikulincer & Shaver, 2007, 2009); thus, the results of this study are consistent with these findings.

Though these moderation effects of attachment security provide a novel perspective of research regarding personality change and development, the obtained results should be treated carefully. The assessment interval was short, so the results about moderation effects may be temporary. However, it was suggested that an accumulation of short-term fluctuations in personality states leads to change of personality traits (Heller et al., 2009). Therefore, the current findings provide evidence that daily life experiences are able to influence the change of personality, and that the

small fluctuations may differ across levels of attachment security. Future research should further investigate whether similar trends can be replicated with a longer assessment interval and focus more on daily micro-processes using a diary or wearable devices.

The strengths of this study include the relatively large sample size, the use of a rare sample of Japanese university students, and a unique viewpoint focusing on attachment security as a susceptibility to life experiences. In contrast, some limitations remain that should be taken into consideration. First, this study used a single, self-report questionnaire to measure participants' personality. It was indicated that mono-rater measures of personality constructs are easily influenced by random and systematic error components (Campbell & Fiske, 1959). To avoid these biases, it would be effective to administer additional measurements or independent ratings concurrently by well-informed observers (Hofstee, 1994; Kandler, Riemann, et al., 2010). Indeed, some preceding studies have used self- and peer-reported personality scores together (e.g., Kandler, Bleidorn et al., 2010). Future research should measure multiple-method or multiple-rater personality data to eliminate random and systematic error effects for investigating stability and change in personality. Second, the short assessment interval

was also a limitation of the present study. Many previous studies have examined stability and change in personality with relatively long assessment intervals. These studies are useful for estimating rough trajectories of personality traits. However, personality traits can change and develop due to the accumulation of daily situations and behaviors over time (Heller et al., 2009). This study contributes to the understanding of micro-level processes of personality development that occur in participants' daily lives. Third, the sampling bias that the sample was restricted to university students was also a problem of this study. This might have influenced the results, that is, we cannot extrapolate this finding into the general population. Because personality predicted the occurrence of several objective major life events (Roberts & Wood, 2006), the participants' personality at baseline might have been biased compared to the general population. Furthermore, since the transitions to and increases in investment in social roles of adult life are considered to create increases in Agreeableness, Conscientiousness, and emotional stability (Roberts, Wood, & Smith, 2005), the participants of the current study might show different trajectories of personality compared with individuals who have never attended college. Indeed, Lüdtke et al. (2011) showed differences in developmental trajectories of Big Five personality

traits except Extraversion between youths who entered college after high school and those who entered work or vocational training. However, since the college attendance rate in developed countries has been rising, it is important to understand how the socioemotional aspects of students develop across college years. Thus, focusing on a university student sample is not futile. Last, this study focused on the valence of life experiences. Some previous studies categorized life events as being either positive or negative (e.g., Vaidya et al., 2002), while other studies asked participants to rate the impact of the life experiences (e.g., Kandler et al., 2012; Lüdtke et al., 2011). The approach of this study matches the latter. Valence is important to examine the impact of life experiences (Kuppens et al., 2013); however, participants' responses may involve their interpretation of the experiences. This is one of the problems common to studies focusing on participants' valence ratings. It may be useful to separate emotional valence from the interpretation of experiences to focus on the detailed process after the occurrence of life experiences.

Finally, the present study did not include other sources of personality change than life experiences and attachment security as a moderator. However, we can expect that other processes facilitate personality change. For example, post-traumatic growth,

which is the positive psychological change among people who came to terms with highly stressful and challenging life events, has received attention as a positive personality change (e.g., Jayawickreme & Blackie, 2014). In the future, we should further examine various mechanisms of personality change.

6.5. Conclusion and Suggestion

The present chapter investigated effects of life experiences on personality change and the moderating effects of attachment security on these effects. According to the results, aggregated daily positive and negative life experiences accounted for individual differences in change and stability of the Big Five personality. In addition, the life experience effects were moderated by participants' attachment security. Though the life history construct used in the preceding chapter is an abstract concept, attachment security is regarded as a more concrete indicator of the life history construct (Figueredo et al. 2004; 2006; 2007; Kawamoto, 2015). This chapter focused on daily familiar life experiences; hence, this study extended the theoretical implication from the preceding chapter to everyday life.

