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Development Throughout the Adult Life Span: Stability and Change in Personality Traits and Social Participation

Dissertation

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Table of Content

List of Tables

List of Figures

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Abstract

Children grow and adapt very obviously and constantly, but they are not the only ones. People change across their whole life span. Empirical evidence shows that also adults' personality (i.e., openness to experience, conscientiousness, extraversion, agreeableness, neuroticism) and their social participation (e.g., social network size) change up until old age. Even though the phenomenon of lifelong personality trait change is widely accepted, the causes of change and thus the possibilities to intervene are much debated currently. So far, little attention has been paid to the role of social participation with regard to personality change and vice versa.

Firstly, this thesis introduces the literature on personality development and social participation over the life span (Chapter 1), followed by a review of the empirical evidence on changes in personality traits and in social behavior, i.e., in-person social contacts, leisure activities (Chapters 2-4). In order to further contribute to research on life span development and catalysts of personality change, the following research questions (RQ) will be investigated:

RQ 1. Can an intensive cognitive training change personality trait, especially openness to experience, in the long run? (Study 1, Chapter 2)

RQ 2. How does in-person social contact frequency develop across the adult life span? (Study 2, Chapter 3)

RQ 3. Are changes in frequency of different leisure activities and overall (social) participation associated with personality change? – If so, which direction do they take? (Study 3, Chapter 4)

The data to answer these questions are derived from two data sets. Firstly, the COGITO study that was originally designed to investigate day-to-day fluctuations in cognitive performance and to examine transfer effects of trained cognitive tasks on nontrained cognitive tasks (Chapter 2). Secondly, the German Socio-Economic Panel Study (SOEP), which is a large, ongoing survey of private households and individuals in Germany which was initiated in 1984 (Chapters 3 and 4).

The results of the empirical chapters lead to the following answers (A) to the research questions:

A 1. Cognitive training does not affect changes in any facet of openness to experience in the long-run. This was true for young and old participants as well as for men and women.

A 2. The frequency of in-person contacts with family members remains relatively stable across the life span. The frequency of visits to and from nonfamily members (neighbors, friends, and acquaintances) declines, following a cubic trajectory and drops below the frequency of family visits once people are in their mid-30s.

A 3. Frequency of different leisure activities and the overall participation are most strongly associated with openness to experience trait at a between-person level. However, at within-

person level, reciprocal effects are discerned only for extraversion with overall participation and socializing (i.e. in-person contacts).

These results are integrated into the literature on personality development and social psychology in the general discussion and implications for research and practice are discussed respectively (Chapter 5). In conclusion, this thesis minimizes some gaps in the literature by comprehensively investigating mechanisms of personality change and patterns of social behavior in adulthood.

Zusammenfassung

Kinder wachsen und verändern sich ganz offensichtlich im Laufe der Zeit, aber nicht nur sie. Menschen verändern sich über ihre gesamte Lebensspanne. Empirisch belegt ist, dass sich auch die Persönlichkeit von Erwachsenen (d.h.: Offenheit für Erfahrungen, Gewissenhaftigkeit, Extraversion, Verträglichkeit, Neurotizismus) und ihr soziales Leben (z.B.: Größe des sozialen Netzwerks) bis ins hohe Alter verändern. Derzeit sind die zugrundeliegenden Mechanismen der Persönlichkeitsentwicklung und Eingriffsmöglichkeiten vieldiskutiert. Vergleichsweise wenig untersucht wurde bisher inwiefern Veränderungen des sozialen Lebens und der Persönlichkeitseigenschaften, über die Lebensspanne hinweg, miteinander verwoben sind.

Diese Arbeit beginnt mit einer Einführung in die Literatur zur Persönlichkeitsentwicklung und zur Entwicklung der sozialen Beziehungen im Erwachsenenalter (Kapitel 1). Um einen Beitrag zur Erforschung der Lebensspannenentwicklung und der Katalysatoren von Persönlichkeit und sozialen Beziehungen zu leisten, werden die folgenden Forschungsfragen (F) untersucht:

F 1. Kann ein kognitives Training Persönlichkeitsmerkmale, insbesondere Offenheit für Erfahrungen, langfristig verändern? (Studie1, Kapitel 2)

F 2. Wie verändert sich die Häufigkeit von persönlichen sozialen Kontakten über die Lebensspanne von Erwachsenen? (Studie 2, Kapitel 3)

F 3. Und wie hängen Veränderungen in der (sozialen) Freizeitgestaltung mit Persönlichkeitsveränderungen zusammen? (Studie 3, Kapitel 4)

Eine Beschreibung der empirischen Evidenz zu den o.g. Forschungsfragen schließt sich in den Kapiteln 2 bis 4 an. Die Daten zur Beantwortung dieser Fragen stammen aus zwei Studien. Zum einen von der COGITO-Studie, die ursprünglich konzipiert wurde, um alltägliche Schwankungen in der kognitiven Leistungsfähigkeit und Transfereffekte von trainierten kognitiven Aufgaben auf nicht-trainierte kognitive Aufgaben zu untersuchen (Kapitel 2). Die zweite Datenbasis ist das Sozio-Oekonomische Panel (SOEP), eine große, kontinuierliche Befragung von privaten Haushalten und Einzelpersonen in Deutschland, die 1984 begann (Kapitel 3 und 4).

Die Ergebnisse der empirischen Untersuchungen führen zu den folgenden Antworten (A) auf die Forschungsfragen:

A 1. Langfristig hat kognitives Training keinen Einfluss auf Veränderungen in den Facetten der Offenheit für Erfahrungen. Dies gilt geschlechterübergreifend und sowohl für junge als auch für ältere Erwachsene.

A 2. Die Häufigkeit von persönlichen Kontakten mit Familienmitgliedern bleibt über die Lebensspanne relativ stabil. Die Häufigkeit von Besuchen bei und von Nicht-Familienmitgliedern (Nachbarn, Freunde und Bekannte) hat im Mittel einen abnehmend-

kubischen Verlauf und fällt im Alter von Mitte 30 unter die Häufigkeit von Familienbesuchen.

A 3. Personen, die im Vergleich zu anderen offener für neue Erfahrungen sind, berichten auch von häufigeren Freizeitaktivitäten und größerer allgemeiner Partizipation in der Freizeit. Allerdings gibt es reziproke Effekte innerhalb einer Person nur von der Veränderung von Extraversion auf die Häufigkeit der sozialen Kontakte und der allgemeinen Partizipation und umgekehrt. Für die übrigen untersuchten Persönlichkeitsmerkmale und Freizeitaktivitäten gibt es keinen derartigen Zusammenhang.

In der allgemeinen Diskussion werden diese Ergebnisse in die Literatur zur Persönlichkeitsentwicklung und Sozialpsychologie eingeordnet und Implikationen für Forschung und Praxis diskutiert (Kapitel 5). Diese Arbeit setzt die Mechanismen der Persönlichkeitsentwicklung und die Muster der (sozialen) Freizeitaktivitäten im Erwachsenenalter miteinander in Verbindung.

CHAPTER 1 – Adult Life Span Development in Personality Traits and Social Participation: Previous Research and Open Questions

1.1 Introduction

The most important life outcomes, such as well-being, good health, and longevity are powerfully predicted by personality traits (Roberts, Kuncel, Shiner, Caspi, & Goldberg 2007; Soto, 2019; Ozer & Benet-Martinez, 2006). Additionally, social participation predicts exactly these pivotal life outcomes as well (Berkman, Glass, Brissette & Seeman, 2000; Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015, Holt-Lunstad, 2021). Thus, the mechanisms of change, the life span development, and interrelations of personality traits and social relationships are of great public significance (Bleidorn et al., 2019).

Both personality traits and social relationships tend to alternate over time in some ways, but remain stable for others across the adult life span (Antonucci, Ajrouch, & Webster, 2019; Bleidorn et al., 2021; Damian, Spengler, Sutu, & Roberts, 2019; Wrzus, Hänel, Wagner, & Neyer, 2013; Yang et al., 2016). Internal and external causes for stability and change are theorized respectively for personality traits (e.g. Wrzus & Roberts, 2017; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020) and social relationships (e.g. Carstensen, 1995, 2006; Antonucci, Ajrouch, & Birditt, 2014). However, the proposed mechanisms are manifold and final verification is still pending.

Social behavior is often shaped by the personality characteristics of the individuals involved (Back et al. 2011; Ozer & Benet-Martinez, 2006). Conversely, it was theorized early on that "social interactions, from birth through death, pivotally shape attitudes and behaviors.", i.e. personality (see Mead, 1943 in Antonucci et al., 2019). Furthermore, there is some evidence with regard to associations between personality traits and social relationships (e.g.: Asselmann & Specht, 2020, Neyer & Lehnart, 2007).

Nevertheless, both lines of research have existed relatively independently of each other until now. From the theoretical perspective of personality development, social relationships are one of many external and environmental components that shape personality development. In turn, (social) behavior is described as a result of, a. o. personality traits (Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020). According to the social relationships research line, personality traits are not described as a theoretical component inaugurating changes in social network composition or size over the life span (Wrzus, Hänel, Wagner, & Neyer, 2013).

This thesis examines the reciprocal effects between social participation and personality trait changes over the adult life span. Thereby, my aim is to broaden the conception beyond the often-studied social network size and composition to in-person contact frequency and frequency of (social) leisure activities across the life span. Furthermore, I will be testing common theories of personality development by investigating effects of different repeated life experiences (i.e.

cognitive training and leisure activities) on long-term personality change. Specifically, I address three research questions that are summarized in Figure 1-1. The research questions are examined in different empirical studies that are presented in Chapter 2, 3 and 4.

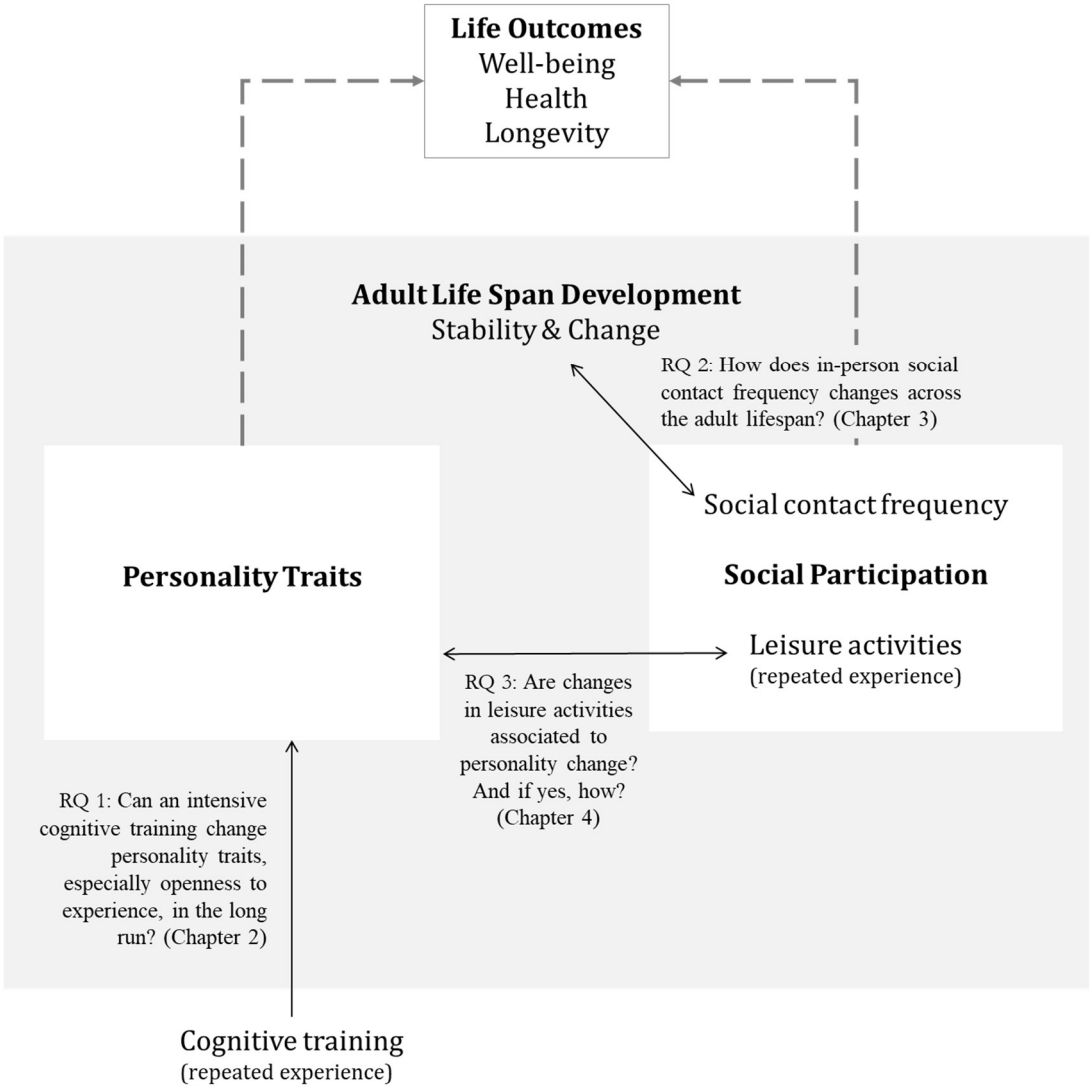

Figure 1.1 Illustration of the Major Research Questions of this Dissertation

In the remaining sections of Chapter 1, I summarize previous findings regarding the patterns of life span development and the mechanisms of change of personality traits (Section 1.2) as well as thematize changes in social participation across the adult life span (Section 1.3). Based on an integration of the literatures concerning personality traits, social participation and adult development, I subsequently deduce the research questions and hypotheses of this dissertation (Section 1.4). The chapter is complemented by a brief introduction of the data sources used for the empirical investigations (Section 1.5), as well as a summary of the goals and structure of this dissertation (Section 1.6).

1.2 Previous Research on Personality Traits

1.2.1 Definition of personality traits

This work, in conjunction with the research on personality psychology in general, assumes that individuals differ systematically in several characteristics. These personality characteristics describe individual differences in thoughts, feelings, and behaviors and are relatively stable across situations and over time (e.g., McCrae & Costa, 2008; Roberts, Wood, & Caspi, 2008).

The Big Five personality traits – openness (to experiences), conscientiousness, extraversion, agreeableness, and neuroticism (versus emotional stability) – comprise a multitude of personality traits and capture much of the covariance in these. Therefore, this work focuses primarily on personality in line with the Big Five trait taxonomy, since it is generally regarded as a set of core dimensions useful for the economic description of individual personality differences (Caspi, Roberts & Shiner, 2005, John & Srivastava, 1999, Kandler, Zimmermann, & McAdams 2014).

Openness to experience describes the tendency of an individual to be intellectually curious and to appreciate new experiences. Conscientiousness describes the tendency of an individual to be self-disciplined, performance-oriented and orderly. Extraversion describes an individual's tendency to be active, assertive and experience positive emotions. Neuroticism is the opposite of emotional stability, it describes an individual's tendency to experience negative emotions, such as anger, fear and sadness. Agreeableness defines an individual's tendency to be altruistic, trusting and sensitive (Caspi, Roberts & Shiner, 2005).

1.2.2 Development of personality traits over the adult life span

By definition, personality characteristics are relatively stable individual differences, yet they may change. Past research shows that individuals change systematically across time (Lucas & Donnellan, 2011; Specht, Egloff, & Schmukle, 2011, McAdams & Olson, 2010; Orth, Erol, & Luciano, 2018; Roberts, Walton, & Viechtbauer, 2006). These changes can alternate over the life span (e.g. Pusch, Mund, Hagemeyer, & Finn, 2019; Roberts, Walton, & Viechtbauer, 2006). There is mounting evidence that personality characteristics, such as Big Five traits develop not only during childhood (for an overview, see Herzhoff, Kushner, & Tackett, 2017) and adolescence (for an overview, see Hill & Edmonds, 2017) but also during adulthood and well into old age (for overviews, McAdams & Olson, 2010; Mueller, Wagner, & Gerstorf, 2017; Specht, 2017). Personality change can be operationalized in several ways. Three indices of

personality changeability are often distinguished: (1) rank-order consistency, (2) mean-level change, and (3) individual differences in change (Bleidorn et al. 2019; Specht et al., 2014).

Rank-order consistency describes the stability in the individuals' positioning toward a given trait relative to each other and thus provides information on the inter-individual differences over time (Mund, Zimmermann, & Neyer, 2018). Rank-order stability of emotional stability, extraversion, openness, and agreeableness all follow an inverted U-shaped function, reaching a peak between the ages of 40 and 60 and decreasing afterward, whereas conscientiousness shows a continuously increasing rank-order stability across adulthood (Roberts, & DelVecchio, 2000; Seifert, Rohrer, Egloff, & Schmukle, 2021; Specht, Egloff, & Schmukle, 2011).

Mean-level change describes the average of all intra-individual increases and decreases in each personality trait across all members of a given population. Most findings suggest that openness to experience tends to reach its peak level during young adulthood and that it either remains stable or decreases between ages 30 and 60. During old age people decrease in openness to experience on average (Graham et al. 2020; Lehmann, Denissen, Allemand, & Penke, 2013; Lucas & Donnellan, 2011; Mund & Neyer, 2014; Roberts, Walton, & Viechtbauer, 2006; Specht, Egloff, & Schmukle, 2011; Wortman, Lucas, & Donnellan, 2012).

With regard to conscientiousness, studies have yielded mixed results (Graham et al., 2020). Taken together, results suggest that in young and middle adulthood individuals tend to have relatively stable levels in conscientiousness, which may decrease in old age (Graham et al. 2020; Lehmann, Denissen, Allemand, & Penke, 2013, Lucas & Donnellan, 2011; Mund & Neyer, 2014, Roberts, Walton, & Viechtbauer, 2006; Specht, Egloff, & Schmukle, 2011; Wortman, Lucas, & Donnellan, 2012). Findings on the development of extraversion are mixed, possibly due to diverging trajectories of facets of extraversion: social dominance and social vitality (Roberts, Walton, & Viechtbauer, 2006; see also Specht, 2017). Social dominance increases during young and the early stages of middle adulthood, then it remains stable. Social vitality increases in early young adulthood but decreases later on. Conversely, it remains stable throughout middle adulthood. Extraversion tends to decrease on average in old age. (Graham, 2020; Lehmann, Denissen, Allemand, & Penke, 2013; Lucas & Donnellan, 2011; Mund & Neyer, 2014, Roberts, Walton, & Viechtbauer, 2006; Specht, Egloff, & Schmukle, 2011; Wagner, Ram, Smith, & Gerstorf, 2016; Wortman, Lucas, & Donnellan, 2012). For agreeableness findings on developmental trends differ greatly between subpopulations (for an overview see Specht, 2017). Individuals during young and middle adulthood individuals tend to remain rather stable in their agreeableness on average. In old age individuals become a little more agreeable (Graham, et al., 2020; Lucas & Donnellan, 2011, Mund & Neyer, 2014, Roberts, Walton, & Viechtbauer, 2016, Specht, Egloff, & Schmukle, 2011). There is strong evidence that

neuroticism tends to decrease during young and middle adulthood (Lucas & Donnellan, 2011; Specht, Egloff, & Schmukle, 2011; Wortman, Lucas, & Donnellan, 2012). During young old age individuals remain at a stable level but become more neurotic at the end of their lives (Graham, et al, 2020; Mueller, Wagner, Voelkle, Smith & Gerstorf, 2018; Wagner, Ram, Smith, & Gerstorf, 2016). The overall increase in agreeableness, conscientiousness and emotional stability during young adulthood is described by the literature as "personality maturation" (Roberts & Mroczek, 2008; Roberts & Wood, 2006).

However, not everyone follows mean-level trends, people may differ relative to one another in their individual trajectories in the absence of rank-order or mean-level change. Inter-individual differences in within-person personality change appear to be most pronounced during young adulthood (Terracciano, McCrae, and Costa, 2010, Schwaba & Bleidorn, 2018).

1.2.3 What may be triggers of change for personality traits?

With regard to personality change and stability, evidence for the influence of both biological and environmental factors should be considered (Bleidorn, Kandler, & Caspi, 2014; Briley & Tucker-Drob, 2014). Normative personality development was long explained by the biological and evolutionary conditioned *intrinsic maturation* (McCrae & Costa, 2008). A psychosocial explanation for personality maturation is the *social investment principle* (Lodi-Smith & Roberts, 2007; Roberts, Wood, & Smith, 2005). That is, individuals invest in their culture's age norms and become less neurotic, more agreeable and more conscientious once they meet responsibilities such as being parents and productive workers during adulthood, thus they react to environmental changes. None of these approaches could be rejected finally (Costa, McCrae, & Löckenhoff, 2019).

In addition to normative personality maturation, individual differences in personality change may result from *genes* (Kandler, Riemann, Spinath, & Angleitner, 2010) and *environmental changes* which impact personality states that, in the long run, might lead to changes in deep-seated personality traits (Roberts & Jackson, 2008). In essence, personality change is conceived as a process of adaptation to new *social roles and demands* which are accompanied by *life events* and changes in the environment. The basic idea is that behavioral changes and *daily life experiences* accumulate and result in personality trait changes as a bottom-up process (see Sociogenomic Model in Roberts & Jackson, 2008; Hudson & Fraley, 2015; Roberts & Mroczek, 2008).

However, recent research shows how shared experiences do not need to have the same influences on people's personality traits necessarily (Bleidorn et al. 2018, Borghuis et al. 2017, Denissen, Luhmann, Chung, & Bleidorn, 2019). The role of *internal (self-) reflective processes*

seems to play a crucial role in personality change as well and is emphasized by the current literature (Allemand & Flückiger, 2017; Hennecke, Bleidorn, Denissen, & Wood, 2014; Hudson, Fraley, Chopik, & Briley, 2020; Quintus, Egloff & Wrzus, 2021; Roberts & David, 2016).

Most recently, Wrzus and Roberts (2017) tried to integrate the existing theories on adult personality development in the TESSERA framework. They pose that long-term personality development attributes to repeated short-term sequences of triggering situations, expectancies, states, and reactions through associative (e.g., habit formation) and reflective processes (e.g. self-reflection). These repeated sequences develop dynamically over time, whilst associative and propositional representations are assumed to alter (Wrzus, 2021). Normative age-related personality development is explained by physical, cognitive, social and societal changes related to age.

The PERSOC framework on the interplay of personality and social relationships (Back et al., 2011; Back, 2021) describes a specific case of TESSERA sequences. On a micro-level it explains how social interaction units that relate to changes in self and relationship dispositions account for personality changes.

Additional contemporary approaches to advance the theories of personality development include Roberts (2018), who revised the Sociogenomic Model (Roberts & Jackson, 2008) by adding two evolutionarily informed systems. On the one hand, a pliable system that reflects permanent modifications of traits through epigenetic changes to the DNA. On the other hand, an elastic system that changes a trait for a significant period of time and then undoes the change.

Furthermore, Wagner and colleagues (2020) proposed an Integrative Model of Sources of Personality Stability and Change. They describe a complex interplay between and within personal and environmental sources and resources for personality development. Genes, gene expression, biological structures and function constitute the rather stable influence on the personality (i.e. affective, behavioral, cognitive, and motivational traits; habits, states) within a person. Environmental influences include, for example, the cultural contexts, social roles, relationships, living conditions, life events, daily hassles etc. According to the model, these vary in stability and interact with one another. Moreover, personal sources and environmental sources transact via a person's behavior and their individual perception of the environment.

Despite differences in details, all recent theoretical frameworks (Roberts, 2018; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017) propose transactional processes: Personality traits evoke a characteristic pattern of behavior which increases the probability of exposure to specific environments and to life experiences (i.e., selection effects). Similarly, environmental factors act via situational processes, through the filter of individual experiences, on personality traits (i.e., socialization effects).

1.3 Previous Research on Social Participation

1.3.1 Definition of social participation

Full social participation is a fundamental human need. That is, social connectedness affects both physiological and psychological well-being (Baumeister & Leary, 1995; Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Yang et al., 2016). Developmental psychology research considers specifically the field of social relationships across the adult life span (Antonucci, Ajrouch, & Webster, 2019). Social relationships are signified by "[…] repeated interactions between the dyad members and a mental representation of the relationship as such" (Wrzus, Hänel, Wagner, & Neyer, 2013, p. 53; Baumeister & Leary, 1995). Social relationships can be described in terms of their structural characteristics (e.g.: number, contact frequency), function, and quality (Antonucci, Ajrouch, & Webster, 2019). Most studies regarding social relationships, especially among adults, measure levels of closeness and social network size over time (Antonucci 2001, Kahn & Antonucci 1980). The social network is the "[…] set of people with whom an individual is directly involved" (see Fischer, C. S. (1982), p. 2 in Wrzus, Hänel, Wagner, & Neyer, 2013). Several types of social networks exist, which can be distinguished by the type of relationship they enclose, e.g., kin network vs. non-kin network.

This thesis focuses on aspects of adult social relations that have been less frequently studied so far: That is, the life span development of frequency of in-person social contacts within different social networks (family vs. non-family) and the change of frequency of (social) leisure activities, that is social participation in a general sense.

1.3.2 Development of social participation over the adult life span

The form and function of social relations vary over the life span (Antonucci, Ajrouch, & Webster, 2019). To date and comparatively, the social relationships characteristic of *network size* is researched most appropriately from a life span perspective. A meta-analysis on age-related social network changes revealed that the global social network increases until young adulthood and then decreases steadily. Thereby the family network is stable in size, whereas the personal network (i.e., subnetwork of closer, personal relationships in the global network) and the friendship network decrease throughout adulthood (Wrzus, Hänel, Wagner, & Neyer, 2013).

A similar picture emerges with regard to the *frequency of social contacts* across the life span. Cross-sectional data shows a decrease of overall contact frequency with the outer circle/non-family members (Antonucci, Ajrouch, &Webster, 2019; Carstensen, 1992; Shaw, Krause, Liang, & Bennett, 2007). In terms of contact frequency with family members mixed results come to the fore: Shaw and colleagues (2007) postulated stability among older adults.

Toyokawa (2013) reported decreases of family contact during the second half of life. For early and middle adulthood, Carstensen (1992) reported an increase of contact frequency with family members.

Additionally, some evidence shows that *participation in (social) leisure activities* changes across the life span. There is a trend towards less participation in a variety of activities over time in later life (Hultsch, Hertzog, Small, & Dixon, 1999; Menec, 2003; Stephan, Boiché, Canada, Terracciano, 2014). The most studied leisure type is physical activity, which increases within younger adults and decreases later on, even after accounting for the effects of health (Shaw, Liang, Krause, Gallant, & McGeever, 2010; Stephan, Sutin, Terracciano, 2014).

1.3.3 Which factors may trigger change for social participation?

Regarding change in social relationships, most prominent developmental theories focus on the normative age-related life span development. According to the socioemotional selectivity theory (Carstensen, 1995, 2006), a shift in *motivational goals* is responsible for a decline in network size. That is, if people perceive their (life)-time as limited, they concentrate mainly on emotionally satisfying social contacts (Carstensen, 1995, 2006). The inner social network remains, whereas the middle and outer social network circles are actively reduced (English & Carstensen, 2014). Carstensen and Lang (2007) situated socioemotional selectivity theory in an *evolutionary context*. Moreover, the evolutionary human life history approach (e.g., Kaplan & Gangestad, 2015) indicates that the social relationships that matter most to survival and reproduction change across the life span. Thus, it predicts a stable kinship core social network and a declining peripheral non-kin social network across the life span as well.

According to social convoy theory, the structure of social networks is influenced by *personal (age, gender)* and *situational (role demands, norms, values)* characteristics, which may chance over time (Antonucci, Ajrouch, & Birditt, 2014). The inner circle is expected to be stable throughout the life span. However, relationships with the outer circle tend to be more unstable, given that they are connected to specific social roles and environment (Antonucci & Akiyama, 1987a; Antonucci, Ajrouch, & Birditt, 2014; Kahn, & Antonucci, 1980). This is in line with the finding of Wrzus and colleagues (2013), who reported that age-related *life events* accompany and possibly even evoke these age-specific network changes.

1.4 Research Questions and Hypotheses of this Dissertation

As described in Section 1.2 and 1.3, the adult's personality traits (i.e.: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) and social participation change up until old age. The underlying change mechanisms and possibilities to intervene in personality traits are much debated currently (Bleidorn et al. 2019; Wagner et al. 2020, Wrzus & Roberts, 2017). The research field on social development across the life span is somewhat less heated. Theories have long focused on the underlying factors of changes in the size and composition of social networks (see Wrzus et al., 2013). Although personality traits and social participation both predict important life outcomes such as longevity, health and well-being (e.g. Soto, 2019; Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015), the two research fields on life span development have rarely been linked up until today. This thesis aims to further contribute to the research on personality change and development of social participation across the adult life span. Additionally, its focus lies with identifying interconnections wherever this is possible. The following research questions were investigated:

1.4.1 Research question 1: Can an intensive cognitive training change personality traits, especially openness to experience, in the long run?

Lifelong personality trait change is a widely accepted phenomenon. Yet the causes of change and thus potential interventions are discussed much of the time (see Bleidorn et al., 2019, Stieger et al., 2020). Understanding the underlying mechanisms is particularly compelling, given that personality characteristics have a strong influence on all kinds of life areas (for an overview see Soto, 2019). As assumed by sociogenomic theory (Roberts & Jackson, 2008, Roberts, 2018), environmental changes might impact personality states which, in the long run, may lead to changes in deep-seated personality traits. According to Hudson and Fraley (2015), environmental changes serve as consistent pressures for new patterns of thoughts, feelings, behaviors and a modified self-view, which is a precondition for enduring personality trait changes. Similarly, the recent TESERRA framework (Wrzus & Roberts, 2017) and the integrative model for personality change and stability by Wagner and colleagues (2020) describe these overarching mechanisms of personality change. Thus, interventions on personality are built on the idea of bottom-up processes, during which personality traits change by way of repeated trait triggering experiences (Chapman, Hampson, & Clarkin, 2014; Jackson, et al., 2012; Magidson, Roberts, Collado-Rodriguez, & Lejuez, 2012; Stieger et al., 2020; Stieger et al., 2021).

Specifically, Jackson and colleagues (2012) reported short-term "side-effects" of an adaptive cognitive training to increase the openness to experiences of elderly people. Openness

to experience is associated with creative thinking, enjoyment of intellectual pursuit, seeking out new challenging activities and cognitive flexibility (Ackerman & Heggestad, 1997; McCrae & Sutin, 2009). Thus, the openness to experience trait may be triggered by cognitive training. However, long-term "side-effects" of a cognitive training on personality traits remain insufficiently investigated at this point.

In this context, the first aim of the dissertation was to investigate whether an extensive cognitive training can lead to long-term changes in openness to experience. Effects of the training on other personality traits as well as interactions with age (young vs. old adults) was explored (see Figure 1.2).

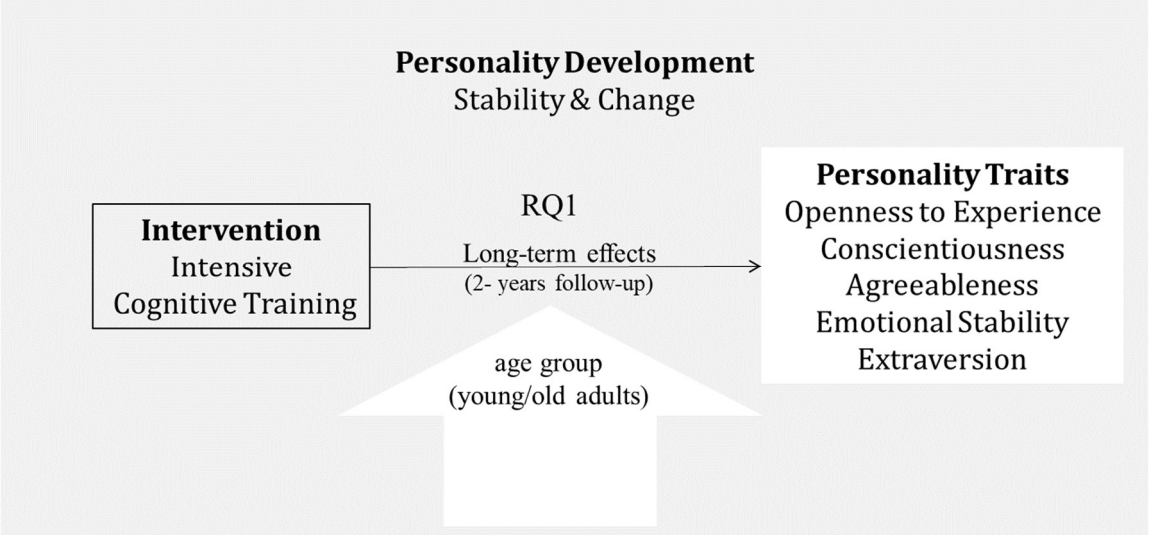

Figure 1.2 Illustration of research question 1 (RQ1). The aim of the analyses presented in Chapter 2 is to investigate whether an intensive cognitive training can change personality traits, especially openness to experience, in the long run, comparatively for young and old adults.

1.4.2 Research question 2: How does in-person social contact frequency develop across the adult life span?

Frequent social interaction enhances social integration and participation. Moreover, it is positively associated with longevity (Shor & Roelfs, 2015) and other important life outcomes (e.g. Berkman, Glass, Brisette, & Seeman, 2000). Much research has been conducted on the development of social networks size and composition across the life span (e.g., English & Carstensen, 2014; Wrzus, Hänel, Wagner, & Neyer, 2013). However, less is known when it comes to the development of social contact frequency across the life span and within different network circles.

Therefore, the second aim of this thesis was to explore the adult life span trajectory of in-person contact frequency with family and non-family members separately.

Furthermore, the following potential moderators of frequency of in-person contact trajectories across adulthood were investigated: effects of gender, relationship status, employment status, subjective health, birth of a child, and relocation (see Figure 1.3).

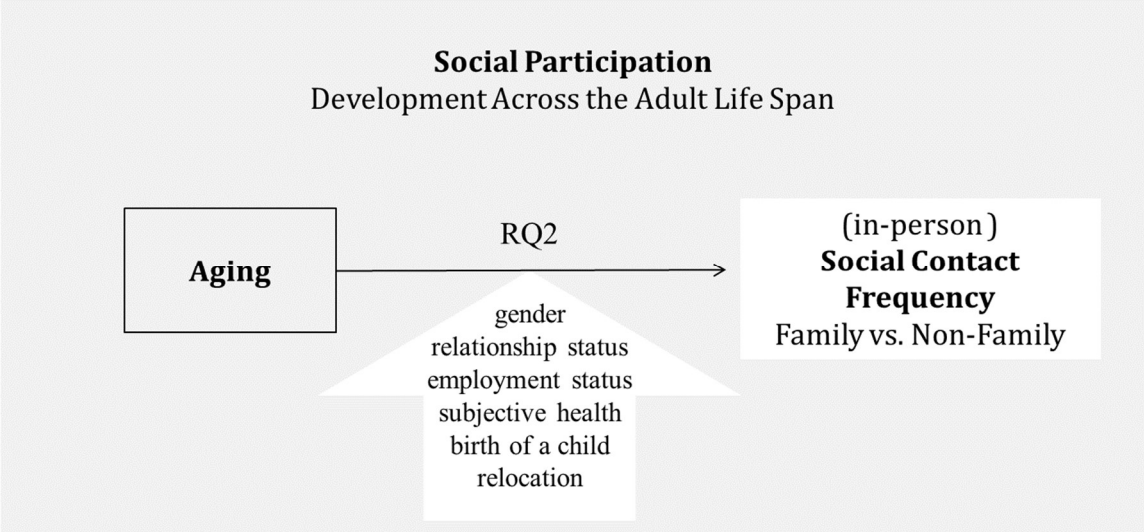

Figure 1.3 Illustration of research question 2 (RQ2). The aim of the analyses presented in Chapter 3 is to explore the adult life span trajectory of in-person contact frequency with family and non-family members separately and compare these trajectories. Additionally, the influence of gender, relationship status, employment status, subjective health, birth of a child and relocation on the trajectories was investigated.

Given the theoretical considerations of e.g. socioemotional selectivity theory (Carstensen, 1995, 2006), social convoy theory (Kahn, & Antonucci, 1980) and evidence presented in Section 1.3, the following hypotheses were derived and tested:

i. The frequency of visits with family members remains relatively stable across the adult life span.
ii. The frequency of visits with non-family members (here: neighbors, friends, and acquaintances) declines across the adult life span.

1.4.3 Research question 3: Are changes in frequency of different leisure activities and overall (social) participation associated with personality change? – If so, which direction do they take?

As discussed in Section 1.2.3, recurrent short-term changes in behavior and experiences in daily life may cause long-term changes in personality traits. Personality traits, in turn, can give rise to a characteristic pattern of (leisure) behavior (e.g. Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017). Nevertheless, a lack of systematic understanding of whether and how participation in leisure activities contributes to personality change and vice versa still remains.

This thesis aims to further approach the mechanisms of personality change. Thus, the extent to which within-person changes in overall participation and in certain leisure activities lead to prospective changes in an individual's Big Five personality traits and whether changes in personality traits elicits prospective changes in a person's leisure activities were examined. In addition to overall participation, the following leisure activities were considered: physical activities, socializing, volunteering, political activities, artistic and musical activities and going out activities (e.g., going to the cinema, pop concerts, dance events, discos, sports events). Cross-lagged effects of leisure activities and personality traits were tested for age group (young, middle-aged and old adults) differences (see Figure 1.4).

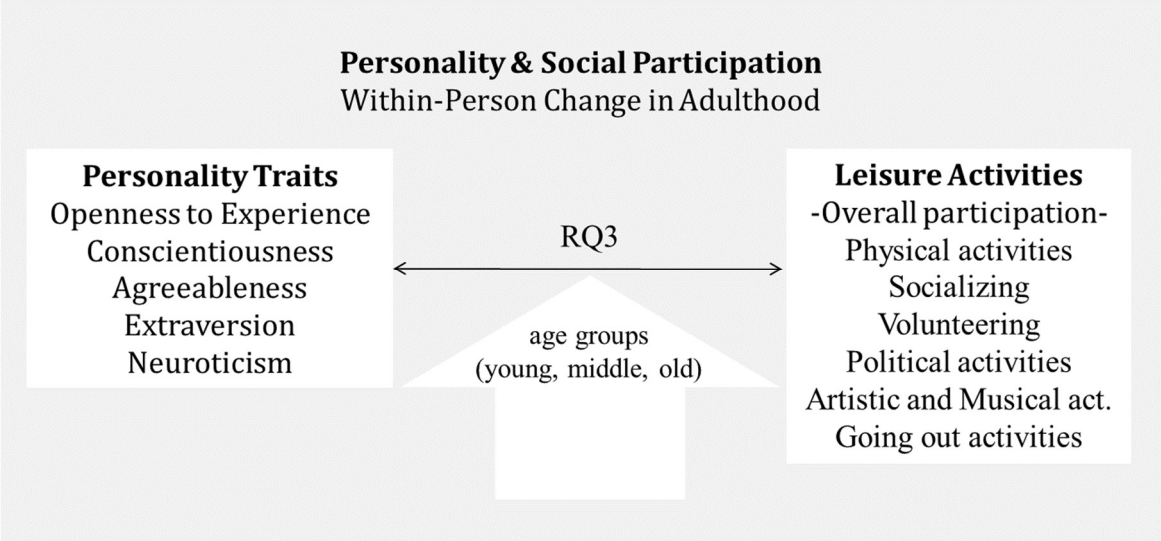

Figure 1.4 Illustration of research question 3 (RQ3). The aim of the analyses presented in Chapter 4 is to examine the extent to which within-person changes in leisure activities lead to prospective changes in personality traits and whether changes in personality elicit prospective changes in leisure activities, comparatively for young, middle and old adults.

The available cross-sectional studies suggest positive associations between participation in various leisure activities with extraversion and openness to experience (e.g., Stephan, Boiché, Canada, & Terracciano, 2014). Moreover, physical activities were associated with higher conscientiousness and lower agreeableness in some studies (Stephan, Sutin, & Terracciano, 2014; Allen, Magee, Vella, & Laborde, 2017). Social activities were associated with higher agreeableness and cognitive activities with higher openness (Jopp and Hertzog, 2010; Speaks, 2013; Stephan, Boiché, Canada, & Terracciano, 2014). Accordingly, the hypotheses for within-person prospective effects were developed. Given the absence of pertinent empirical evidence, age group (young, middle, old adults) related differences in the prospective effects of leisure activities and personality were examined exploratively.

1.5 Data Sources for the Empirical Studies

The data to answer the research questions of this thesis was derived from two studies, the COGITO study and the Socio-Economic Panel Study (SOEP), respectively. The COGITO study was designed originally to investigate day-to-day fluctuations in cognitive performance and to examine transfer effects of trained cognitive tasks on nontrained cognitive tasks. Participants completed perceptual speed, episodic memory, and working memory tasks using verbal, numerical, and figural-spatial task material, for example two-choice reaction tasks, memorizing tasks, and different working memory paradigms in the lab. In total, the participants practiced 12 different basic cognitive tasks for 1 to 1.5 hours per training session (see Schmiedek, Bauer, Lövdén, Brose, & Lindenberger, 2010; Schmiedek, Lövdén, and Lindenberger, 2010; Chapter 2).

The German Socio-Economic Panel Study (SOEP) is a large and ongoing survey of private households and individuals in Germany which was inaugurated in 1984. The survey is based at the German Institute for Economic Research (DIW Berlin). Initially, households were chosen using a multistage random sampling technique with regional clustering. Subsequently, refresher samples were added to maintain the national representative value of the data and to increase the sample size. Further, new household members (e.g., adult children or new partners) were invited to join the study and were interviewed annually. Individuals were accompanied even in circumstantial adjustments, such as cases of relocation or a split of a household. For detailed information about the participants, design, subsamples, variables, and assessment procedures, see Goebel and colleagues (2019). I included every sub- and refresher sample (A-M) in the SOEP. The SOEP survey data was used in empirical analysis of research questions 2 and 3 (see Chapters 3 and 4).

1.6 Summary: Research Questions and Structure of the Dissertation

So as to integrate the existing literature on personality change in adulthood, life span development of social participation and its interrelations, I identified three open questions and developed assumptions about the ways in which personality change may be elicited and how social contact frequency develops with age. I detail a series of empirical studies that separately address the three research questions of this dissertation in Chapters 2, 3 and 4. See Table 1.1 for a summary of the research questions as well as an overview of the empirical analyses. I summarize the results from all empirical studies and discusses their implications for research and practice in Chapter 5.

Table 1.1 Summary of Research Questions, Assumptions, and Empirical Analyses of this Dissertation

Assumptions	Empirical analyses and data
Research question 1: Can an intensive cognitive training change a personality trait, especially openness to experience, in the long run?	
Environmental changes might impact personality states which, in the long run, may lead to changes in deep-seated personality traits. In this way, personality could possibly be actively changed. Results from Jackson and colleagues (2012) supported this hypothesis. They found increased openness to experiences right after an adaptive cognitive training for elderly people.	Chapter 2 compares an intervention group (N= 204), who received daily one-hour cognitive training sessions for about 100 days with a control group that consisted of (N=86), who received no cognitive training. All participants answered the personality trait questionnaire "NEO Five-Factor Inventory" prior and two years after the cognitive training. Latent change models were applied that controlled for age group (young adults, [20-31 years] vs. old adults, [65-82 year]) and gender. Data were retrieved from the COGITO study.
Research question 2: How does in-person social contact frequency change across the adult life span?	
From different theories on adult social development, one could derive an expectation of relatively stable contact frequency with family and relatives throughout adulthood and a decline in contact frequency with non-family members in middle adulthood.	Chapter 3 contains a cohort-sequential longitudinal study to examine intraindividual changes in the frequency of in-person social contact with family and nonfamily members, and potential moderators of these changes. The analysis uses four waves (1998, 2003, 2008, and 2013) of the German Socio-Economic Panel Study (N = 36,716; age range: 17-85 years).
Research question 3: Are changes in frequency of different leisure activities and overall (social) participation associated with personality change? – If so, which direction do they take?	
Changes in leisure participation, in the sense of carrying out daily activities and repetitive experiences, may be a source of individual differences in personality development across the adult life span. Conversely, personality trait change may impact change in type and frequency of leisure activities selected.	Chapter 4 presents a random-intercept cross-lagged panel models (RI-CLPM) to examine the extent to which within-person changes in leisure activities lead to prospective changes in personality traits and whether changes in personality elicit prospective changes in leisure activities. Differences across age groups are tested (young [18-30 years], middle [31-50 years], old [51-75 years]). The analysis uses four waves (2005, 2009, 2013, & 2017) from the German Socio-Economic Panel Study (N = 55,790).

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CHAPTER 2 – Long-Term Effects of an Extensive Cognitive Training on Personality Development

– STUDY 1 –

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2.1 Abstract

Objective: Previous research found that cognitive training increases the Big Five personality trait openness to experience during and some weeks after the intervention. The present study investigated whether long-term changes happen in openness to experience and other personality traits after an extensive cognitive training of memory and perceptual speed.

Method: Intervention group consisted of 204 adults (20-31 years and 65-80 years, 50% female), who received daily one-hour cognitive training sessions for about 100 days. The control group consisted of 86 adults (21-29 years and 65-82 years, 51% female), who received no cognitive training. All participants answered the NEO Five-Factor Inventory before and two years after the cognitive training. Latent change models were applied that controlled for age group (young vs. old) and gender.

Results: In the long-run the cognitive training did not affect changes in any facet of openness to experience. This was true for young and old participants as well as for men and women. Instead, the cognitive training lowered the general increase of conscientiousness.

Conclusion: Even an extensive cognitive training on memory and perceptual speed does not serve as a sufficient intervention for enduring changes in openness to experiences or one of its facets.

Keywords: personality development, openness to experience, cognitive training, intervention, Big Five personality traits

2.2 Introduction

Modern societies focus on self-optimization. Not only the outward appearance is captured by the desire for eternal youth, it is en vogue to test ones brain age and to do brain jogging in order to keep one's mind in shape. In recent years, brain games were a growing market: Many brain training games and apps popped up with promising names like, e.g. "Neuron Gym" (Edlogiq, 2014), "NiceIQ" (Depthlink Inc., 2015), or "Fit Brains" (Vivity Labs, 2015). Marketing strategies fuel the hype of self-improvement, suggesting that cognitive trainings have a positive impact, not only on memory, attention and reaction speed but also on an "increase of […] creativity" (Edlogiq, 2014, Neuron Gym), an indicator for openness to experience, or on a "more positive mood" (Depthlink Inc., 2015, NiceIQ). Positive emotionality again is an indicator for the personality trait of extraversion (John, Naumann, & Soto, 2008).

Indeed, there are some first findings showing effects of cognitive trainings on personality traits (Jackson, Hill, Payne, Roberts, & Stine-Morrow, 2012; see also Dittmann-Kohli, Lachmann, Kliegl, & Baltes, 1991). This applies particularly to openness to experience, a personality trait that is associated with creative thinking, enjoyment of intellectual pursuit, seeking out new challenging activities and cognitive flexibility (Ackerman & Heggestad, 1997; McCrae & Sutin, 2008). In an experimental study, Jackson and colleagues (2012) found that an adaptive cognitive training aimed at improving the fluid cognitive ability of inductive reasoning led elderly people to increase in openness to experiences during the intervention and the following weeks. However, long-term effects on personality remain unknown to date. Furthermore, it is unclear which cognitive trainings impact the development of openness and what potential boundary conditions are.

2.2.1 How changeable is personality?

Is it reasonable to speculate about personality trait change even though personality is defined as being relatively enduring? Yes, it is! According to life span development theory (Baltes, 1997) personality trait changes are possible to happen even in middle and old age (see also Baltes, Lindenberger, & Staudinger, 2006). Empirical findings support the conception of lifelong personality development (see Roberts & DelVecchio, 2000; Roberts, Walton, & Viechtbauer, 2006), pointing to a development towards greater maturity (i.e., increases in emotional stability, agreeableness, and conscientiousness) across the life span. Recent studies reveal that rank-order stability of personality traits follow an inverted U-shaped function reaching a peak between the ages of 40 and 60 and decreasing afterwards with a level of instability in old age comparable to young adulthood (Lucas & Donnellan, 2011; Specht, Egloff,

& Schmukle, 2011). Also, personality types are highly consistent across gender, age, and time but there are meaningful changes in type membership across all of adulthood (Specht, Luhmann, & Geiser, 2014).

Even though lifelong personality trait change is widely accepted, the underlying mechanisms and possibilities to intervene are currently discussed (Specht, Bleidorn et al., 2014). As assumed by sociogenomic theory, environmental changes might impact personality states which, in the long run, might lead to changes in deep-seated personality traits (Roberts & Jackson, 2008). According to Hudson and Fraley (2015), environmental changes serve as consistent pressures for new patterns of thoughts, feelings, behaviors and a modified self-view, which is a precondition for enduring personality trait changes. Thus, interventions on personality built on the idea of bottom-up processes, where personality traits change through repeated behavioral activation (Chapman, Hampson, & Clarkin, 2014; Jackson, et al., 2012; Magidson, Roberts, Collado-Rodriguez, & Lejuez, 2012).

Engaging in an extensive cognitive training that requires mental flexibility and is cognitively stimulating may enhance the willingness to seek for new (cognitive) challenges in general. This generalization in turn would equate to changes at a higher personality trait-level of openness to experience. So far, there is no empirical evidence for such a generalized long-term effect on personality from an intense cognitive training aimed at improving memory and perceptual speed.

2.2.2 The current study

Here, we use data of a cognitive training that was designed to monitor and improve cognitive abilities in episodic memory, working memory, and perceptual speed over 100 daily one hour sessions. Openness to experience and all of the other Big Five personality traits (emotional stability, extraversion, agreeableness, and conscientiousness), were assessed right before the cognitive training intervention and two years after. This enabled us to investigate whether an extensive cognitive training beyond inductive reasoning can lead to long-term changes in openness to experience. Effects of the training on other personality traits as well as interactions with age and gender were explored.

2.3 Method

2.3.1 Participants

A total of 290 participants (50.7% female) were included in the analyses. The intervention group (N = 204 at pretest) consisted of two age groups. The young age group (N = 101, 51.5% female), that completed an average of 101 training sessions (SD = 2.6 sessions, range: 87 -109 sessions) ranged in age from 20 to 31 years (M = 25.6 years; SD = 2.7 years). Participants in this young-intervention group finished an average of 16.1 years of education (SD = 3.2 years of education). The old age group (N = 103, 50.5% female), who also completed an average of 101 training sessions (SD = 2.7 sessions, range: 90 - 106 sessions) ranged in age from 65 to 80 years (M = 71.3 years; SD = 4.1 years). Participants in this old-intervention group finished an average of 13.6 years of education (SD = 3.6 years of education).

Participants in the no-training control group (N = 86) also consisted of two age groups. The young age group (N = 45, 51.1% female), ranged in age from 21 to 29 years (M = 25.2 years; SD = 2.5 years). Young control group participants finished an average of 15.7 years of education (SD = 2.7 years of education). The old age group (N = 41, 51.2% female) ranged in age from 65 to 82 years (M = 70.5 years; SD = 3.9 years). Old control group participants finished an average of 13.0 years of education (SD = 3.9 years of education).

Intervention and control groups did not differ on age, initial cognitive status, and education (see Schmiedek, Lövdén, & Lindenberger, 2010). Also, there were no significant mean differences in the Big Five personality traits or facets between the intervention and control group before the cognitive training (all ps > .05; d ranging from -.11 to .16).

The attrition rate for participants who attended the pretesting and had entered the intervention was low (93.2% of the initial intervention group completed the cognitive training phase; for details on dropout by study phase and reasons for dropping out, see Schmiedek et al., 2010). At 2-year follow-up 71 (82.6%) members of control group and 167 (81.9%) members of intervention group participated in personality assessment again. Those who did not attend the follow-up personality assessment after two years (dropouts, 56% female) more often were in the young age group than in the old age group (χ^2 = 5.7, p = .02). Continuers and dropouts did not differ on any of the investigated personality facets or traits at pretest; neither did they differ in education.

2.3.2 Procedure

Participants come from the COGITO study that was originally designed to (1) investigate day-to-day fluctuations in cognitive performance and (2) to examine transfer effects of trained

cognitive tasks on non-trained cognitive tasks. Participants completed perceptual speed, episodic memory, and working memory tasks using verbal, numerical, and figural-spatial task material, for example two-choice reaction tasks, memorizing tasks, and different working memory paradigms in the lab. In total, participants practiced 12 different basic cognitive tasks for 1 to 1.5 hours per training session (see Schmiedek, Bauer, Lövdén, Brose, & Lindenberger, 2010; Schmiedek, Lövdén, and Lindenberger, 2010).

Individuals were recruited via different kinds of advertisement, such as newspaper advertisements, word-of-mouth recommendation, and distribution of flyers with no further information on financial remuneration mentioned at this point. At the end of the study, participants in the intervention group were paid between 1,450 and 1,950 EUR, depending on a bonus for participation frequency. Participants in the control group were paid 460 EUR.

Assignment to groups was not completely random (i.e., the control group was filled after filling the intervention group), but the resulting samples were well comparable (see sample description in Participants paragraph and Schmiedek, Lövdén, and Lindenberger, 2010). For details of the study procedure, please see Figure 2.1.

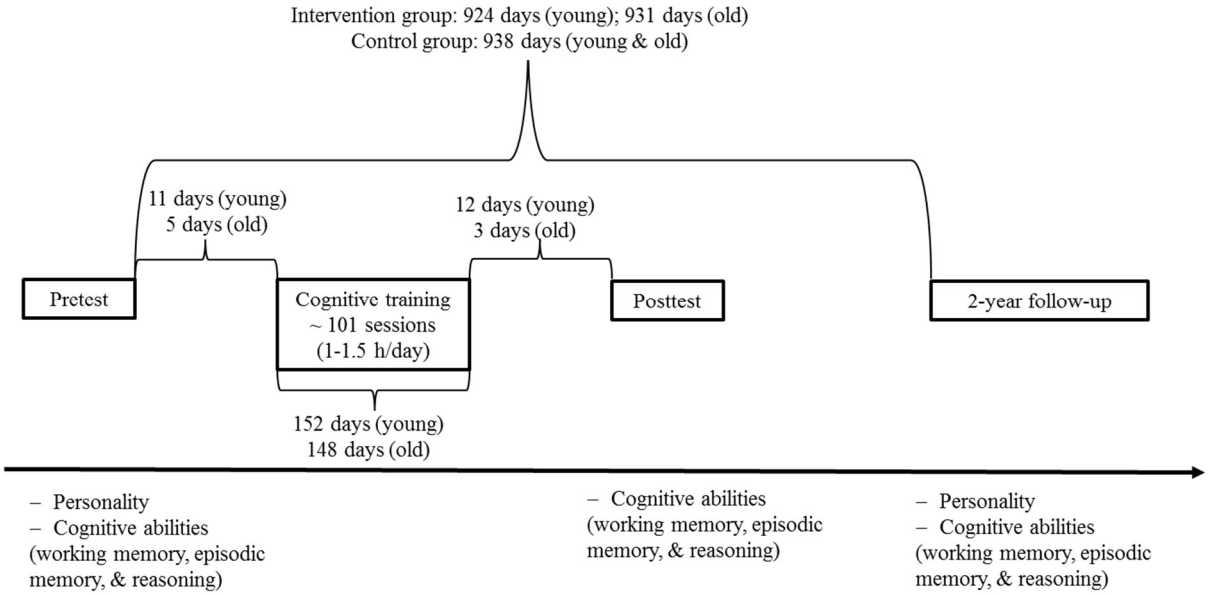

Figure 2.1 Timeline of COGITO study with median time intervals in days. For details on cognitive training content, personality assessment, cognitive abilities assessment see method section, Schmiedek, Bauer, Lövdén, Brose, & Lindenberger, (2010), and Schmiedek, Lövdén, & Lindenberger, (2010).

Difficulty level of the cognitive tasks was adapted to pretest performance once before the training phase started. Reliable positive transfer of cognitive training was found on cognitive abilities, especially on reasoning and episodic memory, in the young age group, but not on other cognitive abilities and not in the old age group (Schmiedek, Lövdén, & Lindenberger, 2010; Schmiedek, Lövdén, & Lindenberger, 2014).

2.3.3 Measures

The Big Five personality traits were assessed with 60 items of the NEO-PI-R Inventory (NEO-FFI; Costa & McCrae, 1992). Participants rated the items on a 5 point scale ranging from (0) *strongly disagree* to (4) *strongly agree*. Evidence on convergent and discriminant validity of the NEO-FFI is given in Costa and McCrae (1992). In order to monitor effects of cognitive training on specific facets of personality and to enhance the precision of findings, analyses were made using Saucier's subscales of the NEO-FFI (cf. Saucier, 1998; see also Chapman, 2007). Following Saucier (1998), two items of the openness to experience scale were left out ("I often try out new and foreign food"; "I rarely notice moods or feelings that are evoked by different environments"). Further, we excluded two items because of unexpected loadings (i.e., negative) on their personality trait in our sample at post-test: "I live a hectic life" (subscale: activity, extraversion factor loading = -0.10) and "I believe that we should take heed of the views of our religious authorities at ethical decisions "(subscale: unconventionality, openness factor loading = -0.02)[1].

Descriptive statistics and internal consistencies of personality traits and Saucier's subscales in the current sample are listed in Table 2.1. Given the small number of items per cluster, the reliabilities for some item clusters were moderate, ranging from Cronbach's alpha .55 to .85, with two exceptions in openness facets, in particular unconventionality (Cronbach's alpha = .37) and aesthetic interests (Cronbach's alpha = .47). Nevertheless, alpha reliabilities in the current sample are within the range of previous studies using the same item clusters (Allemand, Hill, & Lehmann, 2015; Chapman, 2007).

[1] Including the omitted openness to experience item leads to a significant lower trait mean in the sample at pretest ($M = 2.62$, $SD = 0.49$, $p < 0.01$); Cronbach's alpha = 0.70 was of similar size. Including the omitted extraversion item also leads to a significant lower trait mean at pretest in the sample ($M = 2.27$, $SD = 0.49$, $p < 0.001$); Cronbach's alpha $\alpha = 0.79$ was slightly smaller. The pattern of results in the latent change models did not change when adding these items, except for model fit indices being lower.

Table 2.1 Descriptive Statistics of Saucier's Personality Facets in the Full Sample at Pretest

Big Five Personality Facets	N	M	SD	Number of Items	Cronbach's Alpha
Openness to Experience					
Intellectual Interests	286	2.76	0.61	3	0.47
Unconventionality[a]	289	2.36	0.69	3	0.37
Aesthetic Interests	287	2.79	0.67	3	0.64
Extraversion					
Positive Affect	287	2.67	0.72	4	0.82
Sociability	289	2.17	0.61	4	0.63
Activity[a]	289	2.12	0.61	3	0.55
Emotional Stability					
Self-Reproach (inverse coded)	289	2.40	0.65	7	0.79
Negative Affect (inverse coded)	289	2.26	0.67	5	0.65
Conscientiousness					
Dependability	289	2.73	0.58	4	0.70
Goal Striving	289	2.47	0.66	3	0.68
Orderliness	289	2.41	0.73	5	0.77
Agreeableness					
Nonantagonistic orientation	289	2.41	0.46	8	0.57
Prosocial orientation	288	2.89	0.46	4	0.56

2.3.4 Statistical models

Structural equation modeling was used in the current study to investigate changes at the construct level of latent factors representing the personality dimensions free of measurement error. Latent change score models (LCSM; McArdle, 2009) were estimated with Mplus Version 7.3 (see Muthén & Muthén, 1998-2012). To include the greatest possible number of observations we used the full information maximum likelihood (FIML) approach, which is a model-based approach to missing data in dependent variables (Enders & Bandalos, 2001). Evaluation of model fit was based on the Comparative fit index (CFI), the Root mean square error of approximation (RMSEA), and the Standardized root mean square residual (SRMR). A CFI above .90 and an RMSEA and SRMR below .08 indicate an acceptable model fit to data (Hu & Bentler, 1998; Marsh, Hau, & Grayson, 2005).

In order to test the assumption of measurement invariance across time, measurement invariance models were evaluated (cf. Marsh, Nagengast, & Morin, 2013; van de Schoot, Lugtig, & Hox, 2012). To examine the effects of age group on personality change due to cognitive training, we compared model fit indices of models where the slopes were freely estimated for all four groups (young control, young intervention, old control, and old intervention group) with models in which the slopes were set equal across groups. Comparisons were conducted using χ^2-difference tests for every personality facet.

There were two latent change models for each personality trait and facet. First, we modeled change over time in the control group to examine general developmental trends. Second, we estimated models including covariates to analyze effects of cognitive training (0 = *control group*; 1 = *intervention group*), age group (0 = *young*; 1 = *old*) and gender (0 = *female*; 1 = *male*) on the latent intercept and slope factors. Factor loadings on the intercept factor were fixed to 1. Factor loadings on the slope factor were fixed to 0 at the first measurement point, before the training, and to 1 at the second measurement point, two years after the training. A significant effect of a covariate on the intercept factor reflects individual differences on the respective personality facet before the cognitive training. A significant influence of a covariate on the slope means that individuals with different values on this covariate differ in their personality trait change over time.

2.4 Results

First, we present the findings on measurement invariance across time, followed by multiple group models that test interaction effects of age group and cognitive training on changes in personality facets. Afterwards, we report on the latent change models including the effects of cognitive training, and age group on intercept of personality traits and facets. The effect of gender was modeled as an additional covariate with potential effects on initial personality (e.g. Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009). Subsequently, we focus on the latent change models that estimated changes in personality facets in the control group over time and we report effects of cognitive training, age group, and gender on slope of personality traits and facets.

Strong measurement invariance was established in all models, meaning that factor loadings and item intercepts within all personality traits and facets remained invariant across time. Except for two personality subscales, all strong measurement invariance models fit the data well (CFI > .94, RMSEA < .08, SRMR < .06). There was a slightly worse, but still acceptable, model fit for the measurement invariance models of the personality facet dependability (conscientiousness; CFI = .91, RMSEA = .10, SRMR =.07), and negative affect (emotional stability; CFI = .88, RMSEA = .08, SRMR = .07). Personality traits were modeled as second-order factors whose indictors were the respective personality facets. Strong measurement invariance models for personality traits at the factor level show moderate model fit (CFI >.87, RMSEA < .07, SRMR = .08).

There were no interaction effects of age group and cognitive training on changes in personality facets: Multiple group models show that for all investigated personality facets, the latent change models did not fit significantly worse when slopes were constrained to be equal across groups than when estimated freely (this was true for the following four groups: young control, young intervention, old control, and old intervention). Thus, cognitive training effects on personality trait change can be interpreted as being independent from age group.

Model fit indices for the latent change models on personality trait level in the control group ranged from CFI = 0.78 to 0.86, RMSEA = 0.07 to 0.08 and SRMR = 0.09 to 0.12. Except for both agreeableness facets, all model fit indices for latent change on personality facets in control group indicated good fit, with CFI > .93, RMSEA < .08, SRMR < .09. Model fit indices for the latent change model of nonantagonistic orientation (agreeableness) in the control group were CFI = 0.92, RMSEA = 0.11, and SRMR = 0.05. Model fit indices for the latent change model of prosocial orientation (agreeableness) in the control group were CFI = 0.88, RMSEA = 0.11 and SRMR = 0.09.

Of primary interest were the latent change models with covariates. Table 2.2 includes all model fit indices and intercepts of these models. There was no effect of group membership (intervention or control) concerning latent differences on personality traits or facets before the cognitive training (intercepts). However, there were effects of age on personality before the intervention: With regard to openness to experience, older individuals were less intellectually interested and less unconventional but more aesthetically interested than younger participants. But, because of effects in opposite directions on facet-level no age group effect on trait level in openness to experience was apparent. There were no age differences in trait of extraversion or any of its facets. Further, older participants were more emotionally stable and agreeable than younger participants on trait-level and regarding all respective facets. Moreover, older participants were significantly higher in conscientiousness on trait-level, whereas on facet-level they were only more dependable and orderly than the younger participants, but there was no age difference in the facet of goal striving. With regard to gender, men had higher intellectual interests (openness to experience facet), and were less dependable and orderly (conscientiousness facets) compared to women before the training. Men showed higher values on trait-level of emotional stability than women but not on facet-level. Further, men were less agreeable on trait-level and all agreeable facets.

In addition to change over time in the control group the impact of cognitive training, age group, and gender on changes in personality facets after two years (slopes) can be found in Table 2.2. On the trait level only extraversion, emotional stability and conscientiousness increased over two years in control group with no cognitive training. Yet, for all of the Big Five personality traits, one or more personality facets changed over time in the control group. Thus, there was a general increase over time in intellectual interest (openness to experience), sociability (extraversion), self-reproach (inverse coded; emotional stability), dependability and orderliness (both conscientiousness), as well as in prosocial orientation (agreeableness).

Contrary to our expectations, openness to experience did not change in the long-term in reaction to this extensive training. Also, there was no long-term effect of this cognitive training on changes in any other personality trait or facet despite one exception: Individuals who did the cognitive training showed less increase over time in the conscientiousness trait, particularly in dependability and orderliness facets. However, dependability still significantly increased in the intervention group ($M_{Slope} = 0.351$, $p < .001$)[2], even though to a smaller degree than in the control group. Orderliness remained stable in the intervention group ($M_{Slope} = 0.044$, $p > .05$)[2] whereas this facet increased in the control group (see Table 3). Furthermore, being old raised the

[2] We standardized all model parameters using the square root of the estimated variance of the latent intercept.

likelihood to decline in unconventionality (a facet of openness to experience) over time, irrespective of whether individuals had a training or not. In addition, being male raised the likelihood to decline over two years in aesthetic interests (a facet of openness to experience) and raised the likelihood to decrease in self-reproach (a facet of emotional stability that was inverse coded).

Table 2.2 Information on the Slope of the Latent Change Models (LCM) for the Control Group without any Covariates, Model fit indices for LCM with Covariates, and Effects on Intercepts and Slopes of Models that include Training, Age group, and Gender as Covariates.

Big Five Personality facets	LCM for control[a]	LCM with covariate effects on intercept and slope								
		Model fit indices for LCM with covariates			Cognitive training (0 = control; 1 = exp.)		Age group (0 = young; 1 = old)		Gender (0 = female;1 = male)	
	Slope	CFI	RMSEA	SRMR	Intercept	Slope	Intercept	Slope	Intercept	Slope
Openness to Experience										
Intellectual Interests	0.332*	0.932	0.071	0.053	n.s.	n.s.	-0.359*	n.s.	0.633*	n.s.
Unconventionality	n.s.	0.933	0.069	0.073	n.s.	n.s.	-1.970*	-0.667*	n.s.	n.s.
Aesthetic Interests	n.s.	0.950	0.066	0.047	n.s.	n.s.	0.323*	n.s.	n.s.	-0.243*
Extraversion										
Positive Affect	n.s.	0.932	0.085	0.061	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Sociability	0.363*	0.929	0.063	0.057	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Activity	n.s.	0.966	0.054	0.043	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Emotional Stability										
Self-Reproach (inverse coded)	0.265*	0.945	0.049	0.058	n.s.	n.s.	0.646*	n.s.	n.s.	n.s.
Negative Affect (inverse coded)	n.s.	0.871	0.082	0.060	n.s.	n.s.	0.683*	n.s.	n.s.	0.319*
Conscientiousness										
Dependability	0.472*	0.899	0.083	0.058	n.s.	-0.275*	0.578*	n.s.	-0.283*	n.s.
Goal Striving	n.s.	1.000	0.000	0.029	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Orderliness	0.281*	0.939	0.067	0.056	n.s.	-0.226*	0.916*	n.s.	-0.261*	n.s.
Agreeableness										
Nonantagonistic orientation	n.s.	0.873	0.053	0.067	n.s.	n.s.	0.516*	n.s.	-0.576*	n.s.
Prosocial orientation	0.425*	0.906	0.071	0.064	n.s.	n.s.	0.436*	n.s.	-0.502*	n.s.

Note. Slope and intercept are standardized by square root of estimated covariance for the latent intercept variable; LCM = latent change model; exp. = experimental group; n.s. = not significant, $p > 0.5$; CFI = Comparative fit index; RMSEA = Root mean square error of approximation; SRMR = Standardized root mean square residual; *$p < .05$;
[a] Means of intercept factors in latent change models for the control group are set to zero by default. For information on model fits in latent change model for control group, please see main text.

2.5 Discussion

Mean-level increase of conscientiousness, emotional stability, extraversion and facets of agreeableness and openness, evidenced in our control group is in line with the maturation principle of personality development and growth over time (for reviews see, Roberts, Walton, & Viechtbauer, 2006; Roberts, Wood, & Caspi, 2008; Specht, Bleidorn, et al., 2014). With regard to the impact of a cognitive training on personality change two years after intervention: Our analysis revealed that, despite of the successful cognitive transfer of training on reasoning and episodic memory in our sample (Schmiedek, Lövdén, & Lindenberger, 2010; Schmiedek et al., 2014), such a highly extensive cognitive training did not lead to long-term increases in openness to experience in young or old, male or female individuals. Two years after the cognitive training, no "side–effects" on openness to experience were found, even though the cognitive training was part of everyday life, including daily one-hour sessions for a period of a hundred days. Due to repeating cognitive challenges during the training phase, we expected openness to experience to change in line with personality state changes. Changes in personality states might have been apparent but contrary to predictions of sociogenomic theory (Roberts & Jackson, 2008), no bottom-up transfer on the personality facets of openness to experience, that is, intellectual interests, unconventionality, or aesthetical interests, persisted in the long run.

Cognitive trainings are designed to change cognitive abilities in the first place. A lack of impact on the development of openness to experience is therefore not necessarily a drawback of the cognitive training. However, it raises awareness to the fact that enduring behavior change with regard to intellectual activity does not necessarily lead to changes in personality, in particular, to intellectual interests and other facets of openness to experience.

Former studies found effects of cognitive trainings on personality development (e.g.: Jackson et al., 2012). Our extensive cognitive training study now provides information of boundary conditions of such trainings. One of these boundary conditions might be the type of cognitive task trained. The present sample practiced working memory, episodic memory, and perceptual speed. In their meta-analysis, Ackerman and Heggestad (1997) show that openness is more strongly related to crystallized abilities (e.g., knowledge) but less so to fluid intelligence, learning, memory, and speed, which were in the focus of the training here. Hence, our findings might imply that training aiming to stimulate increases in openness to experience should focus on tasks related to crystallized abilities (e.g., Sudoku, puzzles, crosswords; Jackson et al., 2012).

Another boundary condition might be the duration of training effects on personality. Our cognitive intervention might either have produced short-term changes in openness to experience

that faded over two years or no changes in openness at all. Most importantly, the cognitive intervention had no lasting impact on trait measures and thus, true personality change did not take place.

Additionally, ongoing tailoring of task difficulty to progress might be another potential boundary condition and worth further investigation. The difficulty level of tasks was adapted only once, at the pretests, and was not tailored again in the cognitive training phase. Maybe dynamic adaption of task difficulty might be necessary to continuously provide new challenges that reinforce a person's interest and thus openness to experience.