The results in this chapter offer implications about the investigation of micro-

processes in developmental changes. Chapter 3 simply described the trends of personality development while Chapter 4 disclosed their etiology. The subsequent Chapter 5 focused on the effects of relatively major life events and investigated the corresponding personality changes. However, developmental changes are not only due to impactful environmental events but also to minor daily life events. In recent studies regarding human development, daily life experiences are regarded as highly important (for reviews, see Hektner, 2012; Hoppmann & Riediger, 2009). Considering these notions, it is meaningful to empirically examine the effects of daily life experiences on personality stability and change in this chapter. As noted above, daily diary methods and computerized sampling of experiences and behaviors with wearable devices are possible daily life research methods. These microscopic approaches may provide new insight into personality development processes.

Table 6.1

Correlations between the personality traits at Time 1 and other variables

	EXT	AGR	CON	EMO	OPE	AVO	ANX	PLE	NLE	Age	Gender
EXT	.76	.27	.24	.27	.31	−.43	−.13	.30	−.01	.02	.03
AGR	.30	.77	.33	.25	.18	−.43	−.19	.24	−.08	.08	.08
CON	.18	.33	.74	.14	.38	−.11	−.19	.15	−.14	.11	.00
EMO	.28	.20	.11	.81	.30	−.24	−.53	.07	−.15	.01	−.09
OPE	.32	.12	.39	.26	.78	−.03	−.23	.15	−.06	.13	−.16

Notes. EXT = Extraversion; AGR = Agreeableness; CON = Conscientiousness; EMO = Emotional stability; OPE = Openness; AVO = attachment avoidance; ANX = attachment anxiety; PLE = positive life experiences; NLE = negative life experiences. Rank-order stability coefficients are boxed. The correlations below the rank-order stability are those among Big Five domains at Time 1. The correlations above the rank-order stability are those among Big Five domains at Time 2. Correlation coefficients are significant ($p < .001$) if $|r| > .10$.

Table 6.2

Fit information for the latent class analysis

	Number of classes					
	1	2	3	4	5	6
BIC	128941.86	124892.83	122559.66	122270.66	121874.61	121658.88
P-value of the BLRT	-	0.00	0.00	0.00	0.00	0.00
Entropy	1.00	0.89	0.90	0.89	0.89	0.89
Proportion of each class	1.00	0.58	0.45	0.41	0.39	0.33
		0.42	0.33	0.21	0.18	0.18
			0.22	0.20	0.17	0.14
				0.19	0.14	0.13
					0.13	0.12
						0.10

Note. $N = 1000$. BIC = Bayesian Information Criterion; BLRT = Bootstrap Likelihood Ratio Test.

Table 6.3

HLM coefficients and variance estimates of the intercepts and linear terms for the BFPI scales

	BFPI Scales				
	EXT	AGR	CON	EMO	OPE
Intercept					
Mean	50.21***	49.92***	49.74***	51.46***	52.32***
	(0.61)	(0.31)	(0.60)	(0.60)	(0.59)
Age	−0.09	0.39	0.57*	−0.42	0.63*
	(0.28)	(0.28)	(0.28)	(0.29)	(0.28)
Gender	−0.06	1.53*	−0.06	−2.19**	−3.45
	(0.72)	(0.72)	(0.72)	(0.72)	(0.71)
PLE	0.25***	0.21***	0.13**	0.09*	0.15**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
NLE	−0.04	−0.12	−0.15*	−0.20**	−0.04
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Variance	72.55***	66.50***	65.73***	73.41***	68.72***
Slope					
Mean	−0.65	0.30	0.58	−0.13	0.80
	(0.52)	(0.69)	(0.74)	(0.61)	(0.69)
Age	0.17	−0.74*	0.22	1.10**	0.20
	(0.27)	(0.76)	(0.39)	(0.33)	(0.36)
Gender	−1.09	0.81	0.04	0.44	−1.24
	(0.60)	(0.81)	(0.86)	(0.72)	(0.80)
PLE	0.03	0.12***	0.10**	0.07*	0.08*
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
NLE	−0.06	−0.15**	−0.10*	−0.08	−0.10*
	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)
Variance	0.88*	2.51*	1.90*	3.59*	2.32*