Also, a strong motivation to treat one's characteristics might be a promising factor when investigating personality trait change through cognitive interventions (see Hudson & Fraley, 2015; Peters, 2015). We cannot rule out that a low motivation to change in personality characteristics might have prevented transfer from cognitive training to personality trait change in our sample.

Instead of increasing openness to experience, there were two unexpected effects on the facets of conscientiousness. Individuals who took part in the training increased less in dependability and orderliness compared to those without a cognitive training. However, dependability still increased, even though to a smaller degree. Orderliness remained static in the intervention group. This rather negative effect of cognitive training on conscientiousness facets was particularly surprising because previous research stated that changes in conscientiousness could not be attributable to the cognitive training (Jackson et al., 2012). Certainly, these unexpected findings await replication before drawing conclusions.

2.5.1 Limitations and future directions

Despite several strengths, such as the longitudinal investigation of a diverse sample and the quasi-experimental design with an extensive cognitive training, there are also some limitations in the present study. First, alpha reliabilities were unfortunately lower than desired for openness to experience facets. Nevertheless, reliability values in our sample are similar to previous studies using the same openness to experience facets (Allemand, Hill, & Lehmann, 2015; Chapman, 2007). Further, comparative fit indices for the overall trait models were rather poor compared to models on personality facet level. Thus a cautious interpretation of results on trait level is advised. In order to improve validity and to detect small effects, future studies would benefit from applying more reliable personality questionnaires or observer measures. Second, even though the investigated sample was diverse, it was not nationally representative and probably had more time available for this extensive intervention than others. Third, intervention and control groups only consisted of a young and an old age group. Ideally, one uses

a life span sample if one wants to generalize across age. Under limited resources it is however very common in research on adult development to work with special groups of younger and older adults, only. Fourth, we only have self-report data on personality which may be biased by social desirability responding. Ideally, self-report is combined with observer methods when assessing personality (Vazire, 2010). Thus, future research on personality trait change in wake of a cognitive training would surely benefit from taking observer reports into account. A fifth limitation of the present study is that we did not assess personality traits immediately after the cognitive training phase, but two years later. Thus, we do not know whether participants changed in openness to experience or other personality traits in short-term or not.

Future studies should compare the short-term and long-term effects of different kinds of cognitive training on openness to experience and reinvestigate the surprising negative influence of cognitive training on conscientiousness that we found. Additionally, all potential boundary conditions to cognitive training effects on openness change carved out here need further investigation and systematical testing.

2.6 Conclusion

This study has identified that, other than tentatively expected, even an extensive cognitive training of episodic memory, working memory, and perceptual speed does not serve as a sufficient intervention for enduring long-term changes in openness to experiences or one of its facets. Our results highlight the relevance of cognitive training type and time frame when investigating cognitive training interventions as a context for change in openness to experience and other personality traits.

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CHAPTER 3 – Getting together: Social Contact Frequency Across the Adult Life Span

– STUDY 2 –

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3.1 Abstract

Frequent social interactions are strongly linked to positive affect, longevity, and good health. Although there has been extensive research on changes in the size of social networks over time, little attention has been given to the development of contact frequency across the life span.

In this cohort-sequential longitudinal study, we examined intraindividual changes in the frequency of social contact with family and nonfamily members, and potential moderators of these changes. The data come from the 1998, 2003, 2008, and 2013 waves of the German Socio-Economic Panel (SOEP) study (N 36,716; age range: 17–85 years).

Using latent growth curve analysis, we found that the frequency of in-person contact with family members remained relatively stable across the life span. In contrast, the frequency of visits to and from nonfamily members (neighbors, friends, and acquaintances) declined following a cubic trajectory and dropped below the frequency of family visits when respondents were in their mid-30s. Relationship status and gender had a slight effect on both of these relationship trajectories. Subjective current health status and employment status influenced the life span trajectory of nonfamily social contact only. Changes of residence and the birth of a child, both of which constitute major turning points in the life course, did not affect the life span trajectory of either family or nonfamily in-person contact.

The findings are discussed here in the context of earlier findings and in relation to socioemotional selectivity and social convoy theory and the evolutionary life history approach.

Keywords: social contact frequency, life span development, socioemotional selectivity theory, social convoy theory, life history approach

3.2 Introduction

The frequency of social interaction plays a key role in psychosocial mechanisms linking the social environment to physical and mental health. The relationships that are maintained through frequent interactions provide important sources of social support and may trigger behavioral, psychological, and physiological processes that have significant positive impacts on health (Berkman, Glass, Brisette, & Seeman, 2000). Frequent social interaction enhances social integration and participation and is positively associated with longevity (Shor & Roelfs, 2015) and negatively associated with mortality risk (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015). Furthermore, higher levels of social participation predict a lower linear decline in perceptual speed (Lövdén, Ghisletta, & Lindenberger, 2005). The association of social activity with cognitive decline holds true even after controlling for social network size and a range of health factors (e.g., depression, chronic conditions, disability, and physical activity) (James, Wilson, Barnes, & Bennett, 2011).

Not only does social contact frequency have impacts on physical health and cognitive performance; it also affects aspects of mental health and well-being. Low frequency of in-person contact with family and friends is one of the best predictors for feelings of loneliness across all adult age groups (Luhmann & Hawkley, 2016). Less frequent social contact and interaction leads to lower self-esteem and control beliefs and a reduced sense of belonging and meaningful existence. These effects are observable independent of network size and tone of interaction (Greitemeyer, Mügge, & Bollermann, 2014). Moreover, social activities (e.g., events involving or attended with another person) have a strong relationship to positive affect (Clark & Watson, 1988). Interactions with friends appear to be even more beneficial for this component of well-being than interactions with family members (Lawton, 1983).

There are three main modes of social contact: first, getting together in person; second, talking on the Internet or telephone; and third, writing e-mails, text messages, or letters. Teo et al. (2015) reported that the frequency of in-person contact is more important than telephone or e-mail contact in preventing poor health in old age (Teo et al., 2015). A recent study by Luhmann and Hawkley (2016) showed that frequent in-person contact with both friends and relatives was associated with lower levels of loneliness, whereas frequent online contact was associated with higher levels of loneliness. Thus, the frequency of social interactions—in particular in-person interactions relative to telephone or e-mail contact—is a very strong predictor for several psycho-physiological outcomes beyond network size (Greitemeyer, et al., 2014; James, et al. 2011; Luhmann & Hawkley, 2016, Teo et al., 2015).

Social contact frequency, network composition (e.g., family, friends, and neighbors), and network size are important components of individual relationships. Much research has been done on changes in the size of family, friends, and other networks across the life span (e.g., English & Carstensen, 2014; Wrzus, Hänel, Wagner, & Neyer, 2013). Given the aforementioned results underscoring the importance of contact frequency for health and well-being, it is surprising that comparatively little is known about the development of social contact frequency across the life span and within different network circles.

According to socioemotional selectivity theory (Carstensen, 1995, 2006), there is a shift in motivational goals over the life span: In old age, when (life-) time is perceived as limited, people concentrate more on social contacts that provide emotional satisfaction. The evolutionary human life history approach (e.g.: Kaplan & Gangestad, 2015) states that the social relationships that matter most to both survival and reproduction change across the life span. Based on these ideas, in the present study, we investigate and compare the trajectories of social contact frequency across the adult life span, studying family and non-family relationships separately. According to social convoy theory, the structure of social networks is further influenced by personal (e.g., age, gender) and situational (e.g., role demands) characteristics (Antonucci, Ajrouch, & Birditt, 2014). Thus, we test for effects of different personal and situational moderators on the life span trajectory of social contact frequency. This allows us not only to describe the life span trajectories of family and non-family visits, but also to gain new insights into the forces shaping these developments.

3.2.1 The distinction between family and non-family social contact

In all human societies and cultures, kinship is distinguished from other relationships. The distinction between kin and non-kin relationships has played an important role in the evolution of social behavior and in the survival of a species (Penn, & Frommen, 2010). It is reflected in language, legal distinctions, and in moral and ethical norms. But kinship is not defined solely by shared genes. Rather, kinship describes a subjectively experienced relationship governed by two psychological mechanisms: regulation of emotional closeness and reciprocity monitoring (Neyer & Lang, 2013; Neyer, Wrzus, Wagner, & Lang, 2011).

Initial empirical evidence shows that kin relationships are characterized by higher emotional closeness and lower reciprocity monitoring than non-kin relationships (Neyer, et al. 2011). Family members are important for providing emotional and instrumental support, e.g.: financial aid, assistance with practical tasks and physical needs, and help during periods of illness (Wellman & Wortley, 1989, 1990), when reciprocity cannot always be maintained.

In contrast, cooperative non-kin relationships with friends, neighbors, and co-workers or other acquaintances are characterized by lower levels of emotional closeness and higher reciprocity monitoring (Neyer, et al. 2011). That is, partners in cooperative, non-kin relationships monitor the fairness of their cooperation and exchanges more closely than family members. However, friends and others in cooperative non-family relationships typically share similar characteristics and values, and hence provide emotional and informational support that is more tailored to specific situations (Miller & Darlington, 2002). Support provided in voluntary, informal relationships can also be reciprocated later (Axelrod & Hamilton, 1991) and in different ways (Fehr & Fischbacher, 2003). If the support is not reciprocated at all, however, non-kin relationships are more likely than kin-relationships to be terminated (Lang, 2000; Neyer, et al. 2011). These differences in the psychological processing suggest that family and non-family social contact frequency would differ across the life span. Therefore, in the present study, we investigate frequency of social contact with family and non-family network members separately.

3.2.2 Theoretical perspectives on the development of social contact frequency across the life span

What life span trajectories of in-person contact frequency should we expect to see from a theoretical point of view for family and non-family social relationships? A variety of theories have been proposed to explain mechanisms of change in relationships at levels ranging from the microgenetic to the evolutionary (Fingerman & Lang, 2004). Wrzus et al. (2013) provide a general framework combining developmental perspectives from socioemotional selectivity and social convoy theory with perspectives from social, personality, cultural, and evolutionary psychology to explain why some types of relationships are more stable and others more variable across the life course.

The evolutionary *human life history approach* (e.g., Kaplan & Gangestad, 2015) indicates that the social relationships that matter most to survival and reproduction change across the life span. These changes may be linked to events or situations that generally occur at specific stages: Young children are mainly concerned about obtaining resources from their families, in particular from parents. In early adolescence, young people tend to focus on acquiring social capital through alliances with friends with the aim of advancing status-seeking goals. During young adulthood, affiliations with friends and the status achieved through these relationships are central in acquiring a mate. After reproduction, attention shifts back to the family (Kenrick, Neuberg & White, 2013). Efforts and investments to help family members and genetic relatives also have the indirect effect of improving the individual's own reproductive fitness by increasing the likelihood that shared genes will be passed on to the next generation ("inclusive fitness

principle"; see Hamilton, 1964). Thus, investments in family are significant throughout adulthood.

Note that according to evolutionary psychology, human social behaviors are not a direct consequence of the aforementioned principles of survival and reproduction, such as the inclusive fitness principle. Rather, the nature of social interactions is rooted in evolved psychological mechanisms that underlie these principles (e.g., Tooby & Cosmides, 1992, 2015). Family members and relatives do not care for one another *because* they expect reproductive benefits; they behave in a kinship-oriented way out of a sense of emotional closeness, which is an evolved psychological mechanism (Hamilton, 1964; Lieberman, Tooby, & Cosmides, 2003, 2007, Neyer & Lang, 2003). Such evolved psychological mechanisms are triggered by environmental factors and appear at points in time when they would have once been needed to solve the challenges of that life stage.

From the life history approach, one could therefore derive an expectation of relatively stable contact frequency with family and relatives throughout adulthood and a decline in contact frequency with non-family members in middle adulthood, when the majority of adults have started a family and solved the challenge of reproduction.

The most well established developmental theories dealing with social relationships are socioemotional selectivity theory (Carstensen, 1995, 2006) and social convoy theory (Kahn, & Antonucci, 1980). Both predict a stable core social network and a declining peripheral social network across the life span. Several empirical studies confirm that family networks are stable in size from adolescence to old age, whereas friendship networks decrease in size throughout adulthood (English & Carstensen, 2014; Wrzus et al., 2013). While the anticipated changes are similar, the theories differ in their explanations for the development of social relationships over time.

Socioemotional selectivity theory (Carstensen, 1995, 2006) describes a shift in motivational goals over the life span. Early in life, when the end of life is still in the distant future, the main emphasis is on information acquisition goals, which are satisfied by numerous and diverse social relationships. Later in adulthood, when the end of life begins to come into view and time is perceived as limited, emotion regulation goals take the fore (Carstensen, 1995, 2006; Lang & Carstensen, 2002). As a consequence, during this phase, people concentrate on emotionally satisfying social contacts and actively reduce the size of their social network (Carstensen, 1995, 2006). The inner social network, consisting primarily of family members, remains in place, whereas the middle and outer social network circles, consisting of friends, neighbors, and acquaintances, decline (English & Carstensen, 2014). Age-related reductions in network size are assumed to be managed proactively by older adults (Lang, 2000; Lang &

Carstensen, 1994). Carstensen and Lang (2007) situated socioemotional selectivity theory in an evolutionary context, arguing that adults transfer their own motivational goals and social-emotional investments to younger family members as they become older, partly in an (unconscious) effort to promote the inclusive fitness of their genes (Carstensen, & Lang, 2007).

According to *social convoy theory*, individuals are carried through life embedded in social relationships, "surrounded by supportive others who move with them throughout the life course" (Antonucci, Ajrouch, & Birditt, 2014). The structure (e.g., size, contact frequency), function, and quality of these convoys are influenced by personal (age, gender) and situational (role demands, norms, values) characteristics (Antonucci, Ajrouch, & Birditt, 2014). The inner circle of the social convoy consists of the spouse and immediate family. These relationships are stable throughout the life span (Antonucci & Akiyama, 1987a; Antonucci, Ajrouch, & Birditt, 2014; Kahn, & Antonucci, 1980). Meanwhile, relationships in the outer circle tend to be more unstable. Such peripheral relationships are bound to a specific social role and environment. For instance, one might have a close relationship with a co-worker that is very role-prescribed: that is, it does not transcend the work environment or persist after life transitions like retirement. A few studies provide initial support for social convoy theory: close, core relationships remain stable, whereas peripheral relationships become unstable following changes in life circumstances (Antonucci & Akiyama, 1987a; Guiaux, van Tilburg, & Broese van Groenou, 2007).

The evolutionary life history approach, socioemotional selectivity theory, and social convoy theory all support the idea of relatively stable contact frequency with family across the life span. With regard to interaction frequency with friends, neighbors, and acquaintances, social convoy theory suggests instability and pronounced moderator effects, without stating specifics about the direction of personal and situational effects. In line with social convoy theory, evolutionary psychology assumes that different evolved psychological mechanisms that are linked to life history and specific situational factors (e.g., attraction to potential mates during fertility) shape social behavior across the life span. The life history approach suggests a decline in non-family contacts after mating and during the phase of parenthood, which usually occurs in early and middle adulthood. Socioemotional selectivity theory predicts a decline in non-family contacts as the end of life comes into focus, thus primarily in old age. However, none of the theories make explicit assumptions about in-person contact frequency with family and non-family members across the life span.

3.2.3 Previous research on social contact frequency

Having discussed potential trajectories that emerge from the theoretical literature, we now address the empirical evidence on social contact frequency across the life span. There is

initial cross-sectional evidence of a decline in the overall frequency of social contact with family and friends across the life span in a sample of 21 to 93-year-olds (Lansford, Sherman, & Antonucci, 1998). A longitudinal study of elderly people (aged 57 to 88) by Cornwell, Laumann, and Schumm, (2008) reached different conclusions, finding a U-shaped trajectory for overall contact frequency in old age.

Further, earlier research showed differences in the development of contact frequency for certain relationship types. Two studies on contact frequency with family members indicate an increase in early and middle adulthood (Carstensen, 1992) and decreases at the start of the second half of life (Toyokawa, 2013). One study investigating family contacts among adults 65 and older reports stability in the frequency of in-person, telephone, as well as written contact (Shaw, Krause, Liang, & Bennett, 2007). In contrast, overall contact frequency with non-family members has been reported to decrease in early and middle adulthood (Carstensen, 1992) as well as after age 65 (Shaw et. al., 2007).

Notwithstanding the specific effects of certain contact modes (Luhmann & Hawkley, 2016; Teo et al., 2015), most of the previous research investigated the development of overall contact frequency without differentiating among the possible contact modes (e.g., Carstensen, 1992; Cornwell et al., 2008; Shaw et. al., 2007)

Although there is initial empirical evidence of (a) changes in social contact frequency across the life span (e.g., Cornwell et al., 2008; Lansford et al., 1998), (b) differences in the development of social contact by relationship types (e.g.: Carstensen, 1992; Shaw et al., 2007; Toyokawa, 2013), and (c) a stronger effect of in-person social contact on health and well-being (e.g.: Luhmann & Hawkley, 2016; Teo et al., 2015), to the best of our knowledge no study to date has longitudinally investigated in-person contact frequency across the *entire* adult life span *and* distinguished between family and non-family contacts in a large and representative sample.

3.2.4 Moderators of social contact frequency

Personal (e.g., age, gender) and situational factors (e.g., role demands, social norms) could influence the structure and development of social networks (Antonucci, Ajrouch, & Birditt, 2014; Kahn & Antonucci, 1980). Situational factors accounted for in this study include relationship status, health status, birth of a child, employment status, and change of residence. We take age and gender into account as personal factors.

Gender

Previous research suggests that gender moderates the trajectory of social contact frequency, but results are mixed. Shaw et al. (2007) report less frequent overall contact for men

than for women when 65 or older. Phongsavan et al. (2013) found frequency of social contact with family and friends to decline among men and to increase among women in the second half of life. Antonucci & Akiyama (1987b) found no gender differences in social contact frequency between the ages 50 and 95. So far, gender differences in contact frequency have been investigated mainly in late adulthood. According social convoy theory (Antonucci, Ajrouch, & Birditt, 2014), gender is a personal factor that may influence the structure of the social network, but the authors do not specify how this occurs. Based on previous results (Phongsavan et al., 2013; Shaw et al., 2007), we expect women to have more frequent in-person social contact than men with both family and non-family members throughout adulthood.

Relationship Status

Previous research suggests that relationship status also moderates the trajectories of social contact frequency. Married people pursue fewer new social relationships than singles (Bloem, van Tilburg, & Thomése, 2008), but enjoy higher levels of social contact frequency with family members and close friends (Toyokawa, 2013). Similarly, widowhood increases the frequency of socializing with neighbors between the ages of 57 and 85 (Cornwell et al., 2008). In line with these earlier findings, we expect more frequent contact with non-family members and less frequent contact with family members among singles than among individuals in a long-term relationship. This expectation can also be drawn from the evolutionary life history approach, which states that in early and middle adulthood, evolved psychological mechanisms for finding a mate lead to a preference for social contact with non-family members when a person is single.

Employment Status

There is initial evidence that employment status influences social contact frequency as well. According to Hatch and Bulcroft (1992), unemployment predicts lower contact frequency with friends in late life, probably because once employed people have social contact with former coworkers, which all-time unemployed people do not (Bloem et al., 2008). Continuous full-time workers report a significant greater overall quantity of social contacts than continuous retirees (Bossé, Aldwin, Levenson, Spiro, & Mroczek, 1993). By contrast, the frequency of social contact with neighbors increases during retirement (Cornwell et al., 2008), when more free time is available. However, the effect of employment status on contact frequency with family members and non-family members across the life span remains unclear. Employment status is a situational factor that affects role demands; according to social convoy theory, we expect differences in contact frequency by employment status, at least in the non-family network. We cannot derive any prediction about the direction of the effect, however.

Health Status

Larger social networks and high contact frequency with friends are positively associated with good health (English & Carstensen, 2014; Hatch & Bulcroft, 1992). Similarly, individuals with the highest levels of in-person contact frequency have the lowest probability of depressive symptoms in old age (Teo et al., 2015). A recent meta-analysis reports significant but weak associations between non-family social contact and longevity, but no significant association between family social contact and longevity (Shor & Roelfs, 2015). As far as we are aware, the life span trajectory of in-person contact frequency with family and non-family members has not been investigated to date in relation to health status. Considering past findings on the nature of reciprocity monitoring in family and non-family relationships (Neyer et al, 2011), we assume in-person contact frequency with non-family members to decline when health becomes worse. The inability of individuals in poor health to reciprocate support might result in the termination of some relationships with non-family members. Poor health implies a need for social support without reciprocity. Since only kinship relationships are characterized by low reciprocity monitoring, persons in poor health might fall back on contact with family members and reduce contact with friends (Wellman & Wortley, 1989, 1990).

Birth of a Child

Song (2012) finds no evidence of a direct effect of parenthood on three dimensions of social capital: diversity, extensity, and quality. In a study comparing the network size and support trajectories of parents and childless adults as they age, Klaus and Schnettler (2016) report a surprising degree of similarity: the decline in network size and reduction in social support are no steeper among childless adults than among parents. Nonetheless, research does show short-term effects of parenthood on social contact frequency. Contact frequency with family members increases up to 24 months after birth. Within two years after birth, contact frequency with friends decreases among men and increases among women relative to the sixth month of pregnancy (Bost, Cox, Burchinal, & Payne, 2002). The effect of the birth of a child on in-person contact frequency has not yet been investigated, however, across the entire adult life span. According to social convoy theory, one could expect some instability in peripheral contact frequency due to changes in role demands after the birth of a child. According to the life history approach, we expect evolved emotional processes to lead to more frequent family contact and less frequent non-family contact after the birth of a child.

Change of Residence

Residential mobility has an impact on the structure of adolescents' friendship networks in terms of size, density, and reciprocity (South & Haynie, 2004). Usually, however, networks are restored after relocation, and new relationships develop even in old age (Bloem et al., 2008). To date, the effect of relocation on the life span trajectory of in-person contact frequency with family and non-family members remains unclear. Nonetheless, we expect in-person social contact frequency with neighbors, friends, and acquaintances to decrease after relocation. We assume a (short-term) negative effect of relocation across long distances on contact frequency due to the resulting changes in situational characteristics and geographic proximity. Both of the latter issues are discussed in social convoy theory as potential factors influencing the structure of social networks (Kahn & Antonucci, 1980). According to this idea, "peripheral" relationships with acquaintances, co-workers, and neighbors often do not transcend their given contexts; that is they are role-prescribed.

3.2.5 Current study

To address the aforementioned research gaps, the present study investigated the development of in-person social contact frequency (in the mode of visiting each other) across the *entire* adult life span, comparing (a) the familial social network with (b) the non-familial social network. Using longitudinal data, we tested the following hypotheses, which we derived from the theoretical perspectives and previous research discussed above.

(1) The frequency of visits with family members remains relatively stable.

(2) The frequency of visits with non-family members (here: neighbors, friends, and acquaintances) declines across the adult life span.

Furthermore, we tested for moderators of frequency of in-person contact trajectories across adulthood: specifically, for the effects of gender, relationship status, employment status, subjective health, birth of a child, and relocation on frequency of family and non-family visits.

This research builds on previous studies on social network development in a number of ways. First, it investigates the frequency of in-person contact longitudinally, particularly in middle age and across the entire adult life span. Second, it directly compares trajectories of family and non-family social network development. Third, our cohort-sequential longitudinal design underscores the validity of past conclusions about life course trajectories and shows that observed changes across age groups are due primarily to intra-individual changes rather than to cohort effects. Fourth, our study employs data from a very large national probability sample over the long time period of 15 years.

3.3 Method

Our data come from the German Socio-Economic Panel Study (SOEP, Version 31), based at DIW Berlin (the German Institute for Economic Research). The SOEP is a large, ongoing survey of private households and individuals in Germany that started in 1984. Households were initially chosen using a multistage random sampling technique with regional clustering. Subsequently refresher samples were added to increase the sample size and to maintain the representativeness of the data for the entire population of Germany. In addition, new household members (e.g., new partners or adult children) were invited to join the study and were interviewed annually as well. Individuals were followed even in cases of relocation or a split in a household. For detailed information about the design, participants, subsamples, variables, and assessment procedures, see Wagner, Frick, and Schupp (2007). We used data from waves 1998 to 2013: a 15-year period. We included every sub- and refresher sample (A-M) in the SOEP. Attrition in the SOEP was below 5% yearly across various subsamples for waves 1998 to 2013 (Kroh & Siegers, 2014)

3.3.1 Participants

In the present study, we organized the data by age. Because we analyzed the data on the basis of chronological age rather than measurement occasions, we included every SOEP participant who had provided at least one measurement for our study variables. Few participants provided data under the age of 17 or above the age of 85; therefore, we restricted the sample to individuals aged 17 to 85 years between 1998 and 2013. No further exclusion criteria were applied. The data matrix was therefore very complex; for detailed information on measurement occasions, number of observations, number of continuers from one wave to the next, and means and standard deviations of main study variables see Table 3.1. Frequencies, means, and standard deviations of potential moderator variables are summarized in Table 3.2.

Table 3.1 Descriptive Statistics and Number of Observations for Main Study Variables across All Waves

Variables	Wave	Observ.	(Observ. prev. wave)	M	SD
Age (*min* = 17; *max* = 85)	1998	14,277		43.39	16.11
	2003[a]	22,013	(10,365)	46.06	16.59
	2008[b]	19,240	(15,166)	48.69	17.02
	2013[c,d,e]	18,617	(11,711)	51.86	17.32
	all observations	74,147		47.69	17.06
Frequency of family visits (*min* = 0; *max* = 4)	1998	14,219		2.36	0.94
	2003[a]	21,930	(10,276)	2.29	0.94
	2008[b]	19,186	(15,057)	2.28	0.96
	2013[c,d,e]	18,570	(11,635)	2.25	0.96
	all observations	73,905		2.29	0.95
Frequency of non-family visits (*min* = 0; *max* = 4)	1998	14,240		2.33	0.93
	2003[a]	21,959	(10,295)	2.27	0.91
	2008[b]	19,187	(15,075)	2.20	0.91
	2013[c,d,e]	18,553	(11,617)	2.13	0.92
	all observations	73,939		2.23	0.92

Note. Observ. = Number of observations

Table 3.2 Descriptive Statistics and Number of Observations for Covariates across All Waves

Moderator variable	Wave	0 [no]		1 [yes]	
		Observ.	%	Observ.	%
Relationship status (long-term relationship)	1998	2,907	20.4	11,368	79.6
	2003	4,550	20.7	17,463	79.3
	2008	4,128	21.5	15,112	78.5
	2013	4,208	22.6	14,408	77.4
	all observations	15,793	21.3	58,351	78.7
Employment status /working (age: 17-65 years)	1998	3,296	30.5	7,520	69.5
	2003	4,598	28.0	11,854	72.1
	2008	3,533	24.7	10,759	75.3
	2013	3,535	25.4	10,400	74.6
	all observations	14,962	27.0	40,533	73.0
Child born in last 5 years (age: 20-60 years)	1998	7,298	82.2	1,584	17.8
	2003	10,623	83.3	2,134	16.7
	2008	9,015	85.8	1,497	14.2
	2013	9,154	88.8	1,151	11.2
	all observations	36,090	85.0	6,366	15.0
Change of residence (more than 100km)	2003	21,128	99.3	140	0.7
	2008	18,836	99.4	115	0.6
	2013	18,265	99,2	154	0.8
	all observations	58,229	99,3	409	0.7
		Observ.		M	SD
Current health status (*min* = 1; *max* = 5)	1998	14,253		3.46	0.95
	2003	21,992		3.44	0.95
	2008	19,230		3.37	0.95
	2013	18,608		3.33	0.96
	all observations	74,036		3.40	0.95

Note. Observ. = Number of observations

Altogether, 36,716 participants provided information on at least one measurement occasion for at least one main study variable (frequency of family visits; frequency of non-family visits). The participants' years of birth ranged from 1913 to 1995 (51.6% female). On average, study members participated in 2.01 (*SD* = 1.07) of four assessments of in-person social contact frequency.

To quantify selectivity effects, we compared drop-outs, who participated at most once per main study variable, with continuers, who participated in at least two assessments of at least one main study variable. Drop-outs were significantly younger (45.73 vs. 48.75; t = -32.67; $p < .001$; d = 0.18) than continuers. Drop-outs were slightly more likely to be male (χ^2 = 10.81; p = .001;

ω = 0.01), not to be in a long-term relationship (χ^2 = 433.86; p < .001; ω = 0.15), to report somewhat less frequent family visits (2.27 vs. 2.30; t = -3.35; p < .001; d = 0.03) and more frequent visits with neighbors, friends, or acquaintances (2.31 vs. 2.21; t = 12.64; p < .001; d = 0.11). All mentioned differences in study variables between drop-outs and continuers had very small effect sizes; thus no negative impact on the representativeness of study results due to selective dropout must be assumed.

3.3.2 Measures

Frequency of family visits. The frequency of in-person social contact with family members was assessed in the SOEP in 1998, 2003, 2008, and 2013 (hereafter "family visits"). The item was part of a block of questions concerning leisure-time activities, phrased as follows: "Now we would like to ask some questions about your leisure time. Please indicate how often you take part in each activity: Daily, at least once a week, at least once a month, seldom or never? Visiting or being visited by family members and relatives" For a better intuitive understanding and for statistical analysis, the scale was recoded and inverted to 0 (Never), 1 (Seldom), 2 (At least once a month), 3 (At least once a week), 4 (Daily) with a mean of 2.29 (SD = 0.95) across assessments.

Frequency of non-family visits. The frequency of in-person social contact with non-family members was assessed in the SOEP in 1998, 2003, 2008, and 2013 as well (hereafter: "non-family visits"). Like frequency of family visits, the item was part of a block of questions concerning leisure-time activities (see above), phrased as follows: "Visiting or being visited by neighbors, friends, or acquaintances". For a better intuitive understanding and for statistical analysis, the scale was recoded and inverted to 0 (Never), 1 (Seldom), 2 (At least once a month), 3 (At least once a week), 4 (Daily) with a mean of 2.23 (SD = 0.92) across assessments.

Relationship status. We generated a dichotomous variable contrasting 0 (no long-term relationship) including actual status of being married/living apart, single, divorced, widowed, or not in long-term relationship, and 1 (long-term relationship) including married/living together, civil union/living together, being in a long-term relationship, whether living together or not. Relationship status was assessed in all four waves (1998, 2003, 2008, and 2013). In 78.7% of observations participants were in a long-term relationship.

Employment status. We used a dichotomous variable contrasting 0 (not working) including unemployed, parental leave, and partial retirement working zero hours, and 1 (working) including participants in full-time work, part-time work, vocational training, and

education3; employees below the reporting threshold; and people in military service, civilian service, federal volunteer service, and sheltered workshops. Employment status was assessed in 1998, 2003, 2008, and 2013. Due to the low variation in employment status after age 65 (less than 1% working), we modeled the trajectories for frequency of visits in the age range 17 to 65 only in order to control for employment. Across all observations, 73% of respondents were working. Age was centered at 40 for analysis.

Current health status. Self-rated health was assessed with a single item, "How would you describe your current health very good, good, satisfactory, poor or bad?" For a better intuitive understanding, we recoded the scale from 1 (bad) to 5 (very good). For analysis, health ratings in 1998, 2003, 2008, and 2013 were used with a mean of M = 3.40 (SD = 0.95) across assessments. For further analysis, we centered the variable.

Birth of a child. We generated a dichotomous variable contrasting 0 (no birth within last 5 years) and 1 (birth within last 5 years). For this purpose, we merged information about the event of birth of a child from 1994 to 1998, 1999 to 2003, 2004 to 2008, and from 2009 to 2013. In 15% of all observations, a child had been born within the last reporting period. Because the probability of having a child before age 20 and after age 60 was below 1% in our sample, we estimated the basic models for frequency of visits in the age range 20 to 60 in order to control for the birth of a child. Age was centered at 40 for analysis.

Change of residence. In the years 2003, 2008, and 2013, information about moves and distance to new home were assessed. The spatial distance of these moves was calculated from geographical coordinates as the exact distance (as the crow flies) in meters between the old and the new address. From this data, we generated a dichotomous variable contrasting 0 (no move further than 100 km) and 1 (move further than 100 km) in the particular year. In 0.7% of observations, the participants moved further than 100 km[4].

3.3.3 Statistical analysis

The latent growth curve analyses were estimated with Mplus Version 7.3 (see Muthén & Muthén, 1998-2013). To include the greatest possible number of observations, we used the full

[3] We grouped people in education into "working", because they follow a daily, time-consuming schedule and meet their fellow students regularly (similarly to how employees meet coworkers). Thus, we assume social network characteristics of people in education to be more similar to working individuals than to those who stay at home and do not work.

[4] Here, we consider residential moves of 100 km and more and as long-distance moves. Nevertheless, this distance cut-off is somewhat arbitrary in nature. Recent migration studies use a lower cut-off point of 30 km (Boyle et al., 2009; Reuschke & Maarten van Ham, 2011) to differentiate between short-distance and long-distance moves. In the analyses, we also tested for the effects of residential moves of 32 km (20 miles, 30 minutes' drive). However, as was the case for 100 km (see the Results section), 32 km distance moves had no influence on the predicted life span trajectory of in-person contact frequency.

information maximum likelihood approach, which is a model-based approach to missing data (Enders & Bandalos, 2001). Model fit was assessed with the sample-size adjusted Bayesian information criterion (adjusted BIC). For adjusted BIC, absolute values cannot be interpreted, but when comparing models, lower values indicate better model fit.

Basic growth curve models. To conduct a cohort-sequential longitudinal study, we examined life span growth curve models that capture the development of frequency of family and non-family to and from family and non-family members across the entire observed age range represented in the sample.

Although each participant provided data for at least one and at most four age points (covering a 15-year period), the complete life span trajectory was constructed with information from all participants simultaneously (Preacher, Wichman, MacCallum, & Briggs, 2008). In our latent growth curve analyses (LGC), slope loadings were based on an individual's age at each assessment rather than on the measurement occasion. Thus, in this study, time is conceptualized as a function of an individual's chronological age and not as a fixed measurement wave (Mehta & West, 2000). We computed an individual's age by subtracting birth year from interview year at every assessment. Prior to analysis, age was centered at 50 years to allow for convergence in our complex polynomial growth curve models. Further, age was rescaled by factor 10^{-2} to avoid numerically small estimates related to slope factors and in order to obtain a greater precision of these estimates.

Latent growth curve analyses with individual slope loadings were conducted for frequency of visits to and from family and non-family members separately. In each case, we estimated a linear, quadratic, and cubic model and always chose the one with the best model fit to data according to adjusted BIC. In case of non-convergence of the models, variances for quadratic and cubic slopes were fixed to zero across all individuals. Figure 3.1 illustrates the life span growth curve model, specified for cubic growth.

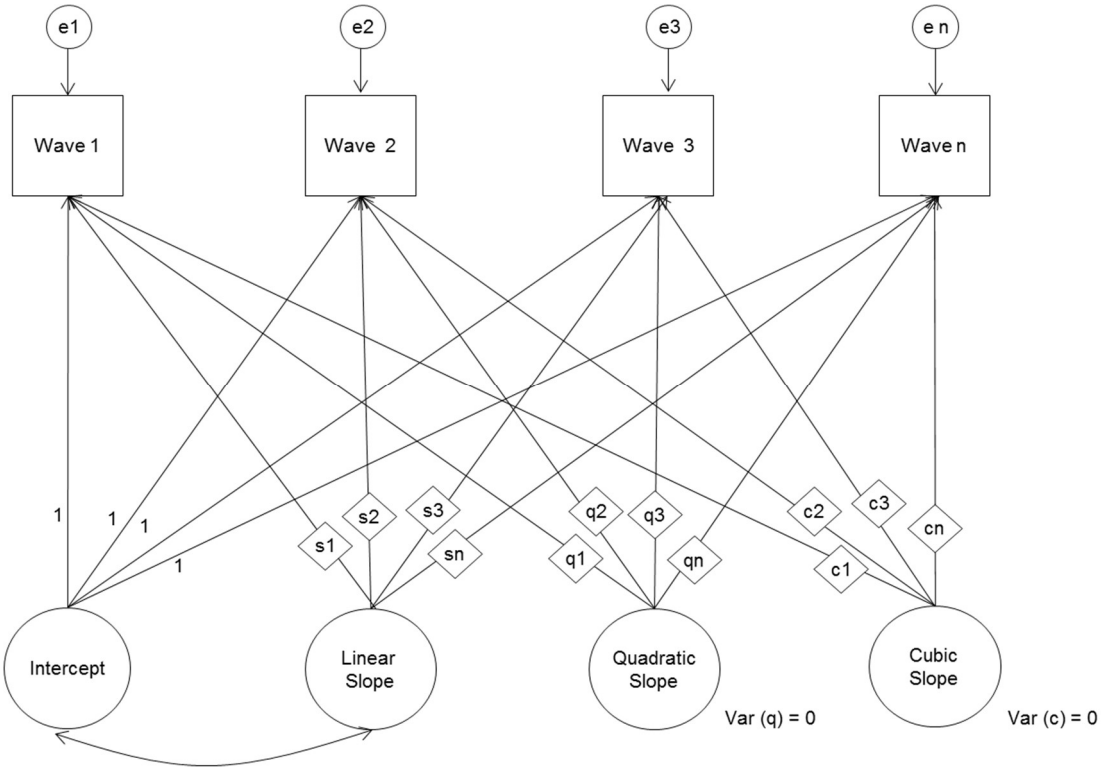

Figure 3.1 Growth curve model for cubic change in frequency of family visits and frequency of non-family visits. The linear or quadratic growths were specified accordingly. The model captures the development across the observed whole age range with individually varying slope loadings which are represented by rhombs (Mehta & West, 2000; Orth, Trzesniewski & Robins, 2010; Preacher et al., 2008). Intercept loadings were set to one at each wave. Residual variances are diagramed as circles e1 to en. The variance of quadratic and cubic slope factors was set to zero to allow for convergence of the models unless it was mentioned differently.

Check for cohort effects. Our approach is based on the assumption that there are no cohort effects. Therefore, a common trajectory should be modeled across all ages, and this trajectory should represent the development that would be found following a single cohort longitudinally.

To test this assumption, we divided our sample into six cohorts according to birth year (born before 1941, 1941-1950, 1951-1960, 1961-1970, 1971-1980, and born after 1980). Cohort effects can be tested comparing fits for models with and without cross-group constraints (see, e.g., Orth, Trzesniewski & Robins, 2010).

Alternatively, we fitted a linear, quadratic, and cubic latent growth curve model for every cohort separately. Once the model with the best fit to data was identified for each cohort (direct comparison of adj. BIC), we tracked the cohort trajectories for their theoretical age range between the year 1998 and the year 2013. The theoretical age ranges provided for cohorts within these years overlap (e.g., born before 1941 [58; 85], 1941-1950 [48; 72], 1951-1960 [38; 62], 1961-1970 [28; 52], 1971-1980 [18; 42], born after 1980 [17; 32]). If the depicted cohort-

specific trajectories for frequency of visits overlapped at shared ages, we assumed an absence of cohort effects.

Time-invariant covariate. To test for gender effects, model fit of multiple group growth curve models with and without cross-group constraints were compared. Men were coded as 1 and women were coded as 0.

Time-varying covariates. Relationship status, employment status, current health status, birth of a child (within last 5 years) and change of residence (>100km) may be subject to changes across waves and age. We applied models including these time-varying covariates (TVC) to investigate their impact on level and shape of frequency of visit trajectories. In these models, the initial level and development of frequency of visits is predicted by the growth factors and the respective, repeatedly measured TVC (Bollen & Curran, 2006; Preacher et al., 2008). Thus, the growth curve in a model including TVC describes the predicted trajectory of a dependent variable when the TVC is held constant. The models include covariance among intercept, linear slope, and TVC at all measurement occasions. Variances of quadratic and cubic slope factors were set to zero to allow for convergence.

To examine whether controlling for TVC affects the development of frequency of visits, we compared two TVC-growth curve models. First, the intercept and slopes were fixed to the values of the basic growth curve model, which assumes that the life span trajectory of frequency of visits is not affected by TVC. Second, the intercept and slopes were freely estimated, allowing the trajectory to alternate from the basic growth curve model. To decide on the moderator effect of each TVC, we compared the fit of both models. See Orth, Trzesniewski, and Robins (2010) for a depiction of a growth curve model with time-varying covariates.

The current health status was centered for analysis. Because of the very low number of participants reporting birth of a child before age 20 (< 1%) or after age 60 (< 0.02%), life span trajectories for frequency of visits including this life event were modeled for this time span only. Also, the TVC employment status was too homogenous, with less than 0.5% of participants working after the age of 65. We therefore limited the investigated life span trajectories for frequency of visits including this TVC. Age was centered at 40 years for analysis in both cases. Except for changes of residence (>100km), information on TVCs was assessed in every wave. The latter was assessed for the first time in 2001; hence the data basis for frequency of visits was limited to the 2003, 2008, and 2013 waves when controlling for TVC change of residence.

3.4 Results

3.4.1 Check for cohort effects

We used a multiple-group analysis to model a simple, linear development of frequency of family visits and frequency of visits with neighbors, friends, and acquaintances to test for cohort effects. Results showed that a model without any cross-group constraints fit better than a model that forced every cohort to follow the same trajectory (frequency of family visits: *adj. BIC* = 193,502.482 vs. 194,073.385; frequency of non-family visits: *adj. BIC* = 182,231.173 vs. 183,328.058), indicating that there might be cohort effects.

However, our alternative analysis revealed that cohort trajectories largely overlap in the frequency of both family and non-family visits (see Figure 3.2) Only the oldest cohort (born before 1941) shows a substantially higher frequency of both family and non-family visits than predicted for the younger cohort (born 1941-1951) in the same age range (58-72 years)[5]. Table 3.3 and Table 3.4 contain model fits (adj. BIC) and parameters for the cohort-specific growth curves. Variances of quadratic and cubic slope factors had to be set to zero for convergence of all models, except for the models of frequency of family visits in cohorts 2 and 3, as well as for the model of frequency of non-family visits in cohort 4.

All graphs in Figure 3.2 considered, we conclude that trajectories across the whole adult life span can be modeled with these data despite the fact that every individual was measured a maximum of four times over 15 years. In further analyses of the development of frequency of family and non-family visits, we take the estimated trajectories for the full sample as a basis. Whenever the information for a certain age was not provided, it was estimated by FIML (see method section for details). These generalized life span trajectories are described in the next section.

[5] In Germany, statutory retirement age was raised from 63 years in 1998 to 65 years in 2013 (Moog & Müller, 2011). The oldest cohort might have profited from earlier retirement and thus had more time for family and non-family social networks in early old age than younger cohorts did (Bonsang & Klein, 2012).

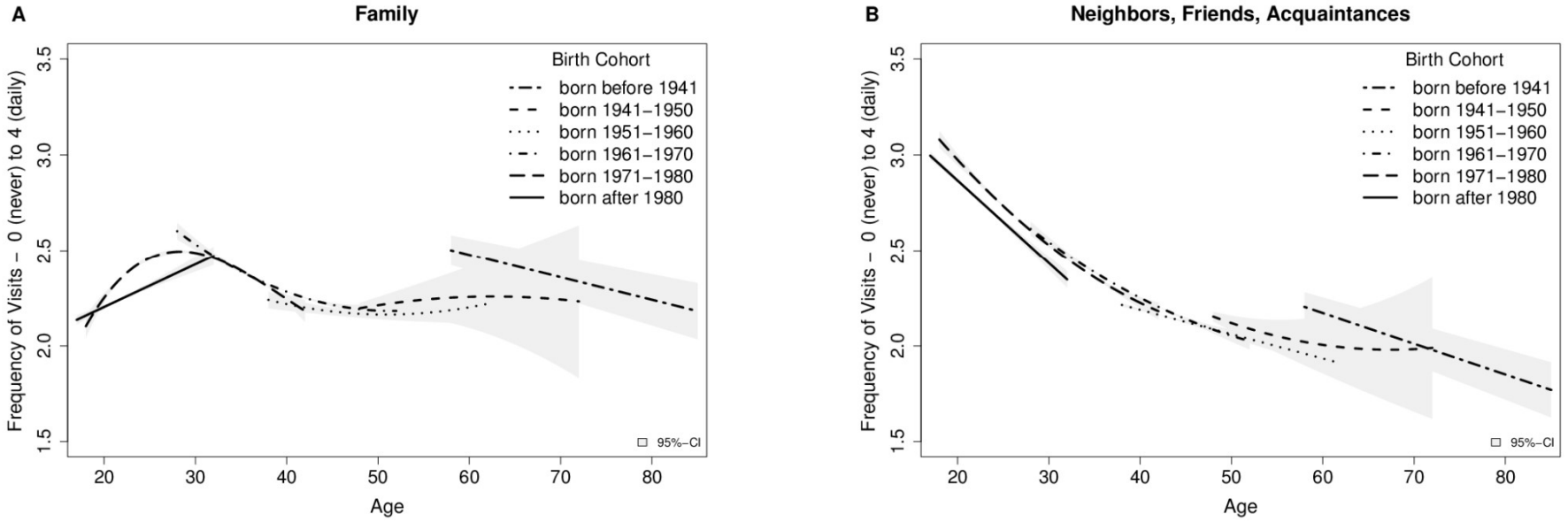

Figure 3.2 Cohort-specific trajectories for frequency of visits; (A) frequency of family visits; (B) frequency of non-family visits (neighbors, friends, or acquaintances); Trajectories are depicted for the theoretical age ranges of six different cohorts in the time.

Table 3.3 Model Fits and Unstandardized Estimates for Cohort-specific Growth Curve Models of Frequency of Family Visits between 1998 and 2013

Frequency of Family Visits	Cohorts (birth years)					
	Cohort 1 (before 1941)	Cohort 2 (1941 - 1950)	Cohort 3 (1951 - 1960)	Cohort 4 (1961 - 1970)	Cohort 5 (1971 - 1980)	Cohort 6 (after 1980)
N	6,634	5,396	6,539	7,242	5,305	5,582
Model fit (adj. BIC)						
Linear model	36,167.522[a]	31,842.641	36,953.096	39,433.370	27,068.656	21,940.074[a]
Quadratic model	36,174.646	31,840.680[a]	36,941.400[a]	39,415.446[a]	26,949.955	21,941.391
Cubic model	not converged	31,850.334	36,952.829	39,417.874	26,937.370[a]	not converged
Estimates						
Means (selected model)						
Intercept	2.597***	2.212***	2.164***	2.184***	2.020***	2.876***
Linear slope	-1.187 ***	0.728	-0.083	-0.223	-0.491	2.243***
Quadratic slope		-2.889	4.579**	7.640***	25.877	
Cubic slope					83.142**	
Variances (selected model)[b]						
Intercept	0.722***	0.386***	0.426***	0.522***	0.987***	0.726***
Linear slope	12.116***	29.474***	12.868***	9.517***	11.669***	5.249**
Quadratic slope		496.269***	892.570***			

Note. [a] Model selected (lower adj. BIC values indicate better model fit) [b] The variances of the quadratic and the cubic slope factors were set to zero to allow for convergence of the model (if not specified differently); *p < .05; ***p < .001

Table 3.4 Model Fits and Unstandardized Estimates for Cohort-specific Growth Curve Models of Frequency of Non-Family Visits between 1998 and 2013

Frequency of non-family visits	Cohorts (birth years)					
	Cohort 1 (before 1941)	Cohort 2 (1941-1950)	Cohort 3 (1951-1960)	Cohort 4 (1961-1970)	Cohort 5 (1971-1980)	Cohort 6 (after 1980)
N	6,637	5,399	6,544	7,248	5,306	5,582
Model Fit (adj. BIC)						
Linear model	36,385.834[a]	29,938.958	34,948.802[a]	36,794.800	24,326.552	19,739.104[a]
Quadratic model	36,386.150	29,937.549[a]	34,953.315	36,774.544[a]	24,316.100[a]	19,742.936
Cubic model	36,390.887	29,937.949	34,957.195	36,793.245	24,318.574	not converged
Estimates						
Means (selected model)						
Intercept	2.332***	2.119***	2.061***	2.053***	2.063***	1.569***
Linear slope	-1.606***	-1.599***	-1.272***	-1.505***	-0.908	-4.326***
Quadratic slope		4.587**		4.764***	7.104***	
Variances (selected model)[b]						
Intercept	0.279***	0.342***	0.291***	0.387***	0.467***	0.439*
Linear slope	3.615**	3.978**	4.744***	31.646***	4.488***	4.641*
Quadratic slope				484.132***		

Note. [a] Model selected (lower adj. BIC values indicate better model fit)
[b] the variances of the quadratic and the cubic slope factors were set to zero to allow for convergence of the model (if not specified differently); $p < .05$; **$p<.01$; ***$p < .001$

3.4.2 Trajectories of social contact frequency across the life span: Family versus non-family visits

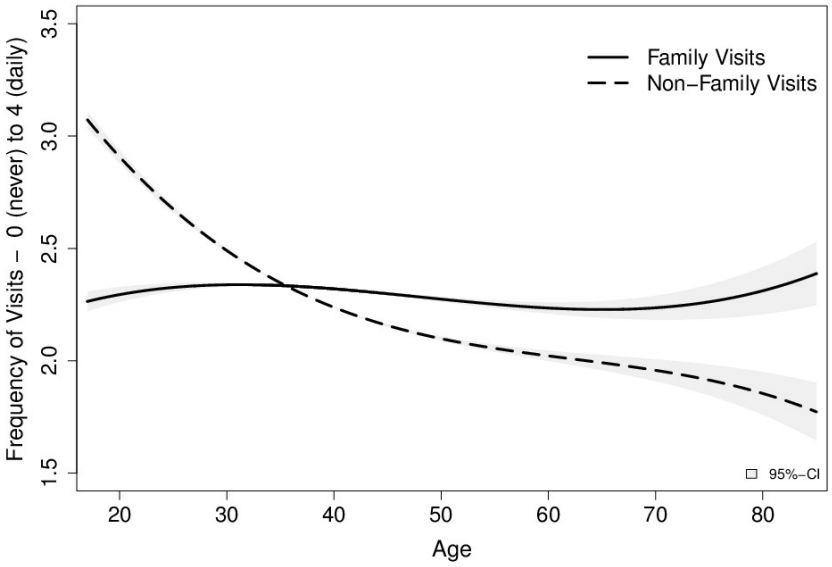

Figure 3.3 Average predicted trajectories of frequency of visits for the full sample. Comparison of family visits and non-family visits (neighbors, friends, or acquaintances).

Frequency of family visits.

We expected the frequency of family visits to remain relatively stable (see hypothesis 1). In fact, the cubic model had the best fit to data of the full sample (Table 3.5). All coefficients in the basic cubic model were significant, including the means of intercept, linear, quadratic, and cubic slope, as well as variances of intercept and slope. The solid line in Figure 3.3 represents the average predicted trajectory of frequency of family visits for the full sample.

The frequency of family visits ranged closely around 2.3 on the scale, meaning slightly more than once a month but less than once a week throughout the whole adult life span. On average, frequency of family visits increased slightly from age 17 up to age 31 (d = 0.08). Following that, the frequency of family visits showed a slight decline up to age 65 (d = -0.12). In old age, the frequency of family visits increased again slightly. But the maximal (at age 85, end of record) and minimal (at age 65) average frequency of family visits across the adult life span diverged by less than one-sixth of a standard deviation (d = *0*.17). Thus, the overall frequency of family visits tended to remain rather stable across adulthood.

Table 3.5 Model Fits and Unstandardized Estimates for Basic Growth Curve Models of Frequency of Family Visits and Non-Family Visits between 1998 and 2013

	Frequency of family visits	Frequency of non-family visits
N	36,698	36,716
Model fit (adj. BIC)		
Linear model	194,139.278	183,366.411
Quadratic model	194,146.271	182.471.538
Cubic model	194,086.998[a]	182,306.099 [a]
Estimates		
Means (selected model)		
Intercept	2.274***	2.098***
Linear slope	-0.484***	-0.995***
Quadratic slope	0.320*	3.144***
Cubic slope	5.693***	-8.455***
Variances (selected model)[b]		
Intercept	0.358***	0.271***
Linear slope	0.992***	0.945***

Note. [a] Model selected (lower adj. BIC values indicate better model fit)

[b] the variances of the quadratic and the cubic slope factors were set to zero to allow for convergence of the model (if not specified differently); p < .05; **p<.01; ***p < .001

Frequency of non-family visits.

For the frequency of non-family social contact—specifically, visits with neighbors, friends, and acquaintances—we expected a declining trajectory across the adult life span (see hypothesis 2). A cubic model had the best fit to data of the full sample. All coefficients in the basic cubic model were significant including the means of intercept, linear, quadratic, and cubic slope, as well as variances of intercept and slope (see Table 3.5). The predicted cubic trajectory of frequency of non-family visits for the full sample is represented by the dashed line in Figure 3.3.

The overall frequency of non-family visits showed a decline across the entire adult life span. There was more than one standard deviation of decrease between age 17 and age 85 (d = -1.41). The trajectory of non-family visits had an inflection point at age 62, where it went

from convex to concave. That indicates a strong decline in early and middle adulthood, followed by a slower decline around age 62, and ultimately by a faster decline in very old age.

Comparison of trajectories. As the trajectories in Figure 3 show, in young adulthood, social contact with neighbors, friends, and acquaintances was considerably more frequent than visits with family members. But in the mid-thirties, the graphs cross. At age 35.6, the average frequency of non-family visits dropped below the average frequency of family visits. This downswing in non-family social contact continued into old age, while the frequency of social contact with family remained relatively stable by comparison.

3.4.3 Effect of time-invariant covariates on life span trajectories

Gender. To explore the effect of gender on the social contact frequency trajectories, we estimated multiple group growth curve models. Model fits without cross-group constraints proved better than those with cross-group constraints for both frequency of family visits (*adj. BIC* = 193,955.976 vs. 194,143.403) and frequency of non-family visits (*adj. BIC* = 182,242.943 vs. 182,336.206), suggesting that there were gender effects.

Figure 3.4 shows the predicted trajectories for men and women in frequency of family visits. Both graphs ran close to parallel, with men reporting slightly less frequent family visits than women. The difference equates to a marginal effect in early and middle adulthood (at age 17: M_{men} = 2.19 vs. M_{women} = 2.34, d = 0.15; at age 50: M_{men} = 2.20 vs. M_{women} = 2.34, d = 0.14). In old age (85 years), reported frequency of family visits is very similar for men and women (M_{men} = 2.37 vs. M_{women} = 2.40, d = 0.04).

Figure 3.4 also shows the predicted trajectories for men and women in the frequency of non-family visits. In young adulthood, men report slightly more frequent contact with neighbors, friends, and acquaintances than women do (at age 17: M_{men} = 3.13 vs. M_{women} = 3.02, d = 0.12). But this changes across the life span. At age 27, the trajectories converge, and men and women show the same frequency of non-family visits. In middle adulthood, the trajectories switch, and women report more frequent visits with neighbors, friends, and acquaintances (at age 50: M_{men} = 2.05 vs. M_{women} = 2.14, d = 0.10) than men. This gender difference grows in old age (at age 85: M_{men} = 1.67 vs. M_{women} = 1.86, d = 0.20). In very young and very old age, the confidence intervals of trajectories for men and woman overlap; thus, gender differences may not be reliable for these periods of life.

As the trajectories in Figure 3.4 show, the average frequency of non-family visits dropped below the frequency of family visits slightly earlier in life for women than for men.

For women, the trajectories of family and non-family visits cross at age 34.3; for men, this occurs at age 36.8.

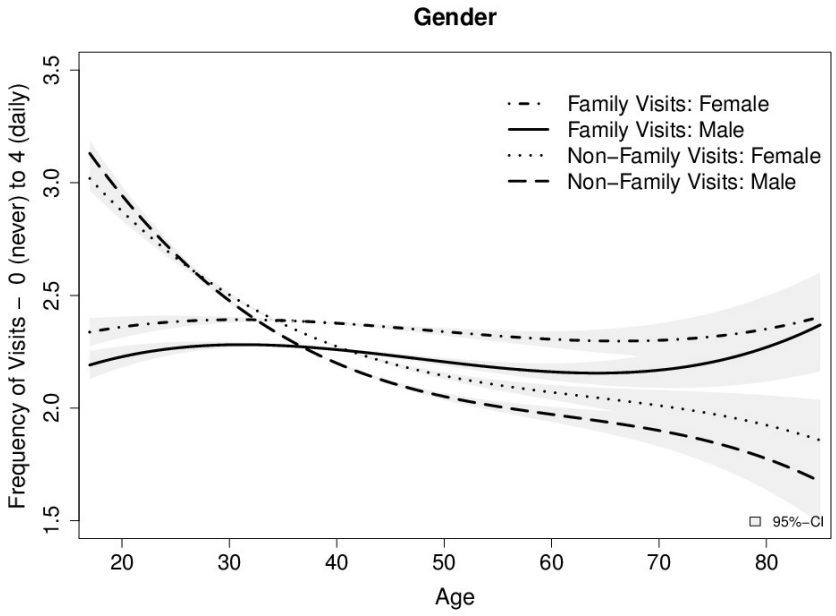

Figure 3.4 Average predicted trajectories for frequency of family visits and non-family visits (neighbors, friends, & acquaintances) by gender

3.4.4 Effect of time-varying covariates on life span trajectories

Analyses with time-varying covariates (TVC) were conducted to study the trajectories of family and non-family social contact separately. The frequency of visits at specific measurement occasions is explained by growth curve factors and repeatedly measured TVC simultaneously. We compared model fits of growth curve models including TVC, once with parameters set to basic model and once with freely estimated growth curve parameters. As Table 3.6 shows, only relationship status influenced the trajectory of frequency of family visits. The trajectory of non-family visits was influenced by three TVCs: relationship status, employment status, and current health status. Life events such as the birth of a child within the last 5 years or changes of residence over 100 km did not influence the life span trajectories of in-person social contact with family or non-family members.

Table 3.6 Model Fit of Growth Curve Models of Frequency of Visits with Time-Varying Covariates

TVCs	Frequency of visits	Model with constrained growths curve parameters	Model with free growths curve parameters
Relationship status	Family	251,378.882	251,374.419 [a]
	Non-family	239,661.964	239,614.676[a]
Employment status	Family	205,241.590[a]	205,257.024
	Non-family	194,404.652	194,404.373[a]
Current health status	Family	382,271.867[a]	382,298.612
	Non-family	370,258.297	370,240.738[a]
Birth of a child	Family	151,508.789[a]	151,589.906
	Non-family	143,965.759[a]	143,981.764
Change of residence	Family	19,537.898[a]	19,565.699
	Non-family	9,348.594[a]	9,377.394

Note. Values in table are sample size adjusted Bayesian information criterion; TVC = time-varying covariate.
[a] Model selected (lower values indicate better model fit

Relationship Status

Being in a long-term relationship slightly affects the trajectory of both family and non-family social contact frequency across the life span. TVC models with free growth curve parameters had a better fit to data than the models with growth curve parameters constrained to the basic model (Table 3.6). Controlling for relationship status results in slightly more frequent family visits for those without a long-term relationship in young adulthood (at age 17: $d = 0.08$). From age 26 to 65, family visits are slightly less frequent when controlling for a long-term relationship, but the effect is very small (at age 42: $d = -0.04$) (Figure 3.5).

Regarding non-family social contact, controlling for relationship status results in a minimal increase in visits across adulthood among participants who are not in a long-term relationship compared to the average (at age 17: $d = 0.08$; at age 50: $d = 0.12$; at age 85: $d = .09$) (Figure 3.5).

The trajectories of family and non-family visits cross about nine years later, when controlling for relationship status. That is, individuals who are not in a long-term relationship begin seeing friends, neighbors, and acquaintances less often than family around the age of 44.6.

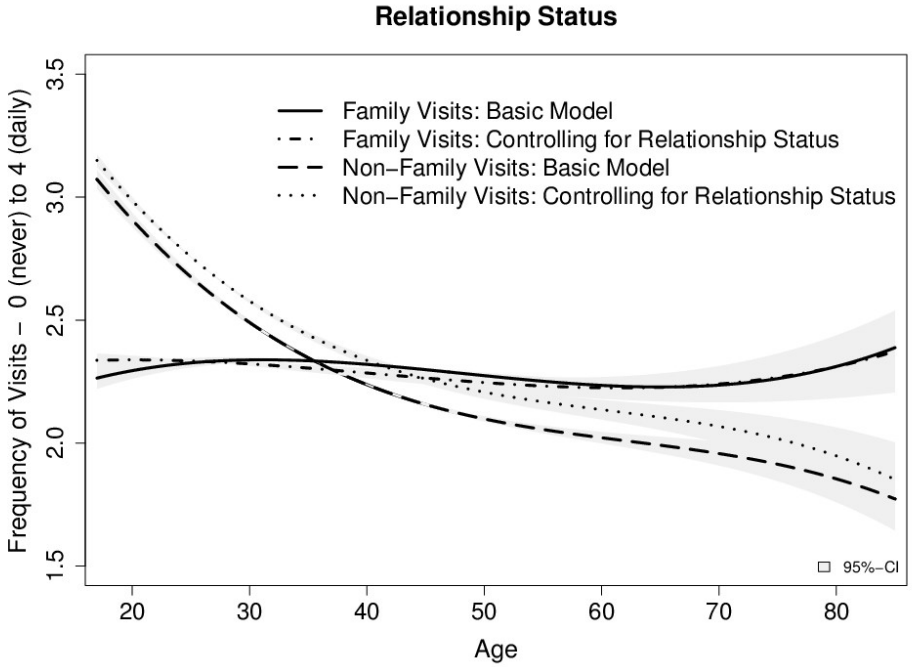

Figure 3.5. Average predicted trajectories for frequency of family visits and non-family visits (neighbors, friends, & acquaintances), controlling for relationship status

Employment Status

The cubic model had the best fit to data on family visits (linear: *adj. BIC* = 144,556.176; quadratic: *adj. BIC* = 144,435.004; cubic: *adj. BIC* = 144,136.457). The quadratic model had best fit to data on non-family visits (linear: *adj. BIC* = 133,803.074; quadratic: *adj. BIC* = 133,262.196; cubic: did not converge) in this period of life.

Only the growth curve of frequency of non-family visits—and not that of family visits—was improved by adding employment status as a covariate (Table 3.6). Results suggest that controlling for work increases the frequency of non-family visits across adulthood—that is, those who are not working see friends and acquaintances more often (Figure 3.6). But the difference in frequency of visits corresponds to marginal effects (at age 17: $d = 0.04$; at age 40: $d = 0.06$; at age 65: $d = 0.07$). Since employment status has no significant effect on family visits the trajectory is not depicted in Figure 3.6.

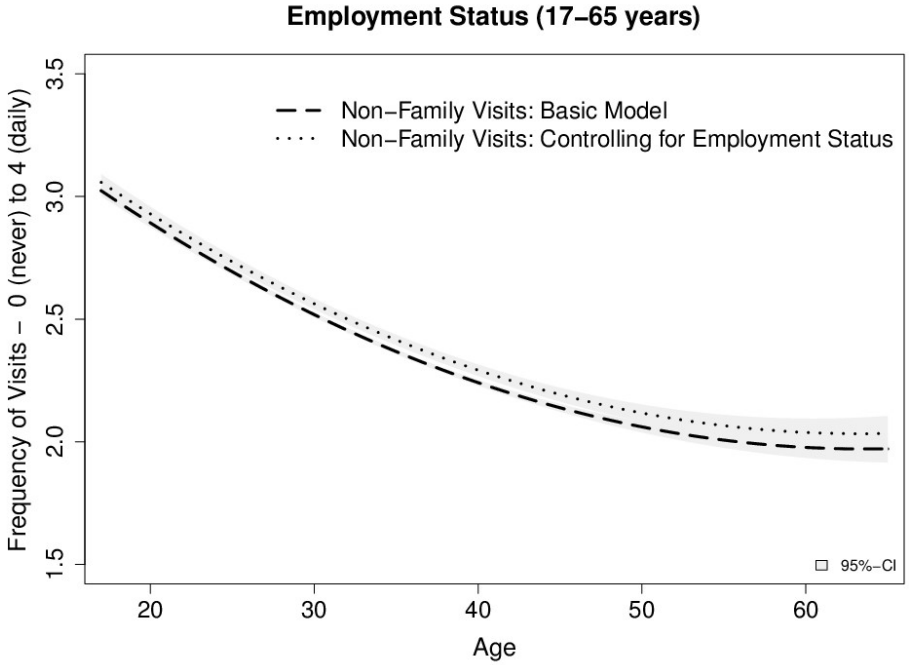

Figure 3.6 Average predicted trajectories for frequency of non-family visits (neighbors, friends, & acquaintances) between age 17 and 65, controlling for employment status

Health status

As Table 3.6 shows, only the growth curve of frequency of non-family visits was affected by current health status. The TVC model with free growth curve parameters had a better fit to data than the model with constrained growth curve parameters to the basic model. In contrast, frequency of family visits was not influenced by current health status. Here, the model with constrained growth curve parameters to the basic model had a better fit than the freely estimated TVC model.

Age and subjective current health status are negatively correlated (e.g.: r = -.42 in 1998; r = -.34 in 2013). To examine the effect of subjective health on frequency of social contact with neighbors, friends, or acquaintances in more detail, we plotted the predicted trajectory, controlling for the TVC, relative to the basic model (Figure 3.7). For analysis, current health status was centered at the mean. The graph shows that controlling for centered health status slightly reduces the predicted decline in the frequency of non-family social contact in old age (d = 0.10). In young adulthood, the trajectory starts at marginally lower values when health is held constant at the overall mean (d = -0.03). Thus, the analyses suggest that adverse changes in health are partly related to a decline in the frequency of social contact with non-family social networks in old age. The frequency of social contact with family does

not increase or decrease due to health status changes. Since current health status has no significant effect on family visits the trajectory is not depicted in Figure 3.7.

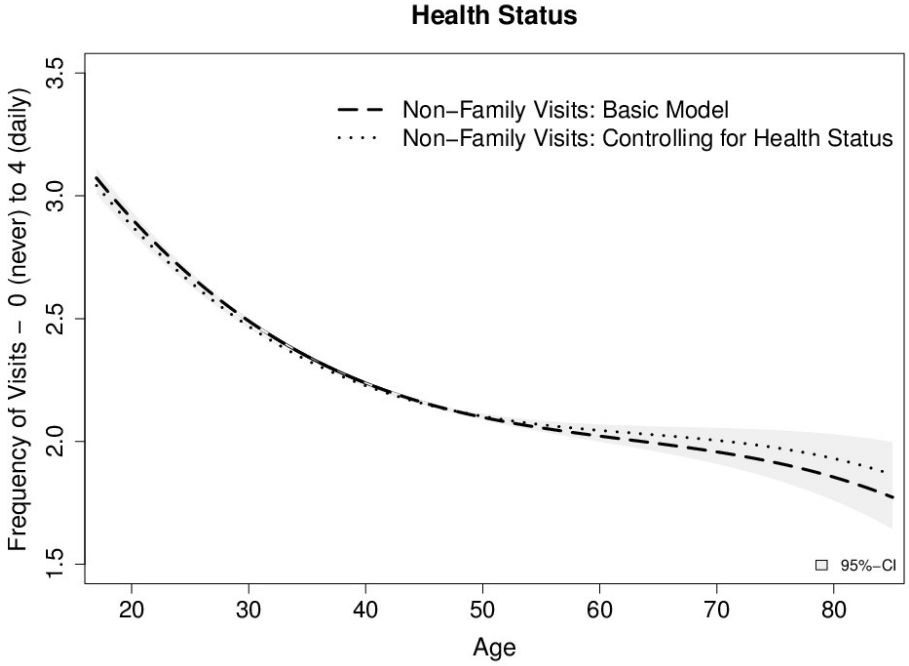

Figure 3.7 Average predicted trajectories for frequency of non-family visits (neighbors, friends, & acquaintances), controlling for health status

Birth of a child

For the basic trajectory of frequency of family social contact, the cubic model had the best fit to data (linear: *adj. BIC* = 109,438.315; quadratic: *adj. BIC* = 109,376.658; cubic: *adj. BIC* = 109,256.512). The quadratic model had best fit to data for frequency of non-family social contact (linear: *adj. BIC* = 101,525.818; quadratic: *adj. BIC* = 101,317.479; cubic: did not converge) in this age range.

For both trajectories, frequency of family and non-family social contact, the models with growth curve parameters constrained to basic model in age range 20 to 60 fit better than the models with free growth curve parameters. Thus, controlling for birth within last five years did not affect the life span trajectories of in-person social contact frequency significantly (Table 3.6).

Change of residence

Neither the life span trajectory of frequency of family visits nor the trajectory of non-family visits was affected by the life event of moving distances of more than 100 km (Table 3.6). For both trajectories, the frequency of family and non-family visits, the models with

growth curve parameters constrained to the basic model fit better than the models with free growth curve parameters.

3.5 Discussion

As discussed in the introduction, previous research on the development of social contact frequency suffers from serious shortcomings. Past studies were either cross-sectional or, if longitudinal, they focused on specific phases of adult life. Although a clear distinction between family and non-family relationships is crucial from a theoretical perspective and has been suggested in other investigations of social relationships, most of the previous studies did not consider this when investigating social contact frequency. The present study therefore set out to explore the adult life span trajectory of in-person contact frequency with family and non-family members separately. Results suggest that the frequency of family visits is relatively stable, whereas the frequency of non-family visits declines across the life course.

3.5.1 Implications of findings

The two most prominent theories on development of social relationships, socioemotional selectivity theory by Carstensen (1995, 2006), and social convoy theory by Kahn and Antonucci (1980), refer to changes in network size and are therefore not directly applicable to the frequency of social contact. Nevertheless, the present results are broadly consistent with their predictions of a stable inner network consisting mainly of family, and a decline in the number of friends and acquaintances in the more peripheral outer network.

We found in-person contact frequency with family to remain relatively stable across the adult life span. It could be that this development is driven by the evolved psychological mechanisms of kinship orientation (Neyer & Lang, 2003) discussed above. These mechanisms, which Hamilton (1964) described as the "inclusive fitness principle," are driven by a lifelong interest in the survival of genetic relatives. Regarding the frequency of non-family visits, we found declines in early and middle adulthood. Socioemotional selectivity theory (Carstensen, 1995, 2006) predicts this decline as the end of life approaches—that is, mainly in old age. These findings are therefore more in line with the evolutionary life history approach (Kenrick, Neuberg, & White, 2013; Neuberg, Kenrick, & Schaller, 2010), which would attribute the observed decrease to a decrease of interest in non-family members, who are no longer important for mating and reproduction.