Notes. Standard errors are shown in parentheses. HLM = hierarchical linear modeling; BFPI = Big Five Personality Inventory; EXT = Extraversion; AGR = Agreeableness; CON = Conscientiousness; EMO = Emotional stability; OPE = Openness; PLE = positive life experiences; NLE = negative life experiences. N = 1,000. Gender is coded: male = 0, female = 1.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 6.4

Results of multi group moderation analyses

	Model	Subgroup	Path coefficient	Model comparison
PLE to intercept factors				
Conscientiousness	Baseline	Secure	0.264***	$\Delta\chi^2(2) = 29.35$
		Avoidant	−0.038	$p < .001$
		Anxiety	0.010	BIC = 14030.37
	Constraint		0.080	BIC = 14045.90
Emotional stability	Baseline	Secure	0.080	$\Delta\chi^2(2) = 19.81$
		Avoidant	0.126	$p < .001$
		Anxiety	−0.070	BIC = 13472.42
	Constraint		0.014	BIC = 13478.41
Openness	Baseline	Secure	0.264***	$\Delta\chi^2(2) = 18.30$
		Avoidant	0.049	$p < .001$
		Anxiety	0.059	BIC = 13932.97
	Constraint		0.120**	BIC = 13937.45
PLE to slope factors				
Emotional stability	Baseline	Secure	0.140**	$\Delta\chi^2(2) = 16.57$
		Avoidant	−0.023	$p < .001$
		Anxiety	0.048	BIC = 13472.42
	Constraint		0.063*	BIC = 13475.18
NLE to slope factors				
Extraversion	Baseline	Secure	−0.077	$\Delta\chi^2(2) = 43.86$
		Avoidant	0.196**	$p < .001$
		Anxiety	−0.126**	BIC = 13287.90
	Constraint		−0.067*	BIC = 13317.95
Agreeableness	Baseline	Secure	0.030	$\Delta\chi^2(2) = 49.09$
		Avoidant	0.110	$p < .001$
		Anxiety	−0.257***	BIC = 13734.44
	Constraint		−0.136**	BIC = 13769.72
Emotional stability	Baseline	Secure	0.077	$\Delta\chi^2(2) = 20.84$
		Avoidant	−0.114	$p < .001$
		Anxiety	−0.123**	BIC = 13472.42
	Constraint		−0.076*	BIC = 13479.44
Openness	Baseline	Secure	−0.039	$\Delta\chi^2(2) = 13.45$
		Avoidant	0.033	$p = .001$
		Anxiety	−0.148**	BIC = 13932.97
	Constraint		−0.097*	BIC = 13932.60

Notes. PLE = positive life experiences; NLE = negative life experiences.

$N = 1{,}000$ (Secure: $N = 331$; Avoidant: $N = 224$; Anxiety: $N = 445$).

All models include control variables for age and gender.

* $p < .05$, ** $p < .01$, *** $p < .001$.

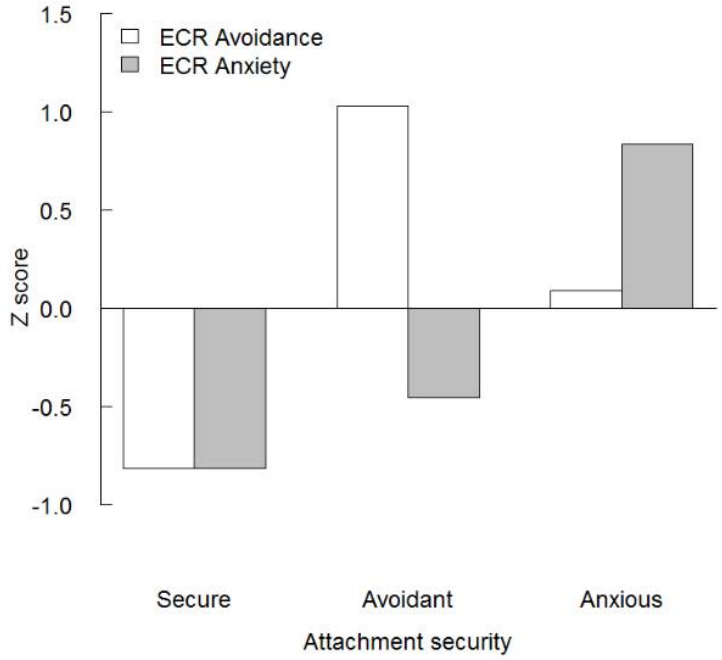

Figure 6.1. Profiles of the attachment security types on the ECR.

Chapter 7.

General Discussion: Future Orientations of Research in Personality Stability and Change

7.1. Findings of the Present Series of Studies

The presented studies consistently investigated individual differences in personality stability and change. The first study in Chapter 3 showed the variabilities of trends of personality change in adolescence, which were explained by gender and birth cohort. This finding adds evidence to the inconsistent previous findings (e.g., Branje et al., 2007; Canals et al., 2005; De Fruyt et al., 2006; Klimstra et al., 2009; Lamb et al., 2002; McCrae et al., 2002; Pullmann et al., 2006; Van den Akker et al., 2014). In addition, the finding regarding cohort effect offers the suggestion that the trends of personality development may change with generation. Some previous studies have confirmed this cohort effect (Helson et al., 2002; Terracciano et al., 2005, 2006; Twenge, 2000, 2001), however, there have been few studies showing the cohort effect on rate of change, which is a new finding of this study.

The second study in Chapter 4 investigated the etiology of personality change and stability. The results showed that rank-order stability of personality is mainly due to genetic factors and that environmental factors make relatively small contributions to rank-order stability of personality. This primary finding is consistent with many previous studies (e.g., Blonigen et al., 2008; Bratko & Butkovic, 2007; Hopwood et al.,

2011; Johnson et al., 2005; Kandler, Bleidorn, et al., 2010; Kandler et al., 2013; McGue et al., 1993; Viken et al., 1994). However, genetic factors were not completely consistent; in other words, additional genetic factors affect later personality trait scores, which is called genetic innovation. These novel genetic influences on personality may reflect genetic influences on later stages in physical development such as sexual and brain maturation.

In addition, genetic and environmental contributions to mean-level change in personality were investigated. The result shows that mean-level personality change is mainly due to environmental factors, which conforms to previous findings in adulthood (Bleidorn et al., 2009; Hopwood et al., 2011). However, genetic factors also affect mean-level personality change, which suggests that genetic factors play a role in increase or decline of personality trait measures. We can offer some interpretations on this point. The genetic factors may directly affect the changes of personality trait levels, and the result of genetic innovation supports this idea. However, as previous studies pointed out (Bleidorn et al., 2014; Johnson, 2007), gene-environment and person-environment interactions may be engaged with mean-level personality change.

In evolutionary psychology, adaptive plasticity has been attracting attention

(e.g., Belsky, 1997b, 2000, 2005; Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Del Giudice, Ellis, & Shirtcliff, 2011). Among this notion, differential susceptibility theory has recently been deemed a valuable idea (Belsky, 1997b, 2005, Ellis et al., 2011). As described in Chapter 2, the gist of differential susceptibility is that susceptibility has been maintained under natural selection and is underpinned by genetic factors. It further interacts with environmental factors and amplifies their effects. This person-environment interaction perspective conforms to previous suggestions in personality psychology (Bleidorn et al., 2014; Johnson, 2007). Hence, the genetic influences on mean-level personality change may reflect this person-environment interaction.

Chapter 5 examined whether this person-environment interaction was phenotypically observed. Based on the strategic differentiation-integration effort (SD-IE) hypothesis (Figueredo et al., 2013), the latent life history construct is considered to reflect susceptible characteristics. Thus, this study investigated individual differences in short-term personality change with focus on the latent life history construct called the *K*-factor. The result indicated that this *K*-factor partly moderated influences of life events on personality change. Low-*K* individuals, who are considered highly susceptible

individuals, experienced larger changes of personality trait levels by positive and negative life events. This finding supports the effectiveness of differential susceptibility theory for investigating individual differences in personality change.