The present study supports some of the conclusions that can be drawn from previous research. For instance, the stability in the frequency of family social contact across the adult

life span found here could have been expected from earlier research on old age: Shaw et al. (2007) reported stability in the frequency of contact with family members both in person and by phone or letter. Other previous research reported lower stability in social contact frequency with family members in earlier life phases. Carstensen (1992) reported an increase in contact frequency with family members in early and middle adulthood. Toyokawa (2013) found a decline in contact frequency with family after age 54. The cubic trajectory of frequency of family social contact found here might be seen as echoing these past findings, but the effect sizes of change in frequency of in-person social contact with family in the present study were extremely small. We therefore interpret its development as stable across the life span. The differences in results for changes in the frequency of social contact with family may be due to differing operationalization. Carstensen (1992) included all modes of interaction and the spouse or partner to measure frequency of family contacts. Since a partner plays an increasing role in early and middle adulthood, social contact frequency with that individual would rise. If contact with family members includes contact with the partner, the trajectory of may be distorted due to increasing partner contacts. Another possible explanation for the increase in family social contacts in the study by Carstensen (1992) is a period effect. Carstensen followed individuals from age 17 to age 52 between 1946 and 1981; a time when new communication technology (e.g., telephone, e-mail) had emerged. Toyokawa (2013) included the use of video and audio media to maintain contact with family members and close friends, whereas we assessed reported in-person contact frequency with family members only. Based on our findings, we assume that the decline in contact with family and close friends reported by Toyokawa (2013) was due primarily to a decline in contact with friends.

The present research study also shows a strong decline in the frequency of visits with neighbors, friends, and acquaintances across the adult life span, as found in earlier studies. For instance, Carstensen (1992) reported a decline in overall contact frequency with friends and acquaintances in early and middle adulthood. Shaw and colleagues (2007) showed that overall contact frequency with friends declines in old age.

According to social convoy theory, personal factors such as *gender* have an impact on social network characteristics. Our investigation of gender differences showed that women report slightly more frequent in-person social contact than men. This result is consistent with findings of Shaw et al. (2007) and Phongsavan et al. (2013), who also describe a greater frequency of social contact with family and friends among women. The reason for this is not clear, but it may have evolutionary roots. Our female and male ancestors likely lived in social groups in which men were the philopatric sex that tended to stay in the birth group (Rodseth

et al., 1991). Under these circumstances, our female ancestors were more likely than males to be transferred into groups where they were not genetically related to the other individuals in the group. Since women had to integrate themselves into a new family, they could have developed a tendency to be more concerned about the nuances of interpersonal relationships than men. The greater attentiveness of women to social cues (e.g., facial expressions), their more frequent use of positive social signaling (e.g., smiling), their skill at strategically using emotion cues in social contexts, and their general motivation to develop intimate social relationships as an end in itself might reflect evolved psychological mechanisms to these social conditions (Geary, 2010).

In line with Toyokawa (2013), we found that individuals in a *long-term relationship* enjoyed slightly higher levels of social contact with family members, at least in middle adulthood. This result may be explained by the fact that having a partner may increase the size of family networks, including parents-in-law, etc. The likelihood of family visits could therefore increase. In order to disentangle contradictory results of earlier research and to study the effect of being in a long-term relationship on contact frequency, we viewed it as essential to distinguish between family and non-family members. In line with the study by Bloem, van Tilburg, and Thomése, (2008) we found that people without a spouse had more frequent in-person social contact throughout adulthood, but only with neighbors, friends, or acquaintances—not with family. Our study also reveals that not being in a long-term relationships leads to a later drop in the frequency of non-family visits to levels below the frequency of family visits. It seems possible that these results are due to the use of non-family networks to seek a potential mate. Our findings also indirectly support the results of Cornwell et al. (2008), who showed that being single increases the frequency of socializing in old age.

Changes in *employment status* might lead to changes in the social role and in the everyday environment. According to social convoy theory, peripheral relationships may not extend into new environments after changes in life circumstances. Prior studies have also noted the importance of employment status for social networks. In particular, contact with coworkers increases overall social contact frequency when working (Hatch and Bulcroft, 1992; Bloem, van Tilburg, & Thomése, 2008; Bossé, et al. 1993). We found that whereas the trajectory of frequency of family visits was not affected by employment status, those not working had slightly more contact with friends, neighbors, and acquaintances than the average. Although we did not investigate old age after retirement here, this result is in line with the findings of Cornwell et al. (2008), who describe an increase in social contact with

neighbors after retirement. The reason for this is not clear, but it may be that more opportunities and more free time simply result in more social contact.

One aim of our study was to assess the life span trajectory of in-person social contact frequency with family and non-family members in dependency on *health status*. Previous studies evaluating health and social networks observed positive associations (e.g., English & Carstensen, 2014; Hatch & Bulcroft, 1992; Shor & Roelfs, 2015; Teo et al., 2015). It is interesting to note that in this study, subjective health status influenced only in-person contact frequency with non-family members. The life span trajectory of frequency of family visits was not affected by changes in health status. But when controlling for current health status, the decline in contact frequency with neighbors, friends and acquaintances was somewhat buffered in old age. In other words: poor health reduces the frequency of in-person non-family social contact, but in-person family contact remains unaffected by illness in old age. This difference might be due to a human kinship orientation (Neyer & Lang, 2003). Family relationships typically provide emotional and instrumental support, especially in periods when reciprocity cannot be maintained, such as during periods of illness.

Based on the evolutionary life history approach, we expected family formation to reduce interest in the non-family social network. At the same time, we expected the frequency of family visits to increase because of interest of grandparents and other relatives in their new kin. Contrary to expectations, in this study, controlling for the covariate, the *birth of a child* within the last five years as a life event had no significant effect on the life span trajectory of social contact frequency with either family or non-family members. Other studies also found parenthood to be surprisingly independent from changes in social network characteristics (see Klaus & Schnettler, 2016; Song, 2012). One possible explanation for the lack of an effect of the birth of a child on non-family social contact during middle adulthood might be the reciprocity of visits. Parents focus on the new child and have less time for their friends, and at the same time, childless adults tend to see friends and acquaintances that have become parents less often than before. Thus, in-person non-family contact frequency might decline as well for single adults even though they have not experienced the birth of a child themselves. A possible explanation for the lack of an effect on in-person social contact frequency with family might be that the birth of a child has only short-term effects on contact frequency (see Bost et al., 2002), which are not covered in our data.

As mentioned in the introduction, social convoy theory (Kahn & Antonucci, 1980) states that relationships on the periphery (e.g., neighbors, co-workers, etc.) are role-prescribed and often do not transcend their given environments. That means, a person might have a close

and important relationship with a neighbor, but that relationship might not persist after relocation, because the relationship was limited to the "neighbor" role. In the present study, we investigated the impact of *changes of residence* of more than a hundred kilometers (as a change in situational characteristics and geographic proximity) on frequency of in-person social contacts. We did not find any effect of such moves on in-person contact frequency with family or non-family members. These results are in agreement with those obtained by Bloem, van Tilburg, and Thomése (2008), who reported networks to be restored after relocation, even in old age. Thus, network composition might have changed, but in-person contact frequency with family, neighbors, friends, and acquaintances did not. And if the frequency of visits with family or non-family members was affected shortly after a move, it might not be mapped in the yearly assessment of SOEP data we used here.

3.5.2 Limitations and future directions

One limitation of this study is that the German SOEP did not follow participants across the entire observed time span (age 17 to 85) but over a 15-year period. To address that limitation, we used the cohort sequential longitudinal methodology that suggests that observed changes across age groups are mostly due to intra-individual changes rather than cohort effects.

In the present study, current health status was measured by self-assessment. Self-rated health could be capturing aspects beyond a person's objective health status and may be affected by recent events such as recovery from an illness or a good medical prognosis (Jylhä, 2009). Future research should therefore use a wider array of health measures. Nevertheless, self-rated health is highly correlated with relevant outcomes such as overall life satisfaction (Ambrasat, Schupp, & Wagner, 2011) and is a strong predictor of mortality (Ilder & Benyamini, 1997).

In addition, this study is limited by its narrow assessment of social contact frequency in terms of visits. Although social contact may also be maintained through telephone and electronic media, in-person contact frequency has been shown to be more beneficial than telephone or email for health outcomes (Teo et al., 2015). Nevertheless, comparative investigation of changes in in-person and indirect social contact frequencies would complete the picture of life span trajectories.

Another limitation of the current study is that we were not able to distinguish among neighbors, friends, and acquaintances although these are distinct relationship categories in terms of closeness and spatial proximity. We also could not disentangle different family

members. Nonetheless, there are several arguments in favor of the broad distinction between family and non-family social contact (collapsing neighbors, friends, and acquaintances) that we were compelled to make here. The distinction between family and non-family relationships is a natural and important one for survival and the reproduction of species. Psychologically, these different types of relationships rely on different manifestations of emotional closeness processing and reciprocity monitoring. Thus, they provide different kinds of social support in different situations and stages on the life course. Hence, it was important to investigate the development of social contact frequency for family and non-family separately in this study.

It remains unanswered whether the relative stability of family visits and the decline of in-person non-family social contact are valid across different cultures and societies. Is this pattern of results due to evolved psychological mechanisms that operate in all human beings, or is it specific to our sample, which is representative of the German population? Comparing our data from the German SOEP study to data from other countries and cultural groups might give further insights into the underlying processes and decisive variables of social contact frequency across the life span.

Another question we could not directly address in the present study is the relationship between social contact frequency and social network size across the life span. Several reports have shown that global social network size decreases throughout adulthood (for a meta-analysis, see Wrzus et al., 2013). Do we see fewer people as we get older and this causes our overall in-person contact frequency to decline as well? Or do we meet those who still are in our network more often, resulting in stable overall in-person contact frequency across adulthood? Past research shows that high in-person contact frequency would be beneficial for many health and wellbeing outcomes (e.g., Greitemeyer et al., 2014; Shor & Roelfs, 2015). In order to compensate for the declining overall network size, contact frequency with the remaining network could increase. However, the present findings tends to support the hypothesis that in-person contact frequency declines, following a similar trajectory to network size across the life span. Further research on this topic needs to be undertaken to better understand the association between contact frequency and network size.

In-person social contact frequency with family members was found to be very stable across the life span compared to contact with non-family members, although who is visiting whom might change. In early adulthood, social contact with family might involve visiting one's parents. In middle adulthood, it might involve being visited by or visiting the grandparents of one's children. In old age, in-person social contact with family might

primarily involve visits from relatives and children. This could not be sufficiently disentangled in our study. Also, we do not know whether or not respondents understood family members to include partners.

Future studies should focus not only on average in-person social contact frequency but also on the network composition and who is visiting whom and how often. Further studies on the relation between different modes of contact frequency, social network size, and network composition across the life span are recommended.

3.6 Conclusion

The main goal of the current study was to determine and compare the life span trajectories of in-person contact frequency with family and non-family members across adulthood. Using longitudinal data and a large German sample, this study has shown that the frequency of social contact with family is relatively stable, whereas the frequency of social contact with non-family members declines. The most prominent decline in contact frequency with non-family members already occurs in early adulthood. Although the in-person mode of contact, especially in non-family relationships, was identified in other studies as exceptionally important for psychological wellbeing and health (e.g., Shor & Roelfs, 2015), social contact with family becomes more frequent than social contact with friends, neighbors, and acquaintances on average between the ages of 35 and 36.

The second major finding was that life span trajectories of social contact frequency were relatively unaffected by the key social roles and life events investigated here. Gender and relationship status affected both family and non-family in-person contact frequency. Employment status and current health status only influenced non-family contact frequency. Although significant, effects were all marginal. The life events of the birth of a child and change of residence had no significant effect on the life span trajectories of social contact frequency in our data.

The study has gone some way towards enhancing our understanding of the development of social relationships across the life span. Taken together, these results suggest that the pattern of development for in-person contact frequency is similar to the pattern of social network size changes described in other studies (e.g., Wrzus et al., 2013), showing stability in family networks and a decline in peripheral networks.

Nonetheless, this study is limited by the lack of information on network size and network composition. What is now needed is a cross-cultural longitudinal study involving network size and network composition to further investigate the mechanisms underlying the changes in social contact frequency across the life span.

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CHAPTER 4 – Leisure Activities as a Driver of Personality Development?

– STUDY 3 –

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4.1 Abstract

Repeated experiences and activities drive personality development. Leisure activities are among the daily routines that may elicit personality change. Yet despite the important role they play in daily life, little is known about their prospective effects on personality traits and vice versa.

The objective of this study was to examine the extent to which within-person changes in leisure activities lead to prospective changes in personality traits, and whether changes in personality elicit prospective changes in leisure activities.

We applied random-intercept cross-lagged panel models (RI-CLPM) to four waves of 13-year longitudinal data (2005−2017) from the German Socio-Economic Panel Study (SOEP) for the sample as a whole (N = 55,790) and for three specific age groups (young, middle-aged, and older adults). We examined between-person associations and within-person auto-regressive effects, correlated change and cross-lagged effects for Big Five personality traits (i.e., openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) with self-reported frequency of leisure activities (i.e., physical activities, socializing, volunteering, political activity, artistic and musical activity, going out) and overall participation in leisure activities.

At the between-person level, leisure activities and overall participation were most strongly associated with openness to experience. At the within-person level, we found reciprocal effects of extraversion only with overall participation in leisure activities and socializing. We found unidirectional within-person cross-lagged effects between leisure activities and personality traits and vice versa. Some effects were age-group-specific only.

These findings suggest that leisure activities that are associated with certain traits at the between-person level are not necessarily those that trigger change in the respective personality trait. We discuss our findings based on the TESSERA framework for personality development. We conclude that the specificity of an experience or behavior and its corresponding trait is essential for personality development and should be subjected to further research.

Keywords: Personality change, lifespan development, leisure activities, random-intercept cross-lagged panel model

4.2 Introduction

Personality has very concrete implications for many life domains such as health, mortality, relationship success, educational and occupational attainment, income, and job satisfaction (for an overview, see Soto, 2019). Because personality is also subject to change, there is great interest in understanding patterns of development and mechanisms of change in personality (Aschwanden & Allemand, 2020; Bleidorn et al., 2019).

In line with recent theories on personality change and stability (Roberts, 2018; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017, for an overview, see also Specht et al., 2014), we hypothesized a gradually unfolding effect of leisure activities on personality and vice versa. We thus assumed that changes in participation in leisure activities may be a source of individual differences in personality development across the lifespan.

In this study, we investigated transactions between overall participation in leisure activities and six specific leisure activities with changes in the Big Five personality traits (John & Srivastava, 1999) over time in adulthood. For this purpose, we used data from 55,790 individuals who participated in the annual SOEP study over a period of 13 years.

4.2.1 Personality development across the life span

Measures of personality traits show both continuity and change throughout adulthood (Roberts, Walton, & Viechtbauer, 2006). The rank-order consistency of personality traits—which reflects the placement of individuals within a population—is relatively but not completely stable across the lifespan (Damian, Spengler, Sutu, & Roberts, 2019; Roberts & DelVecchio, 2000, Specht, Egloff, & Schmukle, 2011). Personality therefore does change. It develops at different ages marking key transitions in the life course from early adulthood to old age. In young and middle adulthood, personality generally develops towards greater psychological maturity: on average, neuroticism decreases, while agreeableness and conscientiousness increase. Sociability, a facet of extraversion, tends to decrease on average with age, while social dominance, another facet of extraversion, tends to increase. Openness to experience shows a curvilinear pattern of mean-level change, with increases in early adulthood and decreases later in life (e.g., Lucas & Donnellan, 2011; Roberts, Walton, & Viechtbauer, 2006, Specht, Egloff, & Schmukle, 2011; for reviews on personality mean-level change, see Bleidorn & Hopwood, 2019; Specht et al., 2014).

Not all individuals change in the same ways with age, however. There are also substantial individual differences in change throughout the lifespan, and not everyone follows

the aforementioned mean-level trends (Bleidorn, Hopwood, & Lucas, 2018, Schwaba & Bleidorn, 2018).

4.2.2 What drives personality development?

Most theoretical frameworks agree that personality can be shaped by *biological factors*, e.g., genetic influences or health issues, as well as *environmental factors*, e.g., social roles, normative life transitions, or major individual life events. There is empirical evidence that both genes and life experiences play a role in personality stability and change (Bleidorn, Kandler, & Caspi, 2014; Briley & Tucker-Drob, 2014). Other factors such as time, role scripts, and individuals' own active involvement appear to be sources of change in personality traits (see Specht et al., 2014).

Despite differences in details, recent theoretical frameworks (Roberts, 2018; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017) broadly describe personality change as a bottom-up process: Recurrent and enduring short-term changes in behavior and daily life experiences drive long-term changes in personality traits. These theories also propose transactional processes: Personality traits evoke a characteristic pattern of behavior that increases the probability of exposure to specific environments and life experiences (i.e., selection effects). Similarly, environmental factors act on personality traits through situational processes—through the filter of individual experiences (i.e., socialization effects).

The recently developed TESSERA framework on personality development in adulthood postulates that short-term personality-changing processes can be generalized as "recursive sequences of triggering situations, expectancy, states/state expressions, and reactions" (TESSERA; Wrzus & Roberts, 2017). Internal reflective or associative processes transform repeated TESSERA sequences into long-term personality development. Internal reflective processes may include self-reflection, accommodation, assimilation, life reflection, and self-narration. Internal associative processes may include implicit learning, reinforcement learning, or habit formation. The authors of the TESSERA framework explain age differences in personality development through variations in components and processes that occur due to physical, cognitive, social, and societal changes related to age.

4.2.3 Participation in leisure activities: A driver of personality development?

Based on the aforementioned theories, personality change may be triggered through bottom-up processes that are part of a person's daily leisure activities and experiences. In

addition, an individual's personality traits will impact the selection of situations, i.e., the type and frequency of leisure activities (Wrzus & Roberts, 2017).

According to the TESSERA framework, personality traits may change if the following short-term process is repeated: A certain leisure activity such as political engagement (a triggering situation) is perceived to be relevant to a trait such as extraversion (expectancy) and thus elicits a relevant state such as speaking in front of a crowd (states/state expression). This state level does not correspond to the actual trait level, e.g., low extraversion, and the reaction elicited is positive: The political talk is a success, and people are convinced (reaction). In the long run, reflective processes such as self-narration or associative processes such as habit formation may lead to higher extraversion in this example (Wrzus & Roberts, 2017). According to this theory, being active and involved in leisure activities may increase the number of potentially triggering situations and thus increase the probability of personality trait change.

4.2.4 What personality – leisure activity – transactions to expect?

Many leisure activities have a social component (Karp et al., 2006). The majority of research investigating the role of social engagement in personality development has focused on social network size (e.g., Lang, Staudinger, and Carstensen, 1998, Mund, Jeronimus, & Neyer, 2018) or social role status (e.g., Lodi-Smith & Roberts, 2012) but less on leisure behavior. Up to now, research on the relationship between personality and leisure activity has been rare. In line with Stephan et al. (2014), in the following we review earlier studies on this topic, broadly ordered by physical, social, and cognitive leisure activities. Some leisure activities may involve more than one of these domains: We summarize the evidence on this in the section "Other activities".

Overall participation in leisure activities

In a study on two adult lifespan samples from different western societies, Stephan et al. (2014) showed that individuals who scored higher on extraversion and openness were more likely to engage in a variety of types of leisure activities.

High extraversion has predicted not only a greater variety of leisure activities but also a higher frequency of overall participation in leisure activities (Brandstätter, 1994, Kirkcaldy& Furnham, 1991; Lu & Hu 2005; Speaks, 2013, Wagner, Ram, Smith, & Gerstorf, 2015). This may be due to higher sensation-seeking (Furnham, 2004) and to the social component of most leisure activities, which may attract extraverted people (Stephan, Boiché, Canada, & Terracciano, 2014).

In contrast, high neuroticism has been shown to predict low participation in leisure activities (Kirkcaldy& Furnham, 1991, Speaks, 2013). However, there is also some evidence that neuroticism is not associated with recreational interest (Nias, 1985) or that it is only associated on a facet level (Barnett, 2013). Barnett (2013) found that low depression and high impulsivity were positively associated with the desire to seek intrinsic rewards through leisure activities.

In addition, people scoring higher on extraversion and openness to experience are more likely to search for new experiences, challenges, and skills; intrinsic rewards (laughing/having fun); social interactions; and active engagement in their free time compared to people scoring low on these traits. The search for challenges and interest in developing skills has also been predicted by higher conscientiousness (Barnett, 2013). People high in agreeableness, in contrast, have been shown to pursue leisure activities with the aims of relieving stress and feeling good (Barnett, 2013).

Physical activities

Cross-sectional research has found that physical activity is mainly positively correlated with extraversion (Egloff & Gruhn, 1996; Kirkcaldy & Furnham, 1991; Rhodes & Smith, 2006; Sale, Guppy & El-Sayed, 2000) and negatively correlated with neuroticism (Barnett, 2006; Rhodes & Smith, 2006, Speaks, 2013). There have been mixed results on the relationship between the level of involvement in leisure sports and conscientiousness (Barnett, 2006; Jopp & Hertzog, 2010, Rhodes & Smith, 2006), agreeableness (Jopp & Hertzog, 2010; Rhodes & Smith, 2006, Speaks, 2013), and openness to experience (Rhodes & Smith, 2006).

Longitudinal research has shown that personality and physical activity are interlinked. In one longitudinal study, more physically active individuals experienced lower declines in conscientiousness, extraversion, openness, and agreeableness over time (Stephan, Sutin, & Terracciano, 2014). Another longitudinal study testing bidirectional associations revealed that increasing conscientiousness and openness predicted subsequent increases in physical activity, whereas increasing agreeableness predicted subsequent decreases in physical activity (Allen, Magee, Vella, & Laborde, 2017). Allen et al. (2017) concluded that personality is important for changes in physical activity, but physical activity has virtually no effect on changes in personality.

Social activities

In past research, social leisure activities were predominantly correlated with extraversion (Stephan, Boiché, Canada, & Terracciano, 2014). Using time-sampling diaries,

Brandstätter (1994) found that extraverts preferred high-stimulation social situations. Social leisure activities can be subdivided into "private" and "public" socializing (Jopp & Hertzog, 2010).

Private socializing, which includes getting together with friends, relatives, and acquaintances, appears to be associated with higher extraversion (Jopp & Hertzog, 2010; Nias,1985, Speaks, 2013). Also, high agreeableness was predictive of the desire for social interactions (Barnett, 2013) and actual socializing (Speaks, 2013) in leisure time.

Public socializing may include engagement in political activities, giving public talks, volunteering, and attending club meetings. Similar to private socializing, public socializing appears to be positively associated with both agreeableness (Barnett, 2013; Carlo, Okun, Knight, & de Guzman, 2005; Jopp & Hertzog, 2010; Penner, 2002; Speaks, 2013) and extraversion (Carlo, Okun, Knight, & de Guzman, 2005; Speaks, 2013; Penner, 2002). Some cross-sectional studies have suggested a positive association between community involvement and conscientiousness (Lodi-Smith & Roberts, 2007; Speaks, 2013); others have not (Carlo, Okun, Knight, & de Guzman, 2005). Results are also mixed for openness (Carlo, Okun, Knight, & de Guzman, 2005; Speaks, 2013). Previous research has shown no relationship between volunteering and neuroticism (Carlo, Okun, Knight, & de Guzman, 2005; Lodi-Smith & Roberts, 2007).

Cognitive leisure activities

Cognitive activities are often differentiated into developmental activities (e.g., reading, writing, going to movies, or attending public lectures) and gaming activities (e.g., doing crosswords or puzzles or playing Scrabble) (Jopp & Hertzog, 2007, 2010; Stephan, Boiché, Canada, & Terracciano, 2014). Most studies have shown positive correlations with the trait of openness to experience.

Research has produced partially contradictory findings on the connection between gaming and personality. In one study, gaming activities were found to be positively associated with openness to experience (Jopp & Hertzog, 2010), whereas other studies have found no significant effects on any personality trait (Stephan, Boiché, Canada, & Terracciano, 2014) and some have even found negative associations with extraversion and neuroticism (Kirkcaldy &Furnham, 1991). Engaging in developmental cognitive activities, such as reading, was consistently related to higher openness to experience (Jopp and Hertzog, 2010; Speaks, 2013; Stephan, Boiché, Canada, & Terracciano, 2014).

Other activities

Leisure activities such as artistic and musical activities, crafts, computer use, watching television, and travel do not fit clearly into the aforementioned physical, social, and cognitive domains. Nevertheless, previous studies have linked these activities as well to personality traits.

Artistic activities in areas such as cultural arts, arts and crafts, and dancing were positively correlated with openness to experience (Speaks, 2013). Similarly, increases in cultural activity such as going to the theater precipitated increases in openness and vice versa. These culture-openness transactions held across different age and education groups and when controlling for household income (Schwaba, Luhmann, Denissen, Chung, & Bleidorn, 2018). Likewise, research has found that students who enjoy listening to music and attending concerts are high in openness to experience (Barnett, 2006). Further, technology use (i.e., using a computer) and playing an instrument were also positively correlated with openness, and watching television was negatively related to openness to experience (Jopp & Hertzog, 2010). Kirkcaldy and Furnham (1991) found that arts and handicrafts such as painting, drama, and pottery were positively correlated with extraversion, but they did not examine openness.

To our knowledge, there is no research on the associations between personality traits and more modern leisure activities such as going out to restaurants, bars, and movies. These kinds of activities may combine cognitive, social, and physical activity components.

4.2.5 Summary of theory and evidence

Past research has found mean-level change (e.g., Hopwood & Bleidorn, 2018), some rank-order instability (e.g., Damian, Spengler, Sutu, & Roberts, 2019), and individual differences (e.g., Schwaba & Bleidorn, 2018) in personality across the lifespan. Recurrent short-term changes in behavior and experiences in daily life may drive long-term changes in personality traits. In turn, personality traits may evoke a characteristic pattern of (leisure) behavior (e.g., Roberts, 2018; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017).

The existing body of mainly cross-sectional studies suggests positive associations between participation in different leisure activities with extraversion and openness to experience. Additionally, in some studies, physical activities were associated with higher conscientiousness and lower agreeableness. Further, social activities were associated with higher agreeableness and cognitive activities with higher openness.

However, a systematic understanding of whether and how participation in leisure activities contributes to personality change and vice versa is still lacking. To come closer to identifying the underlying mechanisms of personality change, we must investigate how changes in individuals' behavior and experiences (e.g., leisure activities) affect their future personality. Comparing personality changes in people who are more active in their leisure time with those who are less active would not allow such causal conclusions. To gain valid insights about prospective effects between personality and leisure activities, we must distinguish between-person and within-person variance in longitudinal data.

4.2.6 Current study

The objective of this research was to examine whether leisure activities are drivers of personality development. More specifically, we aimed to examine the extent to which within-person changes in overall participation in leisure activities and participation in specific leisure activities lead to prospective changes in an individual's Big Five personality traits, and whether changes in personality elicit prospective changes in a person's leisure activities.

This study was based on longitudinal analyses using random-intercept cross-lagged panel models (Hamaker, Kuiper, Grasman, 2015). The data came from a large and nationally representative household panel study from Germany, surveying more than 55,000 adults (SOEP). All Big Five personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) and the self-reported frequency of different leisure activities were assessed in 2005, 2009, 2013, and 2017.

First, we investigated the effect of changes in *overall participation in leisure activities* (sum score across all activities) on personality development and vice versa. We hypothesized that there are positive within-person transactions between openness to experience and extraversion, on the one hand, and overall participation in leisure activities, on the other. This is an advance on past research, which investigated between-person effects only. Further, we investigated these transactions for six different specific leisure activities*:*

Second, we examined the transactions between *physical activities*, (i.e., playing sports) and personality development. In line with aforementioned research, we expected unidirectional positive cross-lagged effects of conscientiousness and openness, and negative cross-lagged effects of agreeableness on physical activities.

Third, we examined the transactions between *socializing* (e.g., meeting friends, relatives, acquaintances, or neighbors) and personality development. The evidence from

cross-sectional data presented above suggests that an increased frequency of private socializing may result in increasing extraversion and agreeableness and vice versa.

Fourth, we examined the transactions between *volunteering* (e.g., volunteer work in clubs, associations, or community organizations) and personality development. Increases in volunteering may trigger increases in the traits of extraversion and agreeableness and vice versa.

Fifth, we examined the transactions between *political activities* (e.g., participation in citizens' initiatives, political parties, and local politics) and personality development. Increases in political activities may trigger an increase in the traits of extraversion and agreeableness and vice versa.

Sixth, we investigated the transactions between *artistic and musical activities* (e.g., making music, dancing, doing theater, painting, photography) and personality development. Considering earlier research, we expected that increases in the frequency of artistic and musical activities may trigger increases in openness and vice versa.

Seventh, we investigated the transactions between activities such as going to movies, restaurants, concerts, dancing, and attending sporting events, to which we refer as *going-out activities*, and personality development. Considering earlier research, we expected that an increased frequency of going-out activities may trigger an increase in extraversion and openness to experience and vice versa.

Using a random-intercept cross-lagged panel model (RI-CLPM), we disentangled between-person and within-person effects to reveal the within-person longitudinal relationship between participation in leisure activities and personality development. The outcomes of this study provide evidence that can be used to evaluate recently proposed models of personality stability and change.

4.3 Method

4.3.1 Participants and procedure

The data used in this study came from the German Socio-Economic Panel Study (SOEP; data from 1984–2017; Version 34, 2019), based at the German Institute for Economic Research (DIW Berlin). The SOEP started in 1984 and is a large, ongoing survey of private households in Germany, and includes all household members. Households were initially chosen using a multistage random sampling technique with regional clustering. Refresher samples have been added periodically to maintain the representativeness of the data and to increase the sample size. Further, new household members (e.g., adult children or new

partners) are regularly invited to join the study and are interviewed annually as well. Individuals are followed even in cases of relocation or a split of a household. For detailed information about the participants, design, subsamples, variables, and assessment procedures, see Goebel et al. (2019). We have included every subsample and refresher sample (A-M) in the SOEP. Attrition in the SOEP was below 5% yearly across various subsamples for waves 1984 to 2016 (Kroh, Kühne, Siegers, & Belcheva, 2018). We included all individuals who were born between 1930 and 1987, i.e., who were between 18 and 75 years of age at T1 in 2005. The maximum number of observations used was N = 43.651.

4.3.2 Age groups

For additional analysis, we generated age groups of approximately equal size: Group 1, *young adults* (*M* = 24.1, min = 18, max = 30 years old at T1, i.e. in 2005; born 1975–1987; N = 17151); Group 2, *middle-aged adults* (*M* = 39.6, min = 31, max = 50 years old at T1; born 1955–1974; N = 24546), and Group 3, *older adults* (*M* = 61.3, min = 51, max = 75 years old at T1; born 1930–1954; N = 14093). For descriptive statistics based on these age groups, in 2005, please see Supplement S1.

4.3.3 Measures

Big Five

The Big Five personality traits were measured four times, first in 2005 and then again in 2009, 2013, and 2017, using the BFI-S (Gerlitz & Schupp, 2005; Hahn, Gottschling, & Spinath, 2012), which is a short version of the BFI (John, Donahue, & Kentle, 1991; see also John, Naumann, & Soto, 2008, and Lang, Lüdtke, & Asendorpf, 2001, for further information on the scale, the German translation, and evidence on its reliability and validity). The BFI-S contains 15 items, and participants were asked to indicate their agreement on a scale ranging from 1 (does not describe me at all) to 7 (describes me perfectly).

Leisure activities

Leisure activities were measured by asking participants how often respondents spend time on a range of specific leisure activities. These were assessed in 2005, 2009, 2013, and 2017. Participants were asked to answer the question: “Which of the following activities do you take part in during your free time? Please check off how often you do each activity: at

least once a week (1), at least once a month (2), less often (3), never (4).[6] Items were reverse-coded so that higher values express a greater frequency. We used six items[7]: "Doing sports yourself", "Meeting with friends, relatives, or neighbors", "Volunteer work in clubs or social services", "Involvement in a citizens' group, political party, local government", "Artistic and musical activities (playing music, singing, dancing, acting, painting, photography)", and "Going to the movies, pop music concerts, dancing, disco, sports events".[8] To measure the level of overall participation, we summed up the frequency scores of all six leisure activities to obtain an index with higher scores indicating higher overall participation in leisure activities (see Gerstorf et al., 2016).

4.3.4 Statistical model

To examine the interdependency between the Big Five personality traits and different leisure activities, we estimated a random-intercept cross-lagged panel model (RI-CLPM), which was first proposed by Hamaker et al. (2015). Our model is depicted in Figure 4.1.

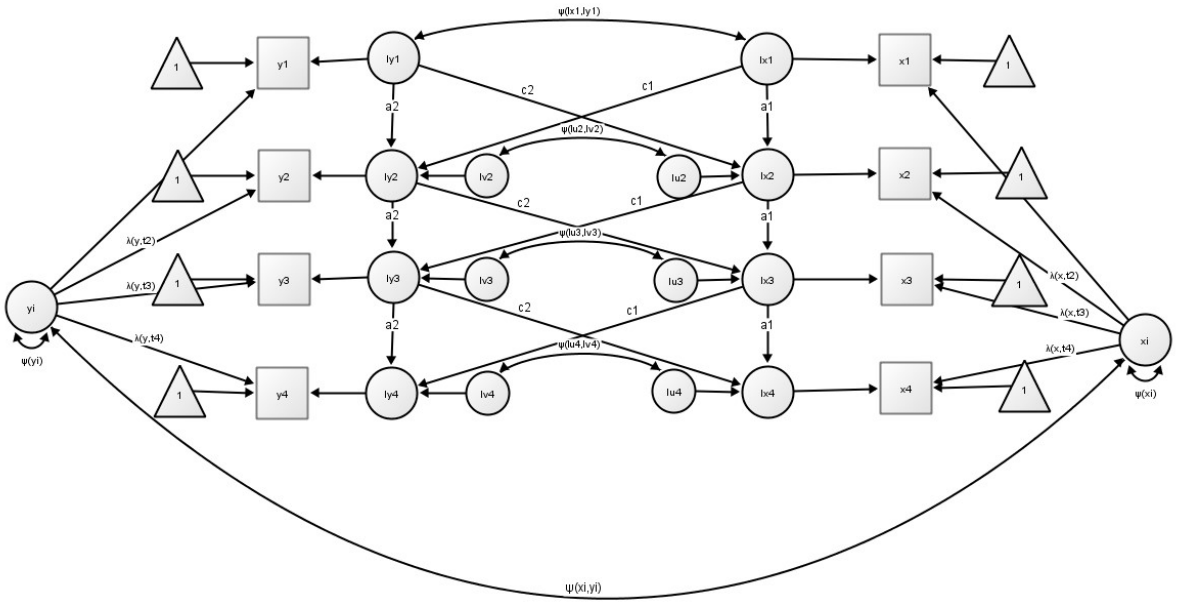

Figure 4.1 Random-intercept cross-lagged panel model (RI-CLPM) in this study.
xi, yi = random intercepts; λx_t, λy_t = time-varying factor loadings; $\psi(x_i)$, $\psi(y_i)$ = variance of the random intercepts; ψ (x_i, y_i) = covariance of the random intercepts; x, y = variables; ly, lx = phantom latent variables; $\psi(lv_i, lu_i)$ = covariance of the phantom variables; a1, a2 = autoregressive paths; c1, c2 = cross-lagged paths

[6] In 2013 answering format differed from 2005, 2009 and 2017: 1= daily, 2 = every week, 3 = at least once a month, 4 = seldom, 5 = never; for better comparability to other waves, we collapsed "daily" and "every week" to "at least once a week".
[7] We had to exclude the item "Going to cultural events such as concerts, theater, lectures, etc.", due to differing included activities in 2013 and therefore significant mean difference compared to 2005, 2009 and 2017.
[8] In wave 2013, "sporting events" was a separate item; for better comparability to other waves we collapsed this into our category "going-out activities".