Finally, the subsequent Chapter 6 examined a similar phenomenon in everyday social life. The result partly supported the moderation effects of attachment security as a type of susceptibility. In the preceding chapter, low-*K* individuals showed larger changes on measures of personality traits in a positive direction by positive life events. Conversely, they showed larger changes in a negative direction by negative life events. However, attachment security, which is an indicator of the life history construct, amplified only the effects of negative life experiences. Insecure individuals strongly reacted to negative life experiences but did not strongly react to positive experiences. This finding is consistent with previous attachment research (Campbell et al., 2005; Gentzler et al., 2010; Mikulincer & Shaver, 2007, 2009) and the diathesis–stress model (Zuckerman, 1999) but does not support differential susceptibility theory.

The essential finding of these studies is the focus on the person-environment interaction for investigating individual differences in personality change. Though this interaction in research on personality stability and change has been pointed out

theoretically (Bleidorn et al., 2014; Johnson, 2007), empirical research is lacking. Therefore, the present series of studies is the first to empirically investigate individual differences in personality change with a focus on person-environment interaction.

7.2. Personality Stability and Change: Explanatory Factors

The present series of studies consistently dealt with personality stability and change over time. The obtained results provide evidence regarding explanatory factors of personality stability and change. First, participants' biological age reliably influences personality change. The first study in Chapter 3 showed the average developmental trends of personality traits in adolescent years, that is, how adolescents' personality trait levels increase or decline with age from 12 to 18 years. In particular, in adolescents, the level of Neuroticism increases, and the level of Extraversion slightly decreases. However, studies focusing on other biological age ranges showed different developmental trends of personality (e.g., Helson et al., 2002; Specht et al., 2011; Terracciano et al., 2005). Despite the cross-sectional approach, it was shown that level of Extraversion remained stable and that of Neuroticism declined with age in a Japanese adult sample (Kawamoto et al., 2015). Therefore, trends of personality development

seem to be partly determined by biological age.

Then, why does biological age account for a part of the variance contributing to personality development? The present study offers two candidate answers to this question. The first idea consists of influences from social contexts. For example, the neo-socioanalytic model of personality trait development suggests that commitment to and investment in social roles is one of the reasons for personality change (Roberts & Wood, 2006; Roberts et al., 2005). The commitment to and investment in social roles increase contextual demand; hence, the contextual demand in our circumstances canalizes the overall trajectories of personality change (Roberts et al., 2008; Turner et al., 2006; Wood & Denissen, 2015). As we grow older, our circumstances gradually alter because of new commitment to or additional investment in social roles. This alteration of circumstances changes the contextual demand, which results in different trends of personality traits.

This idea conforms to the second explanatory factor of personality stability and change, which consists of generation and cohort. Chapter 3 indicated that the trends of personality development gradually change with cohort. Because 30 years is too short for gene frequency to change, this cohort effect is completely attributed to environmental

factors. There have been gradual changes in terms of socioeconomy and social climate in Japan (e.g., Hein, 2008; Tachibanaki, 2006). These changes in social context may affect the way of commitment to and investment in social roles and contextual demand, which results in generation differences in personality development. Similar secular trends have been observed in other countries (Billstedt et al., 2013; Smits et al., 2011; Twenge, 2000, 2001; Terracciano et al., 2005, 2006) but they vary from country to country. Social contexts, such as socioeconomy and social climate, differ between countries. Hence, the differences in secular trends among countries support the influences of social contexts on personality stability and change.

The other reason why age explains a part of the variance of personality development is the effect of biological factors. It was suggested that the trajectories of physical growth and personality dimensions are associated with each other (Lahti et al., 2013), while other studies pointed out that physical changes may affect personality traits (Blankstein et al., 2009; Mensah et al., 2013). Because physical development, including brain development, sexual maturation, and motor development, is highly genetically determined (Chiang et al., 2011; Silventoinen et al., 2008), personality stability and change associated with physical development are deemed to be affected by these genetic

effects. The finding of Chapter 4 showed the genetic innovation in personality traits across adolescent development, which denotes the emergence of a new set of genes related to personality.

In neuroscience research, it has been noted that adolescent brains show a functional imbalance, such that the reward and aversive systems are relatively more activated than the top-down control systems, which are belatedly activated after the adolescent years (Casey et al., 2008, 2010; Spear, 2013). Especially the dorsolateral prefrontal cortex and the posterior parietal cortex appear to mature comparatively late in adolescence (Gogtay et al. 2004; Blakemore & Choudhury, 2006). Brain development throughout the adolescent years is thought to influence personality stability and change in adolescence, and the novel genetic influences on personality traits may reflect genetic influences on the later stages in brain development.

Life events and experiences also affect personality stability and change besides age and cohort. Chapter 5 showed the effects of fitness-related life events on personality change, and Chapter 6 further showed the effects of the accumulation of daily life experiences on personality change. These findings are consistent with previous studies (Kandler et al., 2012; Lüdtke et al., 2011; Vaidya et al., 2002) and the behavioral genetic

finding in Chapter 4. Life events and experiences refer to alterations of environmental conditions, which are thought to cause changes of personality traits (Lewis, 2015). In the condition-dependent model of personality (Lewis, 2015), alterations of environmental conditions change the costs and benefits of personality traits and modify the cost-benefit tradeoffs. Hence, people change levels of personality traits in response to environmental conditions. This evolutionary perspective is consistent with that of social and personality psychology (Roberts et al., 2008; Turner et al., 2006; Wood & Denissen, 2015). As noted above, they suggested that the contextual demand in our circumstances canalizes the overall trajectories of personality change and all agree to focus on environmental selective pressures. In evolutionary discussions, individual-level personality change equals to adaptations to specific socio-cultural micro-niches. When considering individual differences in personality change, we have to focus on fluctuations of environmental conditions, that is, life events and experiences in our social life.

In addition, Chapter 5 and 6 offered evidence regarding validity of differential susceptibility theory. The environmental influences including life events and experiences not only directly affect personality change but also interact with moderating

variables. As noted above, the adaptive plasticity perspective has been attracting attention (e.g., Belsky, 1997b, 2000, 2005; Belsky et al., 2007; Del Giudice et al., 2011). The condition-dependent model of personality by Lewis (2015) seems to follow the same direction. The differential susceptibility theory (Belsky, 1997b, 2005; Ellis et al., 2011) suggests susceptible characteristics, which are adaptive in a changing and unstable environment. Based on the SD-IE hypothesis (Figueredo et al., 2013), the latent life history construct and attachment security, which are indicators of life history strategies, were used as susceptible characteristics in the present study. Especially the latent life history construct amplified the effects of life events for better or for worse. Low-*K* LH strategies are favored in unstable and unpredictable environments, and low-*K* individuals are likely to be raised and grow up in changing, unstable, and unpredictable environmental conditions. Because susceptibility or plasticity to environmental conditions is an adaptive strategy for low-*K* individuals, this phenotype has been maintained under natural selection in evolutionary history.

The notable point of differential susceptibility is that highly susceptible individuals are not only affected for the worse but also for the better. The diathesis–stress model (Zuckerman, 1999), which is the dominant paradigm in psychopathology,

assumes that vulnerable individuals are affected only for the worse but not for the better. However, the author considers the differential susceptibility theory to be superior to the diathesis–stress model because the former can account for human responsivity only with a one-dimensional continuum, "susceptibility." In addition, differential susceptibility theory is based on evolutionary hypotheses, which explains why this phenotype has been conserved. Conversely, since vulnerability does not seem to have a benefit in environmental conditions, it should be eliminated by natural selection pressures. A computer simulation study showed that individual differences in responsiveness to the environmental conditions could certainly evolve under natural selection (Wolf, van Doorn, & Weissing, 2008), which supports the validity of differential susceptibility theory.

However, a note regarding susceptibility is needed, that is, susceptible characteristics do not interact with every life events and experiences. The results of Chapter 5 showed that low-*K* individuals (susceptible individuals) are more affected by some life events for better or for worse but not by every life event. Moreover, the findings of Chapter 6 showed that individuals with insecure attachment (susceptible individuals) are more affected by negative life experiences for worse but not by positive

life events. One possibility is that life events and experiences, with which susceptibility interacts, should be fitness-related, that is, related to growing, mating, and parenting. Life history theory primarily explains how organisms allocate their energy, time, and effort to somatic and reproductive effort depending on life circumstances to maximize their biological fitness. Therefore, life events that are not related to their fitness do not influence cost-benefit tradeoffs, and susceptible characteristics do not matter in this case.