For analysis, we used the package lavaan (Rosseel, 2012) in the open-source software R, version 4.0.2. Missing data were handled using full information maximum likelihood estimation. For model estimation, we standardized personality and leisure activity scores to a mean of zero and a standard deviation of one across all waves.

RI-CLPM: Distinguishing between-person from within-person effects.

The RI-CLPM model offers some advantages over the traditional cross-lagged panel model (Finkel, 1995; see also Mund & Nestler, 2019, or Orth, Clark, Donnellan & Robins, 2020, for more statistical reasoning and model comparison). Most importantly, the model allows us to distinguish between within-person and between-person effects (Allison, 2009). This distinction is achieved by allowing individuals to vary around their own trait-like mean over time instead of fluctuating around a common group mean (Mund & Nestler, 2019). Thus, we control for stable differences between individuals (also called unit effects). Between-person effects are modeled by adding a latent (random) intercept (xi, yi) for each of the respective constructs. To hold the random intercepts constant, it is important to also estimate their variance ($\psi(x_i)$, $\psi(y_i)$) and covariance (ψ (x_i,y_i)) (Hamaker, Kuiper, & Grasman, 2015). This covariance then reflects how stable between-person differences in one construct are in relation to between-person differences in the other construct. Thus, the RI-CLPM controls for stable differences due, for example, to gender or other relatively stable characteristics that make individuals systematically different over time. Estimated auto-regressive (AR) and cross-lagged (CL) terms are therefore no longer confounded by stable between-person differences.

We slightly adjusted the way the random intercept is implemented compared to the originally proposed model. Hamaker et al. (2015) expected the unit effects to be stable differences over time, expressed by fixed factor loadings (λ=1). Since we analyzed a prolonged time frame, we assume that unit effects characteristics, or how they are expressed, do in fact change over time (Zyphur et al., 2020). We therefore decided to include time-varying factor loadings (λx_t, λy_t) to allow unit effects to affect the observed variables differently on each occasion of measurement.[9] This improved the model fit significantly. Consequently, the random intercept factor captures possible confounders, thus, potentially changing between-person differences such as household income.

[9] The comparison of time-invariant and time-varying unit effect models showed that the within-person cross-lagged terms and correlated change effects generally do not differ. The within-person auto-regressive terms are slightly larger in the more restricted models. But there was no relevant difference in the significance of the parameters. For full results on restricted versus unrestricted factor loadings of unit effects, please see R scripts and outputs on OSF: https://osf.io/fdxzp/?view_only=eaffa966ffe14e7c8a4ccb5ace76ace6.

In addition, our model includes a mean structure with observed variable intercepts to account for epoch effects, i.e., overall changes in the sample across occasions (Zyphur et al., 2020).

Interpretation of RI-CLPM

Within-person AR (a1, a2) and CL (c1, c2) terms in the RI-CLPM properly reflect how a deviation from the individual's own mean in one variable is predicted by a random, unpredicted change on the previous occasion. To be more precise, the estimated AR terms in the RI-CLPM reflect how much of a deviation from the individual's mean in a leisure activity (a1) or personality trait (a2) on one occasion persists on the next occasion.

The c1 terms represent the estimated change in the individual's personality trait due to an unexpected change in an individual's leisure activity on the previous occasion. The c2 terms represent the estimated change in the individual's leisure activity due to an unexpected change in a personality trait on the previous occasion. Unexpected change in this instance means that this change was not predicted by the underlying statistical model and thus occurs as a shock or disturbance to the system. However, it is important to note that in the RI-CLPM, cross-lagged effects capture only temporary effects of one construct on the other. In this paper, we refer to these as "short-term boosts" even though they occur at four-year intervals. The RI-CLPM cannot detect sustained prospective effects over multiple time points, which can be seen as a flaw of this model (see Orth, Clark, Donnellan & Robins, 2020).

The covariance of the phantom variables at each measurement occasion (ψ(lvi, lui)) shows whether temporary deviations from a person's leisure activities score are associated with simultaneous temporary deviations from their personality trait score. We call this covariance "within-person correlated change effects" in the following.

Granger-Sims causality tests

For hypothesis testing, we used Granger-Sims causality tests (Ganger, 1969; Sims, 1980) as proposed by Zyphur et al. (2020). For these, we first fitted our full RI-CLPM and then restricted different paths to zero while comparing model fit. Whenever the more restricted model fits were worse than the full model, this implied that the restricted paths significantly improve the model when freely estimated (Mulder & Hamaker, 2020). In addition, Granger-Sims causality tests allow us to test for feedback effects (i.e., bidirectional causality) by restricting both CL paths to zero and then comparing model fit to the full model (Zyphur et al., 2020).

Moderation effects of age groups in RI-CLPM

Subsequently we expanded the RI-CPLM by adding the categorical age grouping variable to the model. Age group differences were investigated by comparing a multiple group version of the RI-CLPM in which there are no constraints across the age groups with a model in which the lagged regression coefficients are constrained to be identical across the groups (see Mulder & Hamaker, 2020). We therefore know from chi-square difference tests whether there is a moderation effect of age group or not. To keep the number of models at a presentable and parsimonious level, we decided to test only whether the full model would show differences between the age groups and present the results in the supplemental materials S1 and S3-S9 only. To facilitate replicability, we provide the complete syntax on https://osf.io/fdxzp/?view_only=eaffa966ffe14e7c8a4ccb5ace76ace6

4.4 Results

We present means, standard deviations, minimums, and maximums of all study variables across waves in Table 4.1 and by age groups in Supplement 1 (S1). Zero-order stabilities of leisure activities, that is, the correlation of one measurement occasion with the following, vary around r = .50, ranging between r = .42 for socializing across waves and r = .60 for physical activity across waves. For comparison: The zero-order stability of the Big Five personality traits ranges between r = .53 and r = .69. The strongest correlation between leisure activities was observed between physical activities and going-out activities (r = .40 at t1). The weakest association was found for political activities and socializing (r = 0.03 at t1). Intercorrelations among all leisure activities and Big Five personality traits over four waves can be found in the supplemental materials (S2). Of the Big Five trait domains, openness had the strongest concurrent associations with overall participation in leisure activities (*rs of* .22 −.28).

Table 4.1 Descriptive statistics of Leisure Activities and Personality

	2005					2009					2013					2017				
	N	Min	Max	*M*	*SD*	N	Min	Max	*M*	*SD*	N	Min	Max	*M*	*SD*	N	Min	Max	*M*	*SD*
Age	55790	18	75	40.34	14.88	55790	22	79	44.34	14.88	55790	26	83	48.34	14.88	55790	30	87	52.34	14.88
Big 5 Traits																				
Openness	19196	1	7	4.52	1.20	18380	1	7	4.64	1.10	16618	1	7	4.81	1.06	23662	1	7	4.95	1.09
Conscientiousness	19233	1	7	5.92	0.92	18437	1	7	5.86	0.92	16697	1	7	5.89	.89	23868	1	7	5.87	.91
Extraversion	19304	1	7	4.84	1.13	18459	1	7	4.77	1.14	16735	1	7	4.84	1.11	23901	1	7	4.94	1.13
Agreeableness	19290	1	7	5.44	.98	18481	1	7	5.33	.98	16733	1	7	5.40	.96	23937	1.33	7	5.48	.99
Neuroticism	19284	1	7	3.96	1.22	18502	1	7	3.83	1.22	16733	1	7	3.76	1.22	23965	1	7	3.76	1.24
Leisure Activities																				
Overall Participation	19095	6	24	12.11	3.22	18308	6	24	12.06	3.20	22422	6	24	12.60	3.31	22030	6	24	12.22	3.24
Physical A.	19346	1	4	2.37	1.29	18594	1	4	2.43	1.32	22677	1	4	2.64	1.36	22167	1	4	2.52	1.37
Social A.	19389	1	4	3.21	.81	18592	1	4	3.16	0.80	22695	1	4	3.11	.86	22202	1	4	3.15	.82
Volunteering A.	19360	1	4	1.61	.99	18556	1	4	1.60	1.02	22663	1	4	1.65	1.06	22156	1	4	1.67	1.06
Political A.	19335	1	4	1.15	.49	18539	1	4	1.12	.45	22647	1	4	1.16	.50	22139	1	4	1.13	.47
Artistic & Musical A.	19302	1	4	1.74	.96	18522	1	4	1.76	.96	22696	1	4	1.96	1.11	22158	1	4	1.79	1.05
Going Out A.	19377	1	4	2.05	.85	18603	1	4	1.96	.79	22651	1	4	2.08	.86	22196	1	4	1.96	.76

4.4.1 Attrition Analyses

In total, we used data from 55,790 individuals, 6,236 of whom (11.2%) provided data for all four waves between 2005 and 2017 (N_{2005} = 18,849; N_{2009}= 18,035; N_{2013} = 16,242; N_{2017}= 21,767). Mean-level comparisons indicated that the participants who completed all four waves were, on average, older in 2005 (M = 46.98 vs. M = 39.05, t (55.789) = -37.86, p < .001, d = 0.52), but were not different from non-completers with respect to gender (χ (1) = 1.075, p = .30). There were small but nevertheless significant differences between these two groups in personality traits in 2005: openness ($M_{\text{completers}}$ = 4.49 vs. $M_{\text{non-completers}}$ = 4.57; t(19194) = -4.38, p= 0.000, d = -.068), extraversion ($M_{\text{completers}}$ = 4.84 vs. $M_{\text{non-completers}}$ = 4.84; t(19302) = -0.33, p=0.37, d = -.005), agreeableness (M = 5.43 $_{\text{completers}}$ vs. $M_{\text{non-completers}}$ =5.44; t(19288) = -0.61, p= 0.27, d = -.009), conscientiousness ($M_{\text{completers}}$ = 5.90 vs. M = 5.95; t(19231) = -3.12, p< 0.001, d =-.048), neuroticism ($M_{\text{completers}}$ = 3.98 vs. $M_{\text{non-completers}}$ = 3.94; t(19282) = 2.07, p = 0.02 , d =.032). Overall participation in leisure activities was slightly higher in participants who completed all four waves ($M_{\text{completers}}$ = 51.24 vs. $M_{\text{non-completers}}$ = 49.98; t(19093) = -8.34, p= 0.000, d= -.128) compared to non-completers.

4.4.2 Random-Intercept Cross-lagged Panel Models

We tested the relations between leisure activities and Big Five personality traits based on RI-CLPMs, each in a separate model. Figure 1 provides a generic illustration of the bivariate RI-CLPMs. RI-CLPM explicitly models the stable between-person variance for each construct. Consequently, a within-person cross-lagged effect tests for the prospective effect of a random deviation from an individual's mean level of one construct at an early occasion on the deviation from the usual level of the other construct at a later occasion.

Overall Participation in Leisure Activities

Table 4.2 shows the standardized estimates, standard errors, and exact p values of the covariation of random intercepts and the within-person AR and CL paths. Further, model fit statistics and results of Granger-Sims causality tests are reported for the overall participation in leisure activities and all Big Five personality traits separately.

At the between-person level, individuals with a higher overall participation in leisure activities are considerably more open (ψ = .251, p < .001) and more extraverted (ψ =.132, p < .001), and less conscientious (ψ = -.032, p < .001) and less neurotic (ψ = -.120, p < .001) than individuals with lower overall participation. No significant covariance between the random intercept of overall participation and agreeableness was found.

At the within-person level, temporary deviations from a person's overall participation score are positively associated with simultaneous temporary deviations from their openness (*r*s of .029−.054, $p < .001$) and extraversion trait scores (*r*s of .020−.054, $p < .001$). Temporary deviations from a person's overall participation score were negatively associated with simultaneous temporary deviations from their neuroticism trait score at first and last measurement occasions only (*r*s of -.039 − -.018, $p < .001$). There were no simulations temporary deviations of overall participation in leisure activities with conscientiousness and agreeableness trait scores.

AR terms at the within-person level show higher stability for the overall volume of participation in leisure activities (βs of .192−.194) compared to personality traits (βs of .109−.134). This means that the persistence of a random deviation from an individual's mean from one occasion to the next is greater for overall participation than for personality traits.

An examination of CL paths shows that there are longitudinal within-person associations for overall participation and extraversion but not for other personality traits. Granger-Sims causality tests revealed that the model fit significantly deteriorates when constraining the cross-lagged path (c1) to extraversion ($\Delta\chi^2$ (1) = 6.626, $p < .05$), implying an overall participation → extraversion prospective effect (β =.024, $p < .05$). That is, a positive within-person deviation from a person's usual overall participation level leads to a prospective positive within-person deviation from the person's trait level in extraversion. Further, constraining all cross-lagged paths and comparing model fit to the full model ($\Delta\chi^2$ (2) = 6.887, $p < .05$) revealed feedback effects of extraversion and overall participation. This means that a short-term boost in extraversion or overall participation may impact extraversion or overall participation, or both, through reciprocal effects.

Adding an age group variable to the model reveals that, at the within-person level, the CL path from overall participation to extraversion is significant for young adults (18−30 years) and older adults (51−75 years), but not for middle-aged adults (31−50 years). In contrast, for middle-aged adults, a prospective within-person effect is only significant in the opposite direction, from extraversion to overall participation. At the between-person level, adding an age group variable reveals a significant positive covariance of overall participation in leisure activities and agreeableness. That is, people with higher levels of overall leisure activities are more agreeable than people who are less active (see Supplement S3 for details).

Table 4.2 Overall Participation (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43543			N = 43619			N = 43592			N = 43639			N = 43651		
Model parameters	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Auto-regressive terms															
a1 (LA)	**0.193**	0.012	0.000***	**0.193**	0.012	0.000***	**0.194**	0.012	0.000***	**0.192**	0.012	0.000***	**0.193**	0.012	0.000***
a2 (P)	**0.122**	0.011	0.000***	**0.134**	0.012	0.000***	**0.114**	0.011	0.000***	**0.109**	0.011	0.000***	**0.122**	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	0.005	0.010	0.575	0.004	0.010	0.703	**0.024**	0.009	0.010*	-0.008	0.010	0.431	-0.005	0.010	0.629
c2 (P → LA)	0.004	0.008	0.604	0.000	0.008	0.970	0.014	0.008	0.097	0.007	0.007	0.338	-0.006	0.008	0.411
Covariances															
Random intercepts ψ(Xi,Yi)	**0.251**	0.006	0.000***	**-0.032**	0.006	0.000***	**0.132**	0.006	0.000***	0.008	0.006	0.168	**-0.120**	0.006	0.000***
Corr. change ψ(lv_1, lu_1)	**0.054**	0.006	0.000***	-0.011	0.006	0.061	**0.054**	0.006	0.000***	-0.008	0.006	0.171	**-0.039**	0.006	0.000***
Corr. change ψ(lv_2, lu_2)	**0.032**	0.005	0.000***	0.009	0.005	0.099	**0.029**	0.005	0.000***	0.007	0.005	0.189	-0.001	0.005	0.881
Corr. change ψ(lv_3, lu_3)	**0.029**	0.005	0.000***	-0.008	0.006	0.130	**0.024**	0.005	0.000***	-0.003	0.006	0.556	-0.007	0.005	0.167
Corr. change ψ(lv_4, lu_4)	**0.038**	0.005	0.000***	0.013	0.005	0.008	**0.020**	0.005	0.000***	0.007	0.005	0.190	**-0.018**	0.005	0.000***
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	52.323	(11)		71.139	(11)		71.086	(11)		43.128	(11)		41.005	(11)	
CFI / TLI	0.999	0.998		0.999	0.996		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.008		0.011	0.010		0.011	0.009		0.008	0.007		0.008	0.006	
AIC / BIC	403018	403304		413371	413657		404935	405222		414354	414640		409439	409725	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	52.638	(12)		71.285	(12)		77.712	(12)		43.748	(12)		41.239	(12)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.008		0.011	0.010		0.011	0.009		0.008	0.007		0.008	0.006	
AIC / BIC	403016	403294		413368	413646		404941	405218		414353	414631		409437	409715	
χ^2 Difference Test ($diff_{df}$) p	0.314	(1)	0.575	0.146	(1)	0.703	**6.626**	(1)	0.010*	0.620	(1)	0.431	0.233	(1)	0.629

Step 3: Constrain P → LA (c2)															
χ^2 (df)	52.592	(12)		71.141	(12)		73.839	(12)		44.048	(12)		41.681	(12)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.008		0.011	0.010		0.011	0.009		0.008	0.007		0.008	0.006	
AIC / BIC	403016	403294		413368	413646		404937	405215		414353	414631		409437	409715	
χ^2 Difference Test ($diff_{df}$) p	0.269	(1)	0.604	0.001	(1)	0.970	2.753	(1)	0.097	0.921	(1)	0.337	0.676	(1)	0.411
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	52.721	(13)		71.353	(13)		77.973	(13)		46.102	(13)		41.691	(13)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.008	0.008		0.011	0.010		0.011	0.009		0.008	0.007		0.008	0.006	
AIC / BIC	403014	403283		413366	413635		404939	405208		414353	414622		409435	409704	
χ^2 Difference Test ($diff_{df}$) p	0.398	(2)	0.820	0.214	(2)	0.899	**6.887**	(2)	0.032*	2.974	(2)	0.226	0.452	(2)	0.501

Note. P = personality; LA = leisure activity; SE = standard errors; Corr. change = within-person correlated change; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

Physical Activities

Standardized estimates, standard errors, and exact *p*-values of the RI-CLPM and Granger-Sims causality tests for physical activity and personality traits are presented in Table 4.3.

At the between-person level, individuals with higher physical activity in their leisure time are more open (ψ =.146, $p < .001$) and more extraverted (ψ =.068, $p < .001$), slightly less agreeable (ψ = -.011, $p < .05$) and less neurotic (ψ = -.082, $p < .001$) than individuals with a lower level of physical activity. No significant covariance between the random intercept of physical activity and conscientiousness was found.

At the within-person level, temporary deviations from a person's physical activity score are positively associated with simultaneous temporary deviations from their openness (*r*s of .029 and .018, $p< .01$), conscientiousness (*r*s of .013 and .014, $p< .05$), and extraversions (*r*s of .025 and .014, $p< .001$) trait scores at two measurement occasions. Temporary deviations from a person's physical activity score were negatively associated with simultaneous temporary deviations from their neuroticism trait at the first and last measurement occasion only (*r*s of -.023 and-.016, $p< .001$). There were no simultaneous temporary deviations of physical activity and agreeableness trait scores.

AR terms at within-person level show higher stability for physical activity (*β*s of .152-.155) compared to personality traits (*β*s of .110-.134). That is, the persistence of a random deviation from the individual's average physical activity from one occasion to the next is greater for physical activity than for personality traits.

CL paths show that there are within-person longitudinal associations for physical activity and agreeableness, but not for other personality traits. Granger-Sims causality tests reveal that the model fit significantly deteriorates when constraining the cross-lagged path (c2) from agreeableness to physical activity ($\Delta\chi^2$ (1) = 8.778, $p < .01$), implying an agreeableness → physical activity prospective effect (β =.025, $p < .01$). Further, constraining all cross-lagged paths and comparing model fit to the full model ($\Delta\chi^2$ (2) = 8.969, $p < .05$) revealed feedback effects of agreeableness and physical activity. This means that a short-term boost in an individual's agreeableness or physical activity may impact one or both characteristics by way of reciprocal effects.

However, adding an age group variable shows that the within-person agreeableness → physical activity prospective effect is significant in the middle age group (31-50 years) only (see Supplement S4 for details).

Table 4.3 Physical Activities (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43563			N = 43644			N = 43609			N = 43657			N = 43667		
Model parameters	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Auto-regressive terms															
a1 (LA)	**0.152**	0.011	0.000***	**0.153**	0.011	0.000***	**0.155**	0.011	0.000***	**0.153**	0.011	0.000***	**0.154**	0.011	0.000***
a2 (P)	**0.121**	0.011	0.000***	**0.134**	0.012	0.000***	**0.116**	0.011	0.000***	**0.110**	0.011	0.000***	**0.121**	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	-0.001	0.008	0.852	0.009	0.009	0.320	0.008	0.008	0.279	0.009	0.009	0.311	0.000	0.008	0.989
c2 (P → LA)	-0.006	0.009	0.533	0.009	0.009	0.315	-0.003	0.010	0.785	**0.025**	0.008	0.003**	-0.009	0.009	0.322
Covariances															
Random intercepts ψ(Xi,Yi)	**0.146**	0.006	0.000***	-0.011	0.006	0.055	**0.068**	0.005	0.000***	**-0.011**	0.006	0.045*	**-0.082**	0.006	0.000***
Corr. change ψ(lv_1, lu_1)	**0.029**	0.006	0.000***	-0.002	0.006	0.745	**0.025**	0.006	0.000***	0.001	0.006	0.832	**-0.023**	0.006	0.000***
Corr. change ψ(lv_2, lu_2)	0.013	0.006	0.022	**0.013**	0.006	0.024*	**0.014**	0.005	0.009**	0.009	0.006	0.127	0.001	0.006	0.859
Corr. change ψ(lv_3, lu_3)	0.013	0.006	0.025	0.001	0.006	0.871	0.006	0.006	0.275	0.008	0.006	0.223	-0.007	0.006	0.255
Corr. change ψ(lv_4, lu_4)	**0.018**	0.005	0.001**	**0.014**	0.006	0.011*	0.002	0.005	0.691	0.006	0.006	0.249	**-0.016**	0.006	0.003**
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	46.763	(11)		53.933	(11)		66.981	(11)		26.807	(11)		41.850	(11)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.996		0.999	0.999		0.999	0.998	
RMSEA / SRMR	0.009	0.007		0.009	0.008		0.011	0.009		0.006	0.006		0.008	0.007	
AIC / BIC	418095	418381		425769	426055		418337	418624		426704	426991		422247	422533	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	46.798	(12)		54.923	(12)		68.151	(12)		27.832	(12)		41.850	(12)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.997		0.999	0.999		0.999	0.998	
RMSEA / SRMR	0.009	0.007		0.009	0.009		0.010	0.009		0.005	0.006		0.008	0.007	
AIC / BIC	418093	418371		425768	426046		418336	418614		426703	426981		422245	422523	
χ^2 Difference Test ($diff_{df}$) p	0.0348	(1)	0.852	0.990	(1)	0.320	1.170	(1)	0.279	1.025	(1)	0.311	0.000	(1)	0.989

Step 3: Constrain P → LA (c2)														
χ^2 (df)	47.151	(12)		54.944	(12)		67.055	(12)		35.586	(12)		42.829	(12)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.007		0.009	0.009		0.010	0.009		0.007	0.007		0.008	0.007	
AIC / BIC	418093	418371		425768	426046		418335	418613		426711	426989		422246	422524	
χ^2 Difference Test ($diff_{df}$) p	0.387	(1)	0.534	1.011	(1)	0.315	0.0745	(1)	0.785	**8.778**	(1)	0.003**	0.980	(1)	0.322
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	47.165	(13)		55.283	(13)		68.938	(13)		35.776	(13)		43.098	(13)	
CFI / TLI	0.999	0.998		0.999	0.997		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.007		0.009	0.009		0.010	0.009		0.006	0.007		0.007	0.007	
AIC / BIC	418091	418360		425766	426036		418335	418604		426709	426978		422244	422513	
χ^2 Difference Test ($diff_{df}$) p	0.402	(2)	0.818	1.350	(2)	0.509	1.957	(2)	0.376	**8.969**	(2)	0.011*	1.248	(2)	0.536

Note. P = personality; LA = leisure activity; SE = standard errors; Corr. change = within-person correlated change; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; Associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

Socializing

Results of the RI-CLPM and Granger-Sims Causality Tests for the association between private social activities, such as meeting family or friends, and personality traits are presented in Table 4.4.

At the between-person level, individuals with higher private social activity in their leisure time are more open (ψ = .098, p < .001), more extraverted (ψ =.140, p < .001), and more agreeable (ψ = .042, p < .001), but slightly less conscientious (ψ = -.015, p < .05) and less neurotic (ψ = -.071, p < .001) than individuals who socialize less.

At the within-person level, temporary deviations from a person's socializing score are positively associated with simultaneous temporary deviations from their openness (*r*s of .015−.036, p< .05), extraversion (*r*s of .044−.052, p< .01), and agreeableness (*r*s of .016−.022, p< .05) trait scores, at least at three of four measurement occasions. Temporary deviations from a person's socializing score were negatively associated with simultaneous temporary deviations from their neuroticism trait at three measurement occasions (*r*s of -.035, -.023 and -.016, p< .001). For simulations temporary deviations of socializing and conscientiousness trait scores, there were associations in both directions at different measurement occasions (*r*s of -.014, .017, and .034, p< .05).

At the within-person level, AR terms show lower stability for socializing (βs of .070-.075) compared to personality traits (βs of .109-.134). This means that the persistence of a random deviation from the individual's average social activity from one occasion to the next is smaller for socializing than for personality traits.

CL results show that there are within-person longitudinal associations of social activity with conscientiousness, neuroticism, and extraversion. Granger-Sims causality tests revealed that the model fit significantly deteriorates when constraining the cross-lagged path (c1) from social activity to conscientiousness ($\Delta\chi^2$ (1) = 4.090, p < .05), implying a positive socializing → conscientiousness prospective effect (β =.015, p < .05), but no significant feedback effects were found here. There is also a significant negative within-person CL effect (c2) from neuroticism → socializing ($\Delta\chi^2$ (1) = 6.666, p < .05; β = -.025, p < .05). Additionally, we find feedback effects of neuroticism and socializing. This means that a short-term individual boost in neuroticism or social activity may impact one or both characteristics by way of reciprocal effects ($\Delta\chi^2$ (1) = 10.777, p < .01). Regarding extraversion and socializing, there are significant CL effects in both directions and feedback effects. Constraining CL (c1) revealed a socializing → extraversion prospective effect ($\Delta\chi^2$ (1) = 18.101, p < .001; β =.028, p < .001). That is, change in a person's extraversion may be

due to an unexpected change in social activity on the previous occasion. The cross-lagged effect is even larger in the opposite direction (c2) from extraversion → socializing ($\Delta\chi^2$ (1) = 25.709, $p < .001$; $\beta = .053$, $p < .001$). Further, the test for feedback effects revealed a reciprocal within-person relationship between extraversion and private social activities ($\Delta\chi^2$ (1) = 10.777, $p < .01$).

Adding an age group variable to the model reveals that the within-person AR term for socializing is no longer significant in the oldest age group (51-75 years). This means that there is no persistence of a random deviation from the individual's average socializing on a previous occasion to the next occasion among older adults. However, there is a significant CL effect in the older age group from openness to socializing ($\beta = .038$, $p < .01$), which was not found in the whole sample or the younger age groups. Another finding, after adding age groups, is that the within-person cross-lagged effect from extraversion → socializing is smaller and not significant ($\beta = .027$, $p = .160$) for young adults (18-30 years). Similarly, for neuroticism, the negative within-person CL effect (c2) on socializing is still significant ($\beta = -.052$ $p < .001$) for the older age group (51-75 years) but not for young and middle-aged adults. The small between-person and within-person effects for socializing and conscientiousness do not hold when adding the age group variable. Please see Supplement S5 for details on results by age groups.

Table 4.4 Socializing (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43566			N = 43644			N = 43612			N = 43661			N = 43670		
Model parameters	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Auto-regressive terms															
a1 (LA)	**0.070**	0.010	0.000***	**0.075**	0.010	0.000***	**0.072**	0.010	0.000***	**0.073**	0.010	0.000***	**0.073**	0.010	0.000***
a2 (P)	**0.128**	0.011	0.000***	**0.134**	0.012	0.000***	**0.117**	0.011	0.000***	**0.109**	0.011	0.000***	**0.123**	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	-0.004	0.007	0.606	**0.015**	0.007	0.043*	**0.028**	0.007	0.000***	-0.003	0.007	0.731	0.005	0.007	0.519
c2 (P → LA)	0.015	0.010	0.127	-0.002	0.009	0.828	**0.053**	0.010	0.000***	0.004	0.009	0.650	**-0.025**	0.010	0.010*
Covariances															
Random intercepts ψ(Xi,Yi)	**0.098**	0.006	0.000***	**-0.015**	0.006	0.010*	**0.140**	0.006	0.000***	**0.042**	0.006	0.000***	**-0.071**	0.006	0.000***
Corr. change ψ(lv_1, lu_1)	**0.021**	0.006	0.001**	**-0.014**	0.007	0.028*	**0.044**	0.006	0.000***	-0.000	0.006	0.955	**-0.035**	0.006	0.000***
Corr. change ψ(lv_2, lu_2)	**0.015**	0.006	0.014*	**0.017**	0.006	0.007**	**0.045**	0.006	0.000***	**0.016**	0.006	0.014*	-0.012	0.006	0.052
Corr. change ψ(lv_3, lu_3)	**0.032**	0.006	0.000***	0.012	0.007	0.078	**0.052**	0.006	0.000***	**0.016**	0.007	0.018*	**-0.016**	0.006	0.012*
Corr. change ψ(lv_4, lu_4)	**0.036**	0.006	0.000***	**0.034**	0.006	0.000***	**0.046**	0.005	0.000***	**0.021**	0.006	0.001**	**-0.028**	0.006	0.000***
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	53.086	(11)		71.767	(11)		76.544	(11)		31.922	(11)		34.772	(11)	
CFI / TLI	0.999	0.996		0.997	0.994		0.998	0.995		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.009		0.011	0.011		0.012	0.011		0.007	0.006		0.007	0.007	
AIC / BIC	426261	426548		433321	433608		424239	424526		434131	434418		429820	430107	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	53.351	(12)		75.858	(12)		94.645	(12)		32.040	(12)		35.189	(12)	
CFI / TLI	0.999	0.997		0.997	0.994		0.998	0.994		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.009		0.011	0.011		0.013	0.012		0.006	0.006		0.007	0.007	
AIC / BIC	426260	426537		433323	433601		424256	424533		434129	434407		429819	430096	
χ^2 Difference Test ($diff_{df}$) p	0.266	(1)	0.606	**4.090**	(1)	0.043*	**18.101**	(1)	0.000 ***	0.119	(1)	0.731	0.416	(1)	0.519

Step 3: Constrain P → LA (c2)															
χ^2 (df)	55.419	(12)		71.814	(12)		102.253	(12)		32.127	(12)		41.438	(12)	
CFI / TLI	0.999	0.997		0.998	0.994		0.997	0.994		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.009		0.011	0.011		0.013	0.013		0.006	0.006		0.007	0.007	
AIC / BIC	426262	426539		433319	433597		424263	424541		434130	434407		429825	430103	
χ^2 Difference Test ($diff_{df}$) p	2.334	(1)	0.127	0.047	(1)	0.828	**25.709**	(1)	0.000 ***	0.205	(1)	0.651	**6.666**	(1)	0.010*
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	57.255	(13)		77.533	(13)		107.338	(13)		32.504	(13)		45.549	(13)	
CFI / TLI	0.999	0.997		0.997	0.994		0.997	0.994		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.009	0.010		0.011	0.011		0.013	0.013		0.006	0.006		0.008	0.008	
AIC / BIC	426261	426531		433323	433592		424266	424535		434128	434397		429827	430096	
χ^2 Difference Test ($diff_{df}$) p	4.170	(2)	0.124	5.766	(2)	0.056	**30.794**	(2)	0.000 ***	0.583	(2)	0.747	**10.777**	(2)	0.005**

Note. P = personality; LA = leisure activity; SE = standard errors; Corr. change = within-person correlated change; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; Associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

Volunteering

Results of the RI-CLPM and Granger-Sims causality tests for the association between volunteer activities, such as volunteer work in clubs, associations, or community organizations and Big Five personality traits are presented in Table 4.5.

At the between-person level, individuals who volunteer more often in their leisure time are more open (ψ = .082, p < .001), more extraverted (ψ =.045, p < .001), and less neurotic (ψ = -.057, p < .001) than individuals who volunteer less.

At the within-person level, temporary deviations from a person's volunteering score are positively associated with simultaneous temporary deviations from their openness (*r*s of .015 − .026, p< .05) and extraversion (*r*s of .013 − .035, p< .01) trait scores at three measurement occasions. Temporary deviations from a person's volunteering score were negatively associated with simultaneous temporary deviations from their agreeableness (*r*s of -.018 and -.013, p< .05) and neuroticism (*r*s of -.016 and -.011, p< .05) trait scores at first and last measurement occasion only. There were no simulations temporary deviations of volunteering and conscientiousness trait scores.

At the within-person level, AR terms show higher stability for volunteering (βs of .219-.221) compared to personality traits (βs of .108-.133). That is, a random deviation from the individual's mean volunteer activity from one occasion to the next is more persistent than the within-person change in Big Five personality traits. Granger-Sims causality tests revealed that the model fit decreases significantly when constraining the CL path (c1) from volunteering to agreeableness ($\Delta\chi^2$ (1) = 4.687, p < .05), implying a small negative CL effect of volunteering → agreeableness (β =-.020, p < .05). No significant feedback effects are found.

However, adding an age group variable to the model reveals that this negative volunteering → agreeableness CL effect (c1) is insignificant (β =-.021, p = .061) in the middle age group (31-50 years). Just as large, but significant in this middle age group is the negative conscientiousness → volunteering CL effect (β =-.021, p < .05), which was not visible in the basic model. Further, on the within-person level, in the young (18-30 years) and older (51-75 years) age groups there are significant prospective effects (c1) from volunteering to extraversion (βs =.021, p < .05), but not in the middle age group (see Supplement S6).

Table 4.5 Volunteering Activities (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43554			N = 43634			N = 43604			N = 43652			N = 43661		
Model parameters	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Auto-regressive terms															
a1 (LA)	**0.220**	0.013	0.000***	**0.220**	0.013	0.000***	**0.221**	0.013	0.000***	**0.219**	0.013	0.000***	**0.219**	0.013	0.000***
a2 (P)	**0.124**	0.011	0.000***	**0.133**	0.011	0.000***	**0.117**	0.011	0.000***	**0.108**	0.011	0.000***	**0.123**	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	0.005	0.008	0.539	-0.014	0.009	0.111	0.014	0.008	0.074	**-0.020**	0.009	0.030*	-0.004	0.008	0.634
c2 (P → A)	0.006	0.009	0.526	-0.012	0.008	0.146	0.006	0.010	0.531	-0.009	0.008	0.292	0.002	0.009	0.859
Covariances															
Random intercepts ψ(Xi,Yi)	**0.082**	0.006	0.000***	-0.006	0.006	0.295	**0.045**	0.006	0.000***	0.002	0.006	0.777	**-0.067**	0.006	0.000***
Corr. change ψ(lv_1, lu_1)	**0.026**	0.006	0.000***	0.010	0.007	0.125	**0.035**	0.006	0.000***	**-0.018**	0.006	0.004**	**-0.016**	0.006	0.009**
Corr. change ψ(lv_2, lu_2)	**0.017**	0.006	0.002**	-0.005	0.006	0.430	**0.015**	0.006	0.009**	-0.002	0.006	0.773	0.001	0.006	0.802
Corr. change ψ(lv_3, lu_3)	0.010	0.006	0.078	-0.010	0.006	0.089	0.003	0.005	0.588	-0.006	0.006	0.332	-0.006	0.006	0.296
Corr. change ψ(lv_4, lu_4)	**0.015**	0.005	0.003**	-0.005	0.005	0.333	**0.013**	0.005	0.007**	**-0.013**	0.005	0.020*	**-0.011**	0.005	0.031*
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	23.992	(11)		31.502	(11)		48.242	(11)		34.466	(11)		22.480	(11)	
CFI / TLI	1.000	0.999		0.999	0.998		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.005	0.006		0.007	0.005		0.009	0.006		0.007	0.007		0.005	0.005	
AIC / BIC	416305	416592		423078	423364		415772	416059		424012	424298		419739	420026	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	24.369	(12)		34.042	(12)		51.425	(12)		39.153	(12)		22.707	(12)	
CFI / TLI	1.000	0.999		0.999	0.998		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.005	0.006		0.006	0.006		0.009	0.007		0.007	0.007		0.005	0.005	
AIC / BIC	416304	416581		423078	423356		415774	416051		424015	424292		419737	420015	
χ^2 Difference Test ($diff_{df}$) p	0.377	(1)	0.540	2.540	(1)	0.111	3.183	(1)	0.074	**4.687**	(1)	0.030*	0.227	(1)	0.634

Step 3: Constrain P → LA (c2)															
χ^2 (df)	24.394	(12)		33.612	(12)		48.635	(12)		35.577	(12)		22.512	(12)	
CFI / TLI	1.000	0.999		0.999	0.999		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.005	0.006		0.006	0.006		0.008	0.006		0.007	0.006		0.005	0.004	
AIC / BIC	416304	416581		423078	423356		415771	416049		424011	424289		419737	420015	
χ^2 Difference Test ($diff_{df}$) p	0.402	(1)	0.526	2.110	(1)	0.146	0.393	(1)	0.531	1.111	(1)	0.292	0.032	(1)	0.859
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	24.505	(13)		34.567	(13)		51.539	(13)		39.160	(13)		22.956	(13)	
CFI / TLI	1.000	0.999		0.999	0.999		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.005	0.006		0.006	0.006		0.008	0.007		0.007	0.007		0.004	0.005	
AIC / BIC	416302	416571		423077	423346		415772	416041		424013	424282		419735	420005	
χ^2 Difference Test ($diff_{df}$) p	0.512	(2)	0.774	3.065	(2)	0.216	3.297	(2)	0.192	46.942	(2)	0.096	0.476	(2)	0.788

Note. P = personality; LA = leisure activity; SE = standard errors; Corr. change = within-person correlated change; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; Associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

Political Activities

Table 4.6 shows the standardized estimates, standard errors, and exact p values of the covariation of random intercepts and the within-person AR and CL paths for political activities in leisure time and all Big Five personality traits. Again, model fit statistics and results of Granger-Sims causality tests are reported.