7.3. Future Orientations of Personality Stability and Change Research

Despite the suggestive findings of the present studies, there are still several unresolved issues that need to be addressed by future research. In my view, the most pressing tasks for future studies would be (1) to reconsider the developmental trajectories of personality traits across the life course, (2) to organize the definition of susceptibility and develop a measure, and (3) to further investigate the developmental outcomes of personality development. In the following, I will elaborate on these three questions and present strategic steps that may be taken to organize future longitudinal studies on personality development.

7.3.1. Reconsider the developmental trajectories of personality traits across the life course

The present study examined personality stability and change in adolescence and adulthood. Many previous studies have examined the same issue (e.g., Lucas & Donnellan, 2011; Specht et al., 2011; Terracciano et al., 2005), and these empirical studies were summarized in a meta-analytic review (Roberts et al., 2006). These studies offer normative developmental trends of personality traits across the life course. The overall tendency is described as the maturity principle (Roberts et al., 2008).

As reviewed in Chapter 1, the evolutionary framework has gained more recognition for understanding personality and individual differences (Buss, 2008; Buss & Hawley, 2010; Buss & Penke, 2015). Based on these suggestions, the present study has placed a particular emphasis on evolutionary perspectives and showed their importance. Especially life history theory has become a prominent, unifying perspective within the evolutionary sciences, because it can comprehensively explain seemingly disparate human behaviors or characteristics. In other words, LH theory can present numerous testable predictions that enhance our integrative comprehension of disparate

human behaviors and characteristics in terms of how humans allocate their total bioenergetic and material resources in their life courses.

Based on the life history theory, the mean-level trajectories of personality can be interpreted with focus on allocation of total bioenergetic and material resources in the life course (Cipriani, 1996; Specht et al., 2014). This interpretation provides us with a new suggestion regarding the reason why we experience increases and declines on measures of personality traits across the life course. Moreover, life history theory insists that harshness and unpredictability of the early environment is essential for adult life history strategies (for a review, see Ellis et al., 2009). Belsky et al. (1991) proposed that early childhood exposure to familial and ecological stressors promotes insecure attachment between mothers and offspring, early onset of menarche, and promiscuous sexual activity. Hence, these long-term effects of early environment are considered to affect life-long personality development. Future research should examine variabilities of these trends of personality development with a focus on early environment.

7.3.2. Organizing the definition of susceptibility and developing a measure of it

Though differential susceptibility offers an exciting new perspective on human

development and its variations, susceptibility itself is an ambiguous and fuzzy concept, because no measures that directly assess individual differences in susceptibility are available. Susceptibility has biobehavioral and neurogenomic bases, which offer five levels of analysis: genetic, epigenetic, neural, neuroendocrine, and behavioral (Ellis et al., 2011). However, no instrument is available to directly measure this psychological phenotype. Other psychological traits, such as the Big Five, can be measured by validated scales, though they also have biobehavioral and neurogenomic bases (Aoki et al., 2011; Benjamin et al., 1996; Bjørnebekk et al., 2013; Bookman et al., 2002; DeYoung et al., 2010; Ebstein et al., 1996; Eichhammer et al., 2005; Katsuragi et al., 1999; Lesch et al., 1996; Luo et al., 2007; Sampaio et al., 2014).

Therefore, in order to develop a scale of susceptibility with reliability and validity, future research should make the definition of susceptibility more explicit. Because differential susceptibility theory highlights the value of an evolutionary developmental perspective, we need to recognize the importance of the evolutionary background and genetic foundations of susceptibility. Further, the developed scale should be reflected by the genotypes of susceptibility related genes, such as *DRD4*, *DRD2*, *5-HTTLPR*, *COMT*, and *OXTR* (Belsky et al., 2009; Brüne, 2012; Ellis et al.,

2011).

7.3.3. Investigation of the developmental outcomes of personality development

In recent years, life course outcomes have gained more attention. Economic growth has remained roughly constant in leading countries. Research investigating the positive psychological, physical, social, and economic outcomes, which contribute to a healthy and happy life, is in need (Beddington et al., 2008). These positive outcomes are also well predicted by cognitive and socioemotional traits (Heckman, Humphries, Veramendi, & Urzua, 2014; Kautz, Heckman, Diris, Ter Weel, & Borghans, 2014). However, research investigating various life course outcomes by personality development has just begun. Thus, we should further investigate these outcomes.