At the between-person level, individuals engaged in political activities in their leisure time are more open (ψ = .078, p < .001), more extraverted (ψ =.038, p < .001), less agreeable (ψ = -.023, p < .001), and less neurotic (ψ = -.041, p < .001) than individuals who were involved less in political activities.

At the within-person level, temporary deviations from a person's political activity score are positively associated with simultaneous temporary deviations from their openness (r = .016, p< .05), conscientiousness (r = .026, p< .001), and extraversions (r = .015, p< .05) trait scores at the first measurement occasions. Temporary deviations from a person's political activity score were negatively associated with simultaneous temporary deviations from their neuroticism trait score (r = -.026, p< .001) at the first measurement occasion and from their conscientiousness trait score (rs of -.011 and -.018, p< .05) at the third and fourth measurement occasions.

At the within-person level, AR terms show higher stability for political activity (βs of .186-.187) compared to personality traits (βs of .108-.134).

We found no within-person CL effects or feedback effects of political activities and Big Five personality traits.

Adding an age group variable to the model does not lead to different results (see Supplement S7).

Table 4.6 Political Activities (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43554			N = 43631			N = 43603			N = 43650			N = 43660		
Model parameters	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Auto-regressive terms															
a1 (LA)	**0.187**	0.011	0.000***	**0.187**	0.011	0.000***	**0.186**	0.011	0.000***	**0.186**	0.011	0.000***	**0.187**	0.011	0.000***
a2 (P)	**0.125**	0.011	0.000***	**0.134**	0.012	0.000***	**0.117**	0.011	0.000***	**0.109**	0.011	0.000***	**0.123**	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	-0.002	0.007	0.803	-0.001	0.008	0.899	-0.010	0.007	0.154	0.002	0.008	0.798	-0.011	0.008	0.160
c2 (P → LA)	-0.003	0.010	0.725	-0.006	0.009	0.488	-0.006	0.010	0.516	0.005	0.009	0.571	-0.002	0.009	0.867
Covariances															
Random intercepts ψ(Xi,Yi)	**0.078**	0.006	0.000***	-0.008	0.006	0.177	**0.038**	0.005	0.000***	**-0.023**	0.005	0.000***	**-0.041**	0.005	0.000***
Corr. change ψ(lv_1, lu_1)	**0.016**	0.006	0.013*	**0.026**	0.007	0.000***	**0.015**	0.006	0.011*	-0.008	0.007	0.231	**-0.026**	0.006	0.000***
Corr. change ψ(lv_2, lu_2)	0.006	0.006	0.316	0.001	0.006	0.833	0.003	0.006	0.620	-0.001	0.006	0.827	-0.001	0.006	0.918
Corr. change ψ(lv_3, lu_3)	0.003	0.006	0.544	**-0.018**	0.006	0.004**	-0.002	0.006	0.735	-0.011	0.006	0.084	-0.003	0.006	0.667
Corr. change ψ(lv_4, lu_4)	0.001	0.005	0.830	**-0.011**	0.006	0.060*	-0.000	0.005	0.962	-0.006	0.006	0.294	0.002	0.005	0.756
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	28.760	(11)		47.272	(11)		47.389	(11)		34.280	(11)		31.846	(11)	
CFI / TLI	0.999	0.999		0.999	0.997		0.999	0.997		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.006	0.005		0.009	0.007		0.009	0.006		0.007	0.006		0.007	0.006	
AIC / BIC	421351	421637		427985	428272		420832	421119		428907	429193		424831	425117	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	28.822	(12)		47.289	(12)		49.425	(12)		34.345	(12)		33.817	(12)	
CFI / TLI	1.000	0.999		0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.998	
RMSEA / SRMR	0.006	0.005		0.008	0.007		0.008	0.006		0.007	0.006		0.006	0.005	
AIC / BIC	421349	421626		427983	428261		420832	421110		428905	429183		424831	425109	
χ^2 Difference Test ($diff_{df}$) p	0.062	(1)	0.803	0.016	(1)	0.899	2.038	(1)	0.154	0.066	(1)	0.798	1.971	(1)	0.160

Step 3: Constrain P → LA (c2)															
χ^2 (df)	28.884	(12)		47.753	(12)		47.811	(12)		34.601	(12)		31.874	(12)	
CFI / TLI	1000	0.999		0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.999	
RMSEA / SRMR	0.006	0.005		0.008	0.007		0.008	0.006		0.007	0.006		0.006	0.006	
AIC / BIC	421349	421626		427984	428262		420831	421108		428905	429183		424829	425107	
χ^2 Difference Test ($diff_{df}$) p	0.124	(1)	0.725	0.481	(1)	0.488	0.421	(1)	0.516	0.321	(1)	0.571	0.028	(1)	0.868
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	28.891	(13)		47.820	(13)		49.429	(13)		34.602	(13)		34.195	(13)	
CFI / TLI	1.000	0.999		0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.999	
RMSEA / SRMR	0.005	0.005		0.008	0.007		0.008	0.006		0.006	0.006		0.006	0.005	
AIC / BIC	421347	421616		427982	428251		420830	421099		428903	429172		424829	425098	
χ^2 Difference Test ($diff_{df}$) p	0.131	(2)	0.937	0.547	(2)	0.761	2.039	(2)	0.361	0.3219	(2)	0.851	2.349	(2)	0.309

Note. P = personality; LA = leisure activity; SE = standard errors; Corr. change = within-person correlated change; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; Associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

Artistic and Musical Activities

Results for RI-CLPM of artistic and musical activities and Big Five personality traits are shown in Table 4.7.

At the between-person level, individuals who are more artistically or musically active, (e.g.: making music, dancing, painting, etc.) in their leisure time are also considerably more open (ψ = .273, p < .001), more extraverted (ψ =.059, p < .001), more agreeable (ψ = .036, p < .001), and less neurotic (ψ = -.041, p < .001) but also less conscientious (ψ = -.030, p < .001) than individuals who are less involved in artistic and musical activities.

At the within-person level, temporary deviations from a person's artistic and musical activity score are positively associated with simultaneous temporary deviations from their openness trait score (*r*s of .027 −.068, p< .001). There are further simultaneous temporary deviations of artistic and musical activity from their extraversion trait scores (*rs of* .017 and .031, p< .01) at the first and third measurement occasions. There were no simulations temporary deviations of artistic and musical activity and conscientiousness, agreeableness, and neuroticism trait scores.

AR terms at the within-person level show that for artistic and musical activities (βs of .103-.107), random deviations from an individual's mean are less persistent than random deviations from an individual's mean of personality traits (βs of .108-.134).

An examination of CL paths shows that there are longitudinal within-person associations of artistic and musical activities with openness and extraversion, but not for other personality traits. Granger-Sims causality tests revealed that the model fit significantly deteriorates when constraining the cross-lagged path (c2) from openness to artistic and musical activity ($\Delta\chi^2$ (1) = 3.936, p < .05), implying a small positive openness → artistic and musical activity effect (β =.019, p < .05). Also, constraining the cross-lagged path (c2) from extraversion to artistic and musical activities ($\Delta\chi^2$ (1) = 3.936, p < .05) revealed a small positive extraversion → artistic and musical activity effect (β =.020, p < .05). Constraining all cross-lagged paths and comparing model fit to the full model did not reveal any within-person feedback effects of artistic and musical activity and personality traits.

Adding an age group variable to the model revealed that the within-person AR term for artistic and musical activities is no longer significant in the youngest age group (18−30 years at t1). Further, the CL effect (c2) from openness → artistic and musical activities (βs from .012 to 0.19, $p > .05$) is now insignificant in all age groups. Additionally, the positive extraversion → artistic and musical activity effect holds in the middle age group (31−50 years at t1) only. Not visible in the basic model is the positive prospective effect from neuroticism to artistic and musical activities ($\beta = .055$, $p < .05$) among young adults. See Supplement S8 for details on age group results.

Table 4.7 Artistic and Musical Activities (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43562			N = 43638			N = 43609			N = 43656			N = 43667		
Model parameters	β	SE	p	β	SE	p	β	SE	p	β	SE	p	β	SE	p
Auto-regressive terms															
a1 (LA)	0.107	0.011	0.000***	0.104	0.011	0.000***	0.103	0.011	0.000***	0.104	0.011	0.000***	0.103	0.011	0.000***
a2 (P)	0.120	0.011	0.000***	0.134	0.012	0.000***	0.117	0.011	0.000***	0.108	0.011	0.000***	0.123	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	0.005	0.008	0.553	-0.003	0.009	0.738	0.002	0.008	0.827	0.001	0.009	0.948	0.000	0.008	0.971
c2 (P → LA)	0.019	0.009	0.048*	0.008	0.008	0.333	0.020	0.010	0.035*	0.001	0.008	0.866	0.002	0.009	0.971
Covariances															
Random intercepts ψ(Xi,Yi)	0.273	0.006	0.000***	-0.030	0.006	0.000***	0.059	0.005	0.000***	0.036	0.005	0.000***	-0.039	0.005	0.000***
Corr. change ψ(lv_1, lu_1)	0.068	0.006	0.000***	-0.009	0.006	0.132	0.031	0.006	0.000***	0.008	0.006	0.183	-0.011	0.006	0.073
Corr. change ψ(lv_2, lu_2)	0.033	0.006	0.000***	-0.003	0.006	0.574	0.007	0.005	0.180	0.002	0.006	0.770	0.009	0.006	0.137
Corr. change ψ(lv_3, lu_3)	0.027	0.006	0.000***	-0.011	0.006	0.066	0.017	0.006	0.002**	-0.011	0.006	0.070	-0.000	0.006	0.978
Corr. change ψ(lv_4, lu_4)	0.039	0.005	0.000***	0.010	0.005	0.065	0.006	0.005	0.199	0.010	0.006	0.073	0.001	0.005	0.840
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	67.754	(11)		34.270	(11)		42.798	(11)		33.821	(11)		24.016	(11)	
CFI / TLI	0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.011	0.010		0.007	0.006		0.008	0.006		0.007	0.007		0.005	0.006	
AIC / BIC	414196	414482		425967	426253		418630	418916		426873	427159		422904	423191	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	68.107	(12)		34.381	(12)		42.846	(12)		33.826	(12)		24.018	(12)	
CFI / TLI	0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.010	0.010		0.007	0.006		0.008	0.006		0.007	0.006		0.005	0.006	
AIC / BIC	414194	414472		425965	426243		418628	418906		426871	427149		422902	423180	
χ^2 Difference Test ($diff_{df}$) p	0.353	(1)	0.553	0.112	(1)	0.738	0.048	(1)	0.827	0.004	(1)	0.948	0.001	(1)	0.971

Step 3: Constrain P → LA (c2)															
χ^2 (df)	71.690	(12)		35.207	(12)		47.264	(12)		33.850	(12)		24.080	(12)	
CFI / TLI	0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.998		1.000	0.999	
RMSEA / SRMR	0.011	0.010		0.007	0.006		0.008	0.007		0.006	0.007		0.005	0.006	
AIC / BIC	414198	414475		425966	426244		418632	418910		426871	427149		422902	423180	
χ^2 Difference Test ($diff_{df}$) p	3.936	(1)	0.047*	0.938	(1)	0.332	4.466	(1)	0.035*	0.029	(1)	0.866	0.064	(1)	0.801
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	71.824	(13)		36.014	(13)		47.970	(13)		33.850	(13)		24.110	(13)	
CFI / TLI	0.999	0.997		0.999	0.998		0.999	0.998		0.999	0.999		1.000	0.999	
RMSEA / SRMR	0.010	0.010		0.006	0.006		0.008	0.007		0.006	0.007		0.004	0.006	
AIC / BIC	414196	414465		425965	426234		418631	418900		426869	427138		422900	423169	
χ^2 Difference Test ($diff_{df}$) p	4.069	(2)	0.131	1.744	(2)	0.418	5.173	(2)	0.075	0.029	(2)	0.986	0.094	(2)	0.954

Note. P = personality; LA = leisure activity; SE = standard errors; Corr. change = within-person correlated change; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; Associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

Going-out Activities

Table 4.8 shows the results of the RI-CLPM for going-out activities, such as going to movies, concerts, etc. and the Big Five personality traits. Again, model fit statistics and results of Granger-Sims causality tests are reported.

At the between-person level, individuals who go out more in their leisure time are also considerably more open (ψ = .136, $p < .001$), more extraverted (ψ =.103, $p < .001$), more agreeable (ψ = .036, $p < .001$), less neurotic (ψ = -.101, $p < .001$), less agreeable (ψ = -.029, $p < .001$), and less conscientious (ψ = -.046, $p < .001$) than individuals who go out less.

At the within-person level, temporary deviations from a person's going-out activity score are positively associated with simultaneous temporary deviations from their openness (*r*s of .016−.025, $p< .001$) and their extraversion (*r*s of .012−.038, $p< .05$) trait scores. Further, at first measurement occasions only, there were negative simultaneous temporary deviations of going-out activities with conscientiousness (r = -0.048, $p< .001$) and agreeableness (r = -0.013, $p< .05$). There were no simulations temporary deviations of going-out activities and neuroticism trait scores.

AR terms show that at the within-person level, random deviations from an individual's mean for going-out activities (*β*s of .104−.109) are less persistent than random deviations from an individual's mean of personality traits (*β*s of .109−.136).

An examination of CL paths shows that there are longitudinal within-person associations between going-out activities and conscientiousness, but not other personality traits. Granger-Sims causality tests revealed that the model fit significantly deteriorates when constraining the cross-lagged path (c1) to conscientiousness ($\Delta\chi^2$ (1) = 4.542, $p < .05$), implying a small positive CL effect of going-out activities → conscientiousness (β =.019, $p < .05$). Further, constraining all cross-lagged paths and comparing model fit to the full model ($\Delta\chi^2$ (2) = 12.664, $p < .01$) revealed feedback effects of conscientiousness and going-out activities. This means that a short-term individual boost in going-out activities or conscientiousness may impact going-out activities or conscientiousness or both by way of reciprocal effects.

Adding an age group variable to the model revealed that the within-person AR term for going-out activities is no longer significant in the youngest age group. Thus, random deviations in going-out activities are not persistent to the next occasion in young adults. The reported positive CL effect of going-out activities on conscientiousness do not hold for the middle age group. Instead, there is a significant prospective effect of extraversion on going-

out activities in the middle age group only that was not visible in the basic model. See Supplement S9 for details on age grouping results for going-out activities.

Table 4.8 Going-Out Activities (LA) and Personality Parameter Estimates from the Random-Intercept Cross-Lagged Panel Model (RI-CLPM)

	Openness			Conscientiousness			Extraversion			Agreeableness			Neuroticism		
Number of observations used	N = 43563			N = 43638			N = 43609			N = 43656			N = 43667		
Model parameters	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Auto-regressive terms															
a1 (LA)	**0.109**	0.011	0.000***	**0.109**	0.011	0.000***	**0.107**	0.011	0.000***	**0.104**	0.011	0.000***	**0.107**	0.011	0.000***
a2 (P)	**0.123**	0.011	0.000***	**0.136**	0.012	0.000***	**0.115**	0.011	0.000***	**0.109**	0.011	0.000***	**0.122**	0.011	0.000***
Cross-lagged terms															
c1 (LA → P)	-0.005	0.008	0.493	**0.019**	0.009	0.033*	0.008	0.008	0.273	0.002	0.009	0.840	0.013	0.008	0.118
c2 (P → LA)	0.001	0.010	0.902	-0.013	0.009	0.150	0.008	0.010	0.433	0.003	0.009	0.708	0.001	0.009	0.889
Covariances															
Random intercepts ψ(Xi,Yi)	**0.136**	0.006	0.000***	**-0.046**	0.006	0.000***	**0.103**	0.005	0.000***	**-0.029**	0.005	0.000***	**-0.101**	0.005	0.000***
Corr. change ψ(lv_1, lu_1)	**0.025**	0.006	0.000***	**-0.048**	0.006	0.000***	**0.038**	0.006	0.000***	**-0.013**	0.006	0.036*	-0.030	0.006	0.061
Corr. change ψ(lv_2, lu_2)	**0.016**	0.006	0.005**	0.006	0.006	0.371	**0.018**	0.006	0.001**	0.003	0.006	0.625	-0.002	0.006	0.729
Corr. change ψ(lv_3, lu_3)	0.003	0.006	0.647	-0.005	0.006	0.420	**0.015**	0.006	0.008**	-0.003	0.006	0.677	0.000	0.006	0.978
Corr. change ψ(lv_4, lu_4)	**0.025**	0.005	0.000***	0.008	0.006	0.144	**0.012**	0.005	0.014*	-0.001	0.006	0.883	0.000	0.005	0.934
Granger-Sims Causality Tests															
Step 1: Derive Fit of Full Model															
χ^2 (df)	40.384	(11)		111.86	(11)		70.654	(11)		31.548	(11)		49.127	(11)	
CFI / TLI	0.999	0.998		0.997	0.991		0.998	0.996		0.999	0.998		0.999	0.997	
RMSEA / SRMR	0.008	0.007		0.014	0.014		0.011	0.010		0.007	0.007		0.009	0.009	
AIC / BIC	420716	421003		428056	428342		420309	420596		429160	429447		424569	424751	
Step 2: Constrain LA → P (c1)															
χ^2 (df)	40.854	(12)		116.40	(12)		71.856	(12)		31.589	(12)		51.577	(12)	
CFI / TLI	0.999	0.998		0.996	0.992		0.998	0.996		0.999	0.998		0.999	0.997	
RMSEA / SRMR	0.007	0.007		0.014	0.015		0.011	0.010		0.006	0.007		0.009	0.009	
AIC / BIC	420715	420992		428059	428337		420308	420586		429158	429436		424570	424746	
χ^2 Difference Test ($diff_{df}$) p	0.470	(1)	0.493	**4.5422**	(1)	0.033*	1.202	(1)	0.273	0.041	(1)	0.840	2.4505	(1)	0.118

Step 3: Constrain P → LA (c2)															
χ^2 (df)	40.399	(12)		113.93	(12)		71.270	(12)		31.689	(12)		49.146	(12)	
CFI / TLI	0.999	0.998		0.997	0.992		0.998	0.996		0.999	0.998		0.999	0.997	
RMSEA / SRMR	0.007	0.007		0.014	0.015		0.011	0.010		0.006	0.007		0.008	0.009	
AIC / BIC	420714	4209925		428056	428334		420308	420585		429158	429435		424567	424743	
χ^2 Difference Test ($diff_{df}$) p	0.015	(1)	0.902	2.064	(1)	0.151	0.616	(1)	0.433	0.141	(1)	0.708	0.0194	(1)	0.889
Step 4: Constrain all cross-lagged terms															
χ^2 (df)	41.106	(13)		124.52	(13)		71.958	(13)		31.690	(13)		52.019	(13)	
CFI / TLI	0.999	0.998		0.996	0.992		0.998	0.997		0.999	0.999		0.999	0.997	
RMSEA / SRMR	0.007	0.007		0.014	0.015		0.010	0.010		0.006	0.007		0.008	0.009	
AIC / BIC	420713	420982		428065	428334		420306	420575		429156	429327		424568	424739	
χ^2 Difference Test ($diff_{df}$) p	0.7227	(2)	0.697	**12.664**	(2)	0.002**	1.304	(2)	0.521	0.142	(2)	0.932	2.893	(2)	0.235

Note. P = personality; LA = leisure activity; SE = standard errors; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; AIC = Akaike information criterion; BIC = Bayes information criterion; Associations are coded to match paths in Figure 1. All variables were standardized to have a mean of zero and a standard deviation of one. Significant parameters and chi-square differences are bold. *p <.05, **p< .01, ***p<.001

4.4.3 Summary of Results

At the between-person level, we found comparatively strong positive correlations between openness and the various leisure activities as well as overall participation in leisure activities (ψ = [.078; .273]). Consciousness and the various leisure activities and the overall participation index have either no significant or small negative correlations (ψ= [-.046; -.015]). Higher extraversion is associated with a higher overall level of participation in leisure activities and with a higher frequency of all of the leisure activities investigated (ψ= [.038; .132]). Agreeableness is not significantly correlated with overall participation in leisure activities at the between-person level, but it is negatively correlated with physical, political, and going-out activities and positively correlated with socializing, artistic, and musical activities. Neuroticism and the various leisure activities and the overall participation index have small negative correlations (ψ= [-.120; -.039]).

At the within-person level, temporary deviations from a person's openness trait score are positively associated with simultaneous temporary deviations from their overall participation in leisure activities, and from their socializing, artistic, and musical activities at all measurement occasions. The same applies to the relationship between fluctuations in extraversion with simultaneous temporary deviations in overall participation in leisure activities, socializing activities, and going-out activities. Temporary deviations from a person's physical activities, volunteering, and political activities are not unambiguously associated with simultaneous deviations in personality traits. That is, there are only a few significant correlations at some measurement points for the aforementioned leisure activities with personality traits; see Tables 4.2−4.8.

AR terms show higher stability for the overall level of participation in leisure activities, physical activities, volunteering, and political activities, compared to personality traits. This means that the persistence of a random deviation from an individual's mean from one occasion to the next appears to be larger for the aforementioned leisure activities than for personality traits. For socializing, artistic and musical activities, and going-out activities, AR terms show lower persistence of a random deviation than for personality traits; see Tables 4.2−4.8.

The CL terms reflect the estimated change in the individual's leisure activity due to an unexpected change in a personality trait on the previous occasion or vice versa. For a summary of results on within-person cross-lagged effects for the full sample and for the age groups, see Table 4.9

Table 4.9 Summary of within-person cross-lagged effects for Big Five and Leisure Activities across Age-groups in RI-CLPM

	Openness				Conscientiousness				Extraversion				Agreeableness				Neuroticism			
	all	young	middle	old	all	young	middle	old	all	young	middle	old	all	young	middle	old	all	young	middle	old
Overall Participation																				
LA → P									+	+		+								
P → A											+									
Physical Activities																				
LA → P																				
P → A													+		+					
Socializing																				
LA → P					+				+	+	+	+								
P → A				+					+		+	+					−			−
Volunteering																				
LA → P										+		+	−	−		−				
P → A							−													
Political Activities																				
LA → P																				
P → A																				
Artistic & Musical Activities																				
LA → P							−													
P → A	+								+		+							+		
Going-out activities																				
LA → P					+	+		+												
P → A											+									

Note. P = personality; LA = leisure activity; + = positive cross-lagged effect, significant on p-level <.05; − = negative cross-lagged effect, significant on p-level <.05; bold+/− = cross-lagged effect in full-sample model; non-bold +/− = cross-lagged effect in models with age-groups; grey shading = feedback effect; young = between 18 and 30 years old at T1, middle = between 31 and 50 years old at T1, older = between 51 and 75 years old at T1 in 2005

4.5 Discussion

In this study, we tested whether temporary fluctuations in leisure activities around an individual's mean level have prospective effects on fluctuations in the Big Five personality traits and vice versa. Finding such within-person feedback effects would contribute to comprehensive theories of personality development. Based on the TESERRA framework (Wrzus & Roberts, 2017), we assumed that frequent leisure activities could be triggering situations in repeated TESERRA sequences.

Data came from the German Socio-Economic Panel (SOEP) study, which includes four waves of personality and leisure activity assessments over a 13-year period in a nationally representative sample of 55,790 individuals, aged 18 to 87 years. Using random-intercept cross-lagged panel models, we disentangled between-person and within-person variance and established temporality and directionality to personality development and participation in leisure activities.

In the following paragraphs, we discuss to what extent the specific leisure activities investigated and the overall participation in leisure activities drive personality development (and vice versa). Additionally, we project the results onto the TESSERA framework.

4.5.1 Overall participation in leisure activities

Derived from earlier, mainly cross-sectional studies, we suspected positive transactions between overall participation and openness and extraversion, and vice versa. Although we found a strong association between openness and overall participation on the between-person level, and simultaneous temporary deviations at the within-person level, we found no cross-lagged effects for openness. In other words, we found that increasing an individual's level of involvement in leisure activities did not lead to a change in openness.

However, we found within-person effects for extraversion. As hypothesized, we found feedback effects for overall participation in leisure activities and extraversion. That is, temporary fluctuations in overall leisure activity around an individual's mean level had prospective effects on fluctuations in extraversion and vice versa. A close relationship between the level of overall leisure activity and extraversion was already reported by Furnham (2004), who attributed this to higher sensation-seeking by extraverts. Interestingly, the within-person cross-lagged effect of a change in overall participation in leisure activities on a change in extraversion was significant for the young and older age groups only. The opposite prospective effect, i.e., the effect of a change in extraversion on a change in overall participation, was found to be significant in the middle age group only. This

suggests that fluctuations in overall leisure activity only show an effect on personality when rank-order stability is smaller, that is, in young adulthood and in old age (Roberts & DelVecchio, 2000, Specht, Egloff, & Schmukle, 2011). In middle adulthood, when rank-order stability in extraversion is highest, short-term fluctuations in extraversion may cause changes in overall participation in leisure activities but not vice versa.

4.5.2 Physical activities

We hypothesized positive prospective effects of an increase of conscientiousness and an increase of openness on physical activity. Further, we suspected a negative effect of increase of agreeableness on physical activity. The existing literature provided no evidence of an effect of changes in physical activity on personality change.

Indeed, we did not find any effect of the change in frequency of physical activity on the personality traits of an individual. However, contrary to expectations, we also did not find any cross-lagged effect of changes in conscientiousness and openness on an individual's level of physical activity. Regarding agreeableness, the effect was different than expected: a random short-term increase in agreeableness on one occasion led to an increase in physical activity (compared to an individual's usual level) on a later occasion and not to a decrease in playing sports. Comparing age groups suggested that this positive prospective effect of agreeableness on physical activity was most prominent in middle adulthood.

4.5.3 Socializing

Previous studies have demonstrated that socializing is positively associated with extraversion and agreeableness. Based on that research, we hypothesized that an increase in the frequency of private socializing may result in an increase in extraversion and agreeableness and vice versa.

The hypothesis on agreeableness was not confirmed. After estimating between-person differences, we still found simultaneous temporary deviations between socializing and agreeableness in the same directions but found no cross-lagged effects for socializing and agreeableness at the within-person level. It may be that the frequency of socializing by itself is not a trait-triggering situation for agreeableness. Hence, it could conceivably be hypothesized that only meetings with emotionally secure attachment figures are state-relevant in the sense of the TESSERA framework. However, we did not capture the valence or other characteristics of leisure activities in this study.

The results confirmed our hypothesis that an increased frequency of socializing drives an increase in extraversion (and vice versa). Regarding extraversion, we found the hypothesized reciprocal prospective within-person effects of socializing and extraversion. That is, temporary

fluctuations in socializing activities, such as meeting friends and relatives, around an individual's mean level had prospective effects on fluctuations in their extraversion and vice versa.

One unexpected finding of this study regarding socializing effects on personality change was that there was a positive within-person cross-lagged effect on conscientiousness. This means that if an individual's social activity was higher than usual on one occasion, he or she was more conscientious on the next occasion. However, this result should be interpreted with caution, because it did not hold after adding age groups to the model. The within-person-correlated change was also inconsistent: partly positive and partly negative. The prospective effect of socializing on conscientiousness should be addressed again in future investigations. It may be a random effect.

Further, we found effects of personality change on change in social activity:

Random increases in neuroticism led to less frequent socializing in the future, especially among older adults. Also, exclusively in old age, increases in openness led to more frequent social activities.

In general, we found that in later adult life, when social situations may need to be pursued more actively, extraversion, openness, and neuroticism were more crucial for the development of future socializing behavior than in young adulthood. A possible explanation for this might be that the persistence of fluctuations, that is, the within-person auto-regressive effect of socializing was much stronger in the young and middle age groups than in the older age group.

4.5.4 Volunteering

Based on earlier research investigating between-person associations of public social activity, we hypothesized that changes in an individual's volunteering behavior may trigger changes in extraversion and agreeableness trait levels and vice versa. Regarding extraversion our hypothesis was partially confirmed. We found within-person cross-lagged effect of volunteering on extraversion, but in the young and older age groups only. This means that when young and older adults engaged in more volunteer work than usual, their extraversion was prospectively higher than their trait level. However, an increase in extraversion did not result in more volunteer work on a subsequent occasion.

There was a similar one-sided effect of volunteering on agreeableness. Contrary to our hypothesis, we found a negative (not a positive) within-person cross-lagged effect of volunteering on agreeableness. This means that if an individual volunteered more than usual on one occasion, this caused a decline in his or her agreeableness in the next occasion. This rather contradictory result may have been due to an increase in the level of volunteer work, far above the usual level, creating a burden for the individual. The resulting stress may in turn have led to lower agreeableness.

A prospective effect of personality change on volunteering was found for conscientiousness when adding age groups only. That is, in middle adulthood, people who became more conscientious than usual subsequently reduced their involvement in volunteering.

From these results, we can infer that volunteering may influence agreeableness and extraversion, but that it tends not to in middle adulthood. Conversely, higher conscientiousness had a significant negative influence on volunteering behavior in middle adulthood only. Since age is mainly a proxy for unknown confounders for development, it could conceivably be hypothesized that transactions between volunteering and personality were moderated by involvement in professional life. Further research should be undertaken to investigate this question.

4.5.5 Political activities

We hypothesized that there may be a positive transaction between the change in political activity and the change in agreeableness and extraversion. Contrary to expectations, we found no within-person cross-lagged or feedback effects of political activities in leisure time and any of the Big Five personality traits. This result may be partly explained by the fact that the mean and variance for political activities were very low. The great majority of the sample was never or seldom politically active. Thus, the distribution was skewed, and prospective effects were difficult to find. Surprisingly, especially among young and middle-aged adults, auto-regressive effects at the within-person level in political activities (i.e., short-term fluctuations) were up to twice as stable as changes in personality traits.

4.5.6 Artistic and musical activities

We expected that changes in the frequency of artistic and musical activities may trigger changes in openness and vice versa. This hypothesis was only partially confirmed. Random increases in openness led to prospective increases in artistic and musical activities. We found no effect, however, of changes in artistic and musical activities on an individual's openness. At first glance, this appears somewhat contradictory to earlier findings by Schwaba et al. (2018), who reported that increases in cultural activity precipitate increases in openness and vice versa. However, their definition of cultural activity involves relatively passive artistic and musical activities, such as going to the theater or opera or visiting museums, whereas our measure covered active behaviors, such as making music, dancing, theater, painting, and photography. Further, the results reported by Schwaba et al. (2018) may have been confounded by between-person effects. Additionally, the time scale is important for investigating causal processes. The measurement occasions in the current study were four years apart, whereas participants in the research of Schwaba et al. (2018) completed the survey

every year or every second year. In the present study, we also found simultaneous temporary deviation in the same direction of openness and artistic and musical activity within persons. This points to shorter cause-effect relationships.

Unexpectedly, we found a negative effect of changes in artistic and musical activity on conscientiousness in middle adulthood. That is, if a middle-aged adult was doing more arts and music in his or her leisure time than usual, he or she might be less conscientious prospectively. Thus, artistic and musical activities in leisure time may drive personality development only in this specific setting.

Further prospective effects of personality change on artistic and musical activities appear to be age-group-specific as well. In this study, we found a significant positive effect of an increase in extraversion on artistic and musical activity in middle adulthood only. In young adulthood, when within-person fluctuations in artistic and musical activity were less persistent, increasing neuroticism led to more artistic and musical activity, i.e., creativity. This last finding was consistent with that of Speaks (2013), who reported a positive association between neuroticism and arts and crafts in their sample of university students.

4.5.7 Going-out activities

To our knowledge, there are no other studies to date on what we refer to as "going-out activities," such as going to the movies, going to concerts, dancing, clubbing, or attending sporting events, in relation to the Big Five personality traits. We hypothesized that going-out activities may show positive transactions between extraversion and openness to experiences and vice versa.

Contrary to expectations, at the within-person level, we found no cross-lagged effects for openness and going-out activities. Partly in line with our hypothesis, positive fluctuations in extraversion led to increased going-out activities in middle adulthood. However, changes in going-out activities had no prospective effects on extraversion.

Surprisingly, we found a positive cross-lagged effect of going-out activities on conscientiousness, but not in middle adulthood. This means that the increase in the individual's conscientiousness may have been due to an increase in the individual's going-out activity on the previous occasion, but only in young adulthood and old age. This result is relatively counterintuitive. According to the TESERRA framework (Wrzus & Roberts, 2017), a possible explanation might be that going-out activities trigger situations in which conscientiousness develops (e.g., planning activities, organizing a group to go out with, etc.), but only in early and later adulthood.

4.5.8 How do findings relate to the TESSERA framework of personality development?

Applying the TESSERA framework on personality development in adulthood (Wrzus & Roberts, 2017) to our results, overall participation in leisure activities and the activities of socializing (i.e., meeting friends, family, acquaintances etc.) and volunteering may be triggering situations for extraversion development. According to the theory, extraversion may change because a triggering situation is repeatedly perceived as trait-relevant and thus elicits a relevant state—e.g., talking at length about one's own experiences—that does not correspond to the actual low extraversion, but nevertheless elicits a positive reaction: e.g., people are grateful or interested in meeting again. The same mechanism can be applied to other traits and situations: Socializing and going-out activities may be triggering situations for conscientiousness development. And a change in agreeableness may be triggered by a change in volunteering, according to our results.

According to this framework, internal reflective or associative processes transform repeated TESSERA sequences into long-term personality development. A note of caution should be added here since we did not assess these cognitive processes. Our measure of leisure activity only addresses frequency. However, cognitive and emotional aspects of leisure activities such as how rewarding they are, how voluntary they are, or how enjoyable they are could have an influence on related personality changes as well. In the above-described relationship between socializing and extraversion, for example, it would be decisive that the reaction of the environment is perceived as positive.