For example, it was pointed out that personality stability and change is associated with psychosomatic health (Letzring et al., 2014; Turiano et al., 2012) and problematic alcohol consumption or alcoholism (Hicks et al., 2012; Littlefield et al., 2009). These studies suggest that the trends of personality development and some health indicators covary, which is a significant finding to understand human lifelong development. However, these studies also have some limitations. First, they did not

consider the specific nature of developmental stages. The effects of biological basis and environmental factors on mental capital and well-being over the life course are progressive and continuously changing. Therefore, when we discuss developmental outcomes, it is necessary to consider specificity of developmental stages. In addition, these studies were relatively short-term longitudinal studies. In order to investigate life course outcomes, we should conduct longer longitudinal studies.

Third, these previous studies simply showed the associations between outcomes and personality development. However, the underlying mechanism of these associations is more important. To further examine the mechanism, a behavioral genetic approach seems to be effective. In Chapter 4, behavioral genetic analyses provided insight into the etiology of personality stability and change. That is, the behavioral genetic approach can indicate the genetic and environmental covariances under the phenotypic associations. Hence, this approach will give us valuable implications. Molecular genetics, which identify the specific genes associated with personality traits and specific diseases, will also contribute to solving this problem. At the same time, it is equally important to focus on the environmental context. As shown in the present research, contextual factors influence personality stability and change. Further, our health is

similarly affected by contextual factors. For example, the health situation of a country influences the health of the people. Especially early life conditions have large influences on health in later life (Listl et al., 2014). Therefore, contextual factors that may affect human development should be considered more in the future.

To summarize these points, we should take cross-disciplinary perspectives to investigate life course outcomes. The individual biological basis certainly has a major role in shaping developmental trajectories, but other environmental contextual factors also contribute to canalize the development. Moreover, both biological and environmental factors may interplay to produce developmental outcomes. For the purpose of investigating these complicated developmental processes, it is better to conduct long-term prospective cohort studies.

7.4. Conclusion

The present research investigated individual differences in personality change with focus on differential susceptibility theory that has been suggested in evolutionary science. Consequently, it was suggested that highly susceptible individuals are more affected by environmental events for better or for worse. These results underscore the

value of an evolutionary development perspective and offer this perspective to personality development research. As previous studies pointed out, the person-environment interaction is an important perspective in personality and developmental psychology. Future studies have to highlight the complex interplay between people and environmental influences behind the phenotypic phenomena.

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Appendix A

Correlations between the YGPI Scales and NEO-PI-R Factors reported in Shimonaka (1996) and the YGPI example items

YGPI scales	NEO−PI−R Factor					Example items
	E	A	C	N	O	
Depression	−.44	−.15	−.33	**.68**	−.06	I become unintentionally sad with some friends.
Cyclic Tendency	−.04	−.15	−.38	**.70**	.07	I am often distracted and my ideas cannot take shape.
Inferiority Feelings	−.37	−.09	.28	**.75**	−.22	I have a fear that I will fail.
Nervousness	−.40	−.23	−.16	**.72**	−.11	I am encumbered by a small thing.
Lack of Objectivity	−.19	−.13	−.30	**.53**	−.24	I often feel agitated.
Lack of Cooperativeness	−.34	−.33	−.19	**.55**	−.24	I think most people neglect their duties when they are not watched.
Lack of Agreeableness	.36	−.21	−.09	.20	.28	I often find other people ridiculous.
General Activity	**.65**	.27	.42	−.45	.13	I briskly manage things.
Rhathymia	**.67**	.05	−.23	.00	.21	I often play with my friends.
Thinking Extroversion	.37	.19	−.19	−.40	−.06	I am often in deep thought.
Ascendance	**.71**	.08	.26	−.41	.21	I willingly take duties upon myself.
Social Extroversion	**.78**	.16	.13	−.33	.19	I like to associate with other people.

Notes. YGPI = Yatabe-Guilford Personality Inventory; NEO-PI-R = Revised NEO Personality Inventory; E = Extraversion; A = Agreeableness; C = Conscientiousness; N = Neuroticism; O = Openness to experience. $N = 245$ (145 female). Correlations greater than ±.50 are shown in bold.