We found no prospective effects of any of the leisure activities investigated on openness or neuroticism. The question of where inter-individual differences in the covarying expression of both traits and leisure activities come from therefore remains. Between-person differences must be the result of differential intra-person developments that took place at some point in the past. However, the leisure activities and the overall participation examined here do not appear to be triggering situations in the sense of the TESSERA framework (Wrzus & Roberts, 2017) for the development of openness to experience and neuroticism.

4.6 Limitations and Future Directions

In this study, we used four waves of longitudinal survey data from a national representative sample from Germany with more than 55,000 participants who were followed over 13 years, from 2005 to 2017. This allowed us to investigate longitudinal associations between Big Five personality traits and the frequency of leisure activities over time. However, our study is not without limitations.

The measure of frequency of leisure activity used in the current study was based on a rather unprecise four-point scale, which may not have been sensitive enough to capture the full extent of within-person change (Ram & Gerstorf, 2009). This may have led to an underestimation of effects. Moreover, personality traits were assessed with only three items each and did not allow for more specific, facet-level analyses, which could have revealed a more fine-grained pattern of results.

As a limitation of our design, we note that the assessment intervals in our study—every four years—were rather long. Frequent and well-timed personality assessments are necessary to understand how trait changes unfold in the context of experiences (Bleidorn, Hopwood, & Lucas, 2018; Luhmann, Orth, Specht, Kandler & Lucas, 2014; Schwaba, Luhmann, Denissen, Chung, & Bleidorn, 2018). However, the magnitude of within-person effects of personality interrelations varies depending on the time interval under consideration (see Müller, Wagner, Smith, Voelkle, Gerstorf, 2018). Our results should therefore be interpreted with caution. Future inquiries may shed further light on personality processes by conducting assessments at different time scales.

It is also important to bear in mind the possible alpha inflation (type-I error) due to multiple testing in this study. It may be that we are reporting effects that do not actually exist. However, we decided not to use a stricter significance threshold than $p<.05$. Due to the long measurement intervals and the small effects that can therefore be expected, the risk of overlooking an effect (type-II error) that can be examined more thoroughly in future studies would have been high.

Our results on age effects should also be interpreted with caution. We obtained a first impression of the impact of age through model fit testing with and without constraints across age groups, but the mechanisms in the different age groups should be investigated in more detail in further studies.

Age and developmental contexts could potentially inform the relationship between leisure activities and personality change, but so could other factors. To better understand the mechanisms underlying the link between change in participation in leisure activities and change in personality, future research might utilize in-vivo data on thoughts and feelings centered on the environmental changes (e.g., Wrzus & Roberts, 2017). This would enable them to examine the relevance of leisure activity characteristics beyond their frequency, such as voluntariness, enjoyment, and consequences and reactions.

4.7 Conclusion

The purpose of the current study was to examine the extent to which within-person changes in overall participation in leisure activities, and participation in a variety of specific leisure activities

lead to prospective changes in an individual's Big Five personality traits, and whether changes in personality elicit prospective changes in a person's leisure activities.

Taken together, by applying RI-CLPM to four waves of 13-year longitudinal data from the Socio-Economic Panel (SOEP) study, the present study has shown that at the between-person level, the leisure activities investigated as well as the overall level of participation are most strongly associated with openness. However, at the within-person level, we found prospective feedback effects for extraversion with socializing and overall participation only. We found first evidence that some within-person cross-lagged effects of specific leisure activities with certain personality traits occur in certain age groups only. For example, a cross-lagged effect of volunteering on a prospective increase in extraversion was significant in young and old age groups only.

Overall, this study adds support to the idea of the TESERRA framework, that repetitive trait-triggering situations can lead to personality change. However, for openness and neuroticism, we could not identify triggering leisure activities in the current study. To develop a broader picture of personality trait-triggering leisure situations, additional studies will be needed that investigate more leisure experiences in connection with personality changes on a shorter time scale.

4.8 References

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4.8.1 Supplemental Material

Table S1-S9 can be found on the Open Science Framework (OSF) website: https://osf.io/fdxzp/?view_only=eaffa966ffe14e7c8a4ccb5ace76ace6

CHAPTER 5 – Adult Development in Personality Traits and Social Participation: Discussion and Implications of the Findings

5.1 Changes in Personality Traits and in Social Participation across The Adult Life Span: Findings

The aim of this dissertation was to complement research on personality change mechanisms and to further developmental research on social participation. Additionally, I strived to combine the two research fields by examining the reciprocal effects between social participation and personality trait change over the adult life span. In particular, the major aims of this thesis were to investigate (1) the extent to which an intervention, such as a cognitive training, could lead to long-term changes in personality traits; (2) how in-person social contact frequency develops across the adult lifespan, with regard to both family and non-family network circles; (3) the extent to which changes in social participation i.e., leisure activities lead to personality change and vice versa.

The three research questions were examined by analyzing data of two different life span samples: (a) COGITO study and (b) the German Socio-Economic Panel (SOEP). In the COGITO study, 101 German young adults and 103 older adults participated in 100 daily testing sessions during which they worked on various cognitive tasks and completed multiple self-assessments, including a two year follow-up (see Schmiedek, Lövdén & Lindenberger, 2010). SOEP is a large and ongoing, nationally representative study of German households, based at the German Institute for Economic Research (DIW Berlin). It records, among other factors personality, time use and environmental behavior (for details please see Goebel et al., 2019).

The assumptions, analyses, main findings and conclusions of the three research questions of this dissertation are summarized in Table 5.1.

Table 5.1 Summary of the Assumptions, Analyses and Findings of this Dissertation.

Assumptions	Empirical Analyses and Data	Findings	Conclusion
Research questions 1: Can an intensive cognitive training change personality trait, especially openness to experience, in the long run? (Chapter 2)			
Environmental changes might impact personality states which, in the long run, may lead to changes in deep-seated personality traits. In this way, personality could possibly be actively changed. Results from Jackson and colleagues (2012) supported this hypothesis. They discovered increased openness to experiences right after an adaptive cognitive training for elderly people.	Study 1 compares an intervention group (N= 204), who received daily one-hour cognitive training sessions for about 100 days with a control group (N=86) who received no cognitive training. All participants answered the personality trait questionnaire "NEO Five-Factor Inventory" prior and two years after the cognitive training. Latent change models were applied that controlled for age group (young adults, [20-31 years] vs. old adults, [65-82 year]) and gender. Data were retrieved from the COGITO study.	Two years after the intensive cognitive training phase no significant changes in any facet of openness to experience were evident. This was the case for young and old participants as well as for men and women. Instead, the cognitive training intervention lowered the general increase of conscientiousness, compared with the control group.	Despite the conceptual association, an extensive cognitive training on memory and perceptual speed does not serve as a sufficient intervention for enduring changes in openness to experiences or one of its facets.

Table 5.1 continued.

Assumptions	Empirical Analyses and Data	Findings	Conclusion
Research question 2: How does in-person social contact frequency change across the adult life span? (Chapter 3)			
Evolutionary differences between family contacts and non-family contacts can be assumed. Furthermore, changes in living conditions and age-related adjustments of emotional-motivational goals could lead to changes in the frequency of contact. Theories of adult social development and earlier studies on network size make evident that, whereas contact frequency with family is rather stable throughout adulthood, contacts with non-family members may decline in middle adulthood.	Study 2 contains a cohort-sequential longitudinal study which examines intraindividual changes in the frequency of in-person social contact with family and non-family members (neighbors, friends, and acquaintances), and potential moderators (gender, relationship status, subjective health, employment status, birth of a child, relocation) of these changes. The analysis uses four waves (1998, 2003, 2008, and 2013) of the German Socio-Economic Panel Study (N = 36,716; age range: 17-85 years).	Frequency of in-person contact with family members remained relatively stable across the adult life span. The frequency of visits of and by nonfamily members declined, following a cubic trajectory and dropped below the frequency of family visits at age 35 roughly. Relationship status and gender had a slight effect on both trajectories. Subjective current health status and employment status influenced the life span trajectory of non-family social contact only. Changes of residence and the birth of a child did not affect the life span trajectories of in-person contacts.	The pattern of development for in-person contact frequency is similar to the pattern of social network size changes described in other studies. Life span trajectories of social contact frequency were relatively unaffected by the key social roles and the life events investigated.
Research question 3: Are changes in frequency of different leisure activities and overall (social) participation associated with personality change? – If so, which direction do they take? (Chapter 4)			
Changes in leisure participation, in the sense of carrying out daily activities and repetitive experiences, may be a source of individual differences in personality development across the adult life span. Conversely, personality trait change may impact change in type and frequency of the leisure activities selected.	Study 3 presents a random-intercept cross-lagged panel models (RI-CLPM) in order to analyze the extent to which within-person changes in leisure activities lead to prospective changes in personality traits. Additionally, it focuses on whether changes in personality elicit prospective changes in leisure activities. Differences across age groups are tested (young [18-30 years], middle [31-50 years], old [51-75 years]). The analysis uses four waves (2005, 2009, 2013, & 2017) from the German Socio-Economic Panel Study (N = 55,790).	On a between-person level, leisure activities and overall participation were most strongly associated with openness to experience. On within-person level, reciprocal effects were discerned for extraversion with overall participation and socializing, only. Further unidirectional within-person cross-lagged effects from leisure activities to personality traits or vice versa were found. Some effects were solely age-group specific.	Leisure activities associated with certain traits on a between-person level are not necessarily those that trigger change to the respective personality trait. The specificity of an experience or behavior and its corresponding trait is essential for personality development.

In the following, I summarize and discuss the findings from Chapter 2 to 4 (Section 5.1.1 to Section 5.1.3). Additionally, I address their wider implications for research on adult personality development (Section 5.2) and research on adult social development (Section 5.3). I will discuss central limitations of the empirical studies and directions for future research (Section 5.4) as well as practical implications of the findings (Section 5.5) at the end of this chapter and will present an overall conclusion (Section 5.6.).

5.1.1 Research question 1: Can an intensive cognitive training change personality trait, especially openness to experience, in the long run?

The first aim of this dissertation was to test whether an intensive cognitive training could be considered to be a sufficient intervention to change the openness to experiences trait or any of its facets. The findings regarding research question 1 are summarized in Figure 5.1.

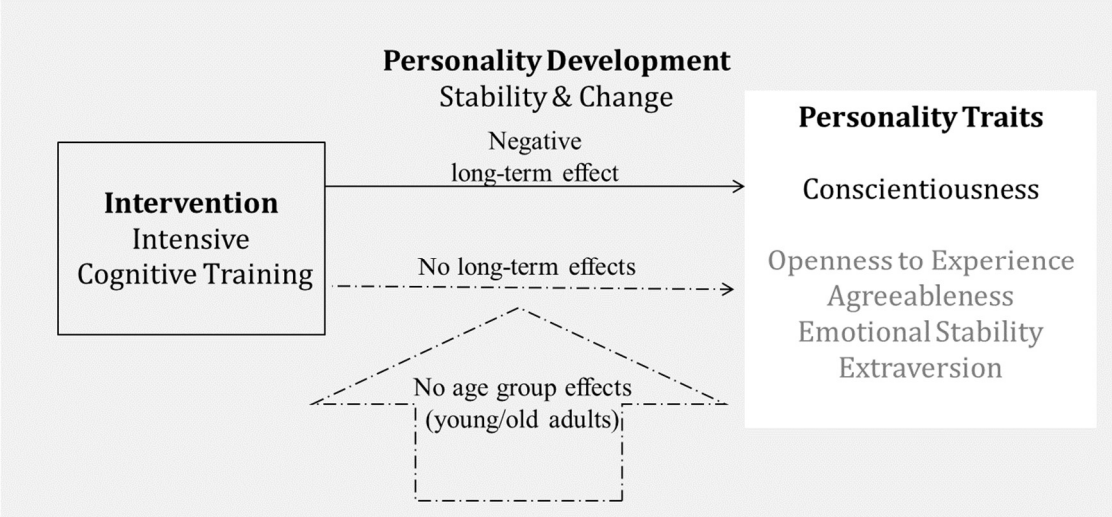

Figure 5.1 Illustration of results for research question 1 (RQ1). Intervention group who took part in the cognitive training increased less over time in conscientiousness facets "dependability" and "orderliness" compared to control group (without any cognitive training). There was no long-term effect of cognitive training on changes in any other personality trait or facet. There were no interaction effects of age group and cognitive training on changes in personality traits or facets.

Currently, causes of personality change and thus potential interventions are much debated (see Bleidorn et al., 2019, Stieger et al., 2020). According to the Sociogenomic approach by Roberts and Jackson (2008) and other more recent frameworks (e.g.: Wrzus & Roberts, 2017), environmental changes impact personality by way of bottom-up processes, by repeating trait-relevant behaviors or experiences. For example, creative thinking, enjoyment of intellectual pursuit, seeking out new challenging activities and cognitive flexibility are associated with the openness to experience personality trait (Ackerman & Heggestad, 1997; McCrae & Sutin, 2008). Thus, a change in the openness to experience trait may be triggered

through cognitive training. Accordingly, Jackson and colleagues (2012) found short-term "side-effects" of an adaptive cognitive training to the openness to experiences of elderly people. Yet the impact of a cognitive training on personality traits in the long-run was not clear.

Our analysis showed that, despite of the successful cognitive transfer of training on memory (Schmiedek, Lövdén, & Lindenberger, 2010; Schmiedek et al., 2014), the very extensive cognitive training did not lead to long-term increases in openness to experience or any of its facets in young or old, male, or female individuals. Thus, enduring behavior change with regard to intellectual activity did not lead to changes in personality, in particular, to intellectual interests and other facets of openness to experience.

The non-effect results of cognitive training on the openness trait may be related to the comparatively long periods of time which were considered. In the present study, there was a pretest and a personality assessment two years after the training. Possibly, there was an effect on the openness to experience trait right after the cognitive training. However, we lack data on this short-term correlation. Another possible explanation for the non-effect may be the missing dynamic adaptation of tasks during the training. Hence, it could be hypothesized conceivably that the cognitive training was not continuously perceived as a new challenge and thus was not sufficiently trait-triggering for openness to experiences. There is another likely cause for the differences between our results and earlier studies (e.g., Jackson et al., 2012). Participants may not have been motivated to change their personality, since they were exclusively instructed regarding the modification of their cognitive abilities within the study. However, according to the TESSERA framework on personality change and stability (Wrzus & Roberts, 2017; please see chapters 1.3.3, & 4.2.3, for details), such corresponding internal reflective or associative processes would have been necessary to elicit long-term personality development.

One unanticipated finding was that the cognitive training showed a negative effect on conscientiousness development. Individuals who participated in the training increased less in dependability and orderliness over time compared to those without any intervention. Certainly, these findings await replication before drawing conclusions.

5.1.2 Research question 2: How does in-person social contact frequency change across the adult life span?

The second aim of this dissertation was to enhance the understanding of the development of social relationships across the adult life span. Therefore, we compared the

lifespan trajectories of frequency of family and non-family (neighbors, friends and acquaintances) in person social contacts across adulthood. Additionally, the influence of gender, relationship status, employment status, subjective health status, birth of a child and relocation was investigated. The findings regarding research question 2 are summarized in Figure 5.2.

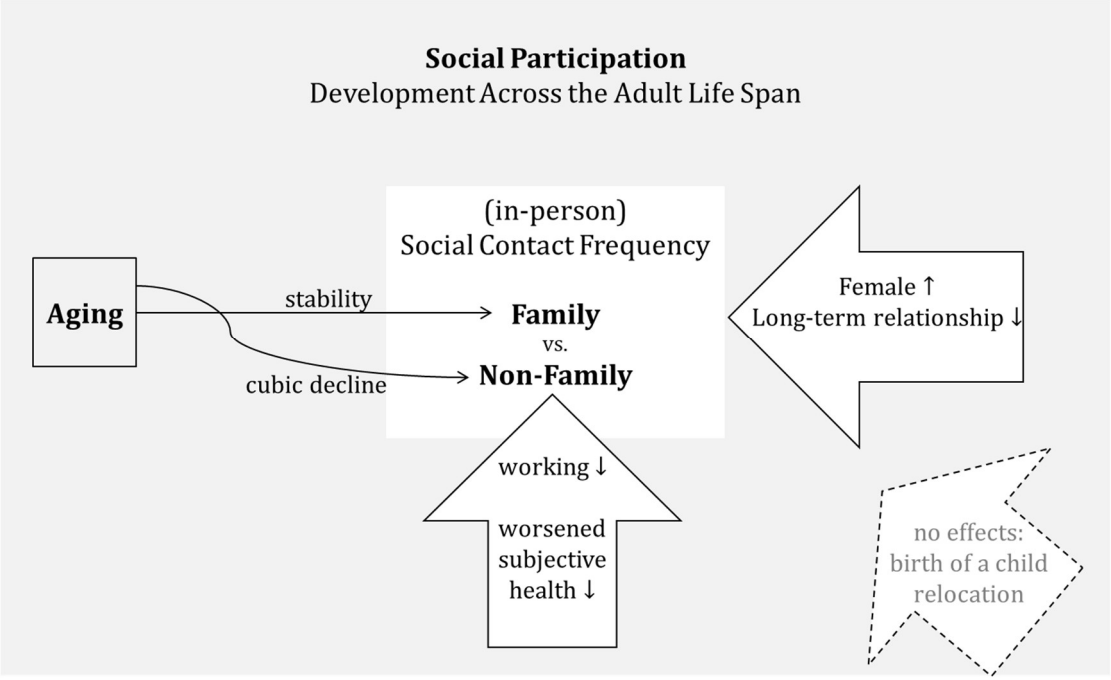

Figure 5.2 Illustration of results for research question (RQ 2). Frequency of in-person social contact with family remained relatively stable across the adult life span. The frequency of visits to and from nonfamily members declined following a cubic trajectory and dropped below frequency of family visits around age 35. *Gender*: Especially in middle adulthood women visit family and non-family more often than men. *Relationship status*: Overall, people in a long-term relationship visit family and non-family more seldom than those without long-term relationships. *Subjective current health status*: Adverse changes in health are partly related to a decline in the frequency of social contact with non-family social contacts in old age. *Employment status*: Those who are not working see non-family members more often, than the working population. *Changes of residence* and the *birth of a child* did not affect the life span trajectories of in-person contacts.

Social participation and integration are positively linked to important life outcomes such as positive affect, longevity, and good health (Berkman, Glass, Brisette, & Seeman, 2000; Shor & Roelfs, 2015). Especially in-person social contacts prevent loneliness and poor health (Holt-Lunstad, 2021; Luhmann & Hawkley, 2016; Teo et al., 2015). But research on development of social relationships across the lifespan focused on social network size and composition, finding family networks to be rather stable in size from adolescence to old age, whereas friendship networks were found to be decreasing in size (e.g., English & Carstensen, 2014; Wrzus, Hänel, Wagner, & Neyer, 2013). However, less is known about the

development of in-person social contact frequency across the life span and within different network circles.

In the context of socioemotional selectivity theory (Carstensen, 1995, 2006) and social convoy theory (Kahn, & Antonucci, 1980), as well as the evolutionary human life history approach (e.g., Kaplan & Gangestad, 2015), we expected in-person social contact frequency with family to be rather stable and non-family contact frequency to decline throughout adulthood. Since personal (e.g., age, gender) and situational factors (e.g., role demands, social norms) could influence the structure and development of social networks (Antonucci et al., 2014; Kahn & Antonucci, 1980) we investigated the relationship status, health status, birth of a child, employment status, change of residence and gender as moderators of in-person social contact frequency.

Our analysis of cohort-sequential longitudinal data confirmed that the frequency of in-person contacts with family members remained relatively stable across the adult life span. The frequency of visits to and from non-family members (neighbors, friends, and acquaintances) declined, following a cubic trajectory. It dropped below the frequency of family visits on average between the ages of 35 and 36.

Investigated key social roles and life events affected the life span trajectories of social contact frequency only marginally. Women reported slightly more frequent family visits than men in early and middle adulthood. With regard to neighbors, friends, and acquaintances women reported slightly less frequent contact than men in young adulthood. Nevertheless, in middle adulthood, the trajectories switched, and women reported more frequent visits of nonfamily members. Overall, individuals who are not in a long-term relationship see their friends, neighbors, and acquaintances more often than those who are committed to a partner. As a result, the crossover point at which the frequency of non-family visits drops below that with the family does not occur until the age of 45 for people with no long-term relationship. Employment status and current health status only influenced non-family contact frequency. In other words, people not working and people with good subjective health see neighbors, friends, and acquaintances slightly more often. The life events of the birth of a child and change of residence had no significant effect on the life span trajectories of social contact frequency in our data.

All in all, these results suggest that the pattern of development for in-person contact frequency is similar to the pattern of social network size changes described in other studies (e.g., Wrzus et al., 2013), showing stability in family networks and a decline in peripheral networks.

It could be hypothesized that this development is related to the evolved psychological mechanisms of kinship orientation (Neyer & Lang, 2003), that is a lifelong interest in the survival of genetic relatives (Hamilton, 1964). The observed decrease of interest in non-family members during middle adulthood may be due to the ending of the mating and reproduction phase (Kenrick et al., 2013; Neuberg, Kenrick, & Schaller, 2010). The stability of frequency of family contacts – in contrast to declining non-family contacts – during poor subjective health may be also due to mechanisms of kinship orientation. Families typically provide support, especially in periods when reciprocity cannot be maintained (Neyer & Lang, 2003). The unexpected non-effect of birthing a child may be due to short-term effects on contact frequency (probably increasing family contacts, decreasing non-family visits), which are not covered by our data with four years intervals. The same may apply to the non-effect of change of residency. It might be that social contacts are restored shortly after relocation. An increase in social contact with friends, neighbors and acquaintances during unemployment may be due to there being more leisure time and opportunities to do so.

So as to further investigate the mechanisms underlying the changes in social contact frequency, a cross-cultural longitudinal study involving network size and network composition might be insightful.

Examining the day-to-day dynamic of interaction patterns for different network circles may provide further insights into the mechanisms that constitute life span development. Future research should focus on questions regarding short- and medium-term processes: How often and how quickly are contacts (e.g. sms, phone calls) reciprocated? What role does the valence of the contact play? What interdependencies exist between different social relationships? Is a decline of relationship quality substituted by seeking more frequent contact with others? How do personality, characteristics of social networks (e.g., size), social status (e.g., education, employment), and a person's environment (e.g., area of living) covary with social interactions? A promising and probably revealing method could be the smartphone sensing (Aharony, Pan, Ip, Khayal, & Pentland, 2011). The latter entails the recording of incoming and outgoing calls, app usage, surrounding sounds and location. It allows to continuously track actual social behavior over a longer period without reporting biases.

5.1.3 Research question 3: Are changes in frequency of different leisure activities and overall (social) participation associated with personality change? – If so, which direction do they take?

The third aim of this dissertation was to contribute to comprehensive theories of personality development by investigating within-person effects of personality trait change in relation to changes in leisure activities. Based on the TESERRA framework (Wrzus & Roberts, 2017), we assumed that frequent leisure activities could be triggering situations which lead to prospective personality change and vice versa. We differentiated between-person and within-person variance and thereby established temporality and directionality to personality development and participation in leisure activities. We estimated random-intercept cross-lagged panel models (RI-CLPM, please see 4.3.4 for details) for the Big Five and the frequency of seven leisure activities: physical activity, socializing (i.e., meeting friends, family, acquaintances etc.), volunteering, political activities, artistic and musical activity, and going-out activity. Furthermore, we summed up the frequency of all leisure activities to generate an overall participation score.

Leisure activities and overall participation were most strongly associated with the openness to experience trait on a between-person level. At the within-person level, which reflects possible mechanisms of personality change, we found reciprocal effects of overall participation and socializing with extraversion as well as several unidirectional effects: Temporary increase in neuroticism led to decreasing socializing. More frequent socializing leads to increasing conscientiousness, to give a few examples. However, the addition of age-groups to the analysis revealed that a change in personality traits was more often induced by a change in leisure activity than vice versa in young and old adulthood. The directionality tended to be reserved during middle adulthood, that is, the stabilized personality more often affected the uptake of certain leisure activities than vice versa. All findings regarding prospective within-person effects are summarized in Figure 5.3 (research question 2).

Overall, this study supports the idea of the TESERRA framework, namely that repetitive trait-triggering situations can lead to personality change. The application of our results to the framework suggests that an increase in extraversion may be triggered by an increase in overall participation in leisure activities and the activities of socializing and volunteering. Surprisingly, increase in conscientiousness may be triggered by increase in socializing and going-out activities. Also, and somewhat counterintuitively, a decrease in agreeableness may be triggered by an increase in volunteering. Thus, our results are in line with the findings of Quintus, Egloff & Wrzus (2021), who found further evidence for the

TESSERA framework and who reported that momentary experiences in daily life were associated with long-term changes in agreeableness, conscientiousness, and extraversion. None of the leisure activities investigated here appear to trigger change in openness or neuroticism. Thus, additional studies that investigate further trait-triggering (leisure) experiences in connection with personality changes on a shorter time scale are necessary.

In Study 3 we derived prospective effects of personality change and change in leisure activity from estimating within-person effects in longitudinal data. Rohrer and Murayama (2021) discussed the link between causality and within-/between-person effects recently. They vividly explained how time-varying confounders can lead to erroneous within-person associations. By using time-varying Unit Effects, we controlled for relatively stable confounding factors (e.g., gender, work situation) that distinguish people from one another when building the model (see Chapter 4.3.4 for details on methods). However, as is the issue with most longitudinal data research, there might be changes in people's lives, that were simply not captured by our data. Future research could address the questions of which confounding factors impact the relationship of personality and leisure activities, at within-person level over time and how they do it.

The plateau of rank-order stability in middle adulthood described in other studies (Lucas & Donnellan, 2011, Roberts, Walton, & Viechtbauer, 2006, Specht, Egloff, & Schmukle, 2011) is reflected in our results. Study 3 suggests personality traits to appear less influenceable by changes in the environment, in this case by change in frequency of leisure activities, than in young and old adulthood. However, we acknowledge that there are other viable taxonomies of personality (Ashton & Lee, 2007) than Big Five personality traits, in addition to other levels of breadth and scope that could add valuable insights to personality development in middle adulthood and old age (Mõttus et al., 2017; Mõttus & Rozgonjuk, 2021).

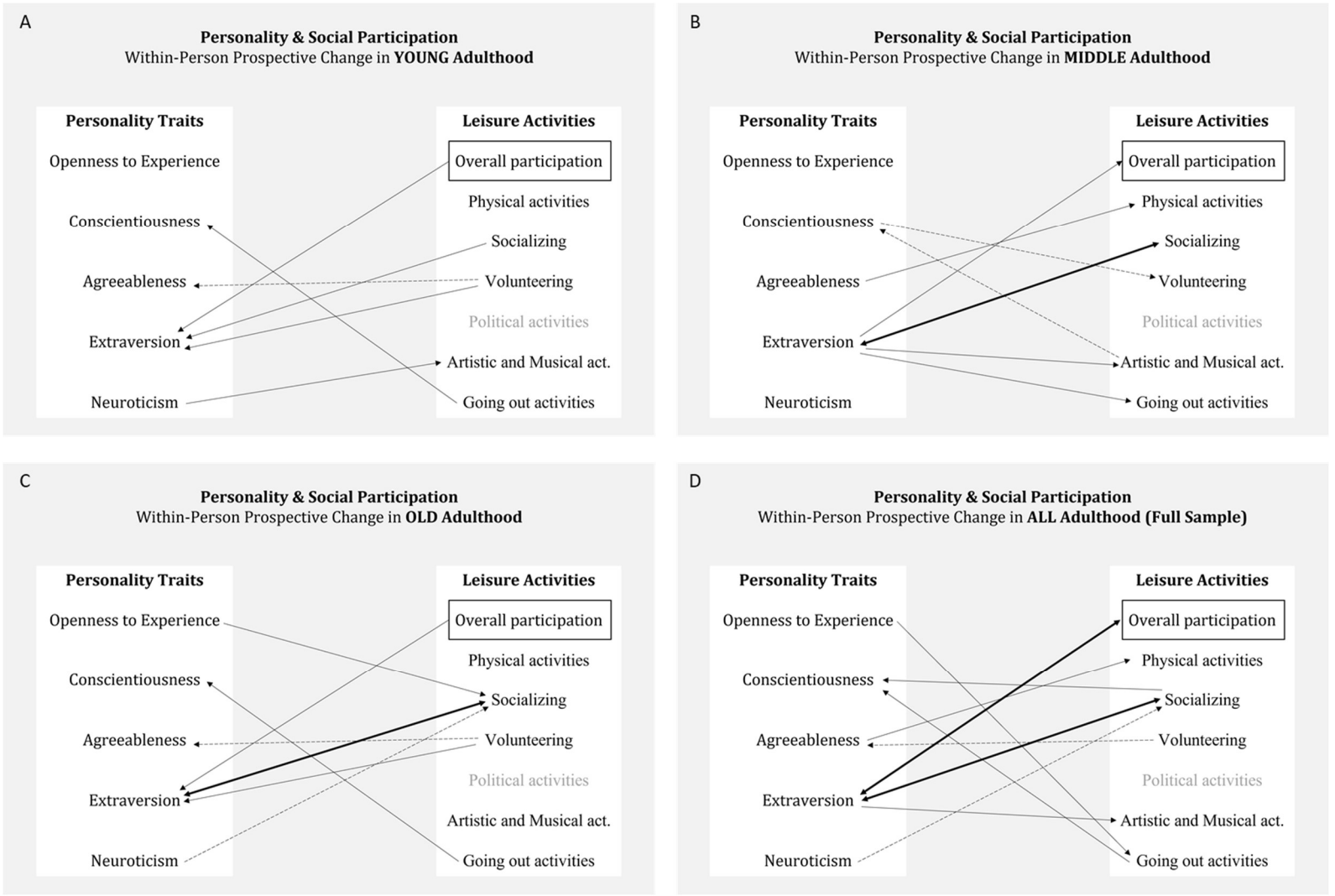

Figure 5.3 Illustration of results for research question 3(RQ3). A: young adulthood (18-30 years at T1) B: middle adulthood (31- 50 years at T1), C: old adulthood (51-75 years at T1). D: Results for all adulthood (18-75 years at T1), i.e., full sample. The direction of the arrow indicates the prospective within-person effect. Thick double arrows indicate reciprocal effects. Solid arrows indicate a positive effect. Dashed arrows indicate a negative effect.

5.2 Implications for Research on Adult Personality Development

Two questions are central to the field of developmental research on adult personality: Firstly, whether and how do personality traits develop across the life span? Secondly, what are the mechanisms of stability and change of personality traits?

The average development of personality traits across the adult life span has been well described. Extensive longitudinal research has shown that across young adulthood agreeableness, conscientiousness, openness and social dominance, i.e. a facet of extraversion, increase in mean-level, whereas neuroticism tends to decrease (Graham et al. 2020, Lucas & Donnellan, 2011; Specht, Egloff, & Schmukle, 2011, Roberts & Mroczek, 2008, Roberts, Walton, & Viechtbauer, 2006). With regard to late middle and old adulthood, several studies have shown mean-level decrease in extraversion and openness. In contrast neuroticism rather increases again in older adulthood (Graham et al. 2020, Roberts et al., 2006, Specht, Egloff, & Schmukle, 2011, Wagner, Ram, Smith, & Gerstorf, 2016, Wortman, Lucas, & Donnellan, 2012). The life period of middle adulthood, i.e. between age 40 and 60, is marked by fewer mean-level change and high rank-order stability (Lucas & Donnellan, 2011, Roberts, Walton, & Viechtbauer, 2006, Specht, Egloff, & Schmukle, 2011).

Regarding the explanation of personality development, the body of literature is somewhat more broad and ambiguous (for review, see Specht et al., 2014). Most recently, new theoretical frameworks have tried to integrate the eclectic evidence on sources of personality stability and change (Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017). Essentially, two interacting factors which influence personality development are proposed by these frameworks: (1) *personal* and (2) *environmental* sources. Personal factors include, for example the genetic disposition, biological functions and internal reflective or associative processes. Environmental sources comprise the wider context such as culture, social roles, life events, as well as more narrowly defined situations and daily hassles (Roberts & Caspi, 2001; Roberts & Caspi, 2003; Roberts & Wood, 2006; McCrae & Costa, 2008, Roberts, 2018; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017).

I attempted to further examine the *environmental influences* on personality by way of this dissertation. In line with Sociogenomic theory (Roberts & Jackson, 2008, Roberts, 2018) and the TESSERA framework by Wrzus and Roberts (2017), I hypothesized that repeated experiences in daily situations may elicit personality states, which in the long run impact personality traits via a bottom-up process. Moreover, I investigated the assumption of

transactional processes from individual life experiences to personality traits (and vice versa). Study 1 and Study 3 examined the impact of 100 days of cognitive training (see Chapter 2) and a change in frequency of different leisure activities (see Chapters 4) on personality trait development. Overall, this dissertation shows no counterevidence for repetitive trait-triggering situations leading to personality change.

However, this dissertation discerned that repeated, conceptionally trait-associated life experiences do *not* necessarily have a corresponding effect on personality change. Study 1 revealed that, although openness is associated with creative thinking and enjoyment of intellectual pursuit, an extensive cognitive training on memory and perceptual speed did not lead to enduring changes in openness to experiences trait or one of its facets. Conversely, we found surprising associations: For example, intensive cognitive training (Study 1) was associated with decreasing conscientiousness, more socializing and going-out activities (Study 3) was associated with increasing conscientiousness.

Additionally, between-person effects do not allow for conclusions about within-person effects of life experiences on personality change. Study 3 shows that the frequency of different leisure activities and a person's overall participation in leisure activities were strongly positively associated with the openness to experience trait on a between-person level. However, at a within-person level there was no relationship between the change in frequency of any leisure activity and change in openness to experiences.

Further, this dissertation complements the idea of transactional processes between personality and the environment (Roberts, 2018; Wagner, Orth, Bleidorn, Hopwood, & Kandler, 2020; Wrzus & Roberts, 2017). In Study 3 we found a reliable within-person feedback effect of change of overall leisure participation and socializing on change in extraversion across adulthood. Hence, we can now say that changing the frequency of meetings with family, friends and acquaintances has an impact on the development of a person's extraversion. Vice versa, an effect of changes in extraversion on changes in socializing and a person's overall engagement in leisure activity can be found. It should be stressed that it is not only a between-person relationship, i.e., the more extraverted someone is, the more he or she meets people and is active. Rather, social activity and overall participation in leisure activities may be driving forces of personality trait development.

The moderators of the relationship between repeated trait-triggering situations and personality trait changes require further research. Given the partially unpredicted results of Study1 and Study 3, one could derive that it will be necessary to focus on the personal sources of personality development. Questions such as, which internal processes and experiences are

elicited by an intensive cognitive training or by certain leisure activities for whom should be answered to better understand the mechanisms of personality stability and change. Future research on adult personality development needs to account for the complex way in which personal and environmental sources interact in shaping personality differences (see also Bleidorn and colleagues (2021) who argue for simultaneously including multiple potential sources of change related to the person, their genes, and their environments, in order to enhance findings in the research field of personality development).

In detail, according to the recent integration of the TESSERA framework on adult personality development (Wrzus & Roberts, 2017, see also Chapter 4.2.2 and 4.2.3), the following additional information should be recorded: (1) environment, i.e. proximate and cultural context of the person; (2) personal characteristics, e.g. dispositions/genetics, goals, health; (T) whether a situation perception is trait-relevant; (E) which expectancy, i.e. motivational construct is linked to the situation: (S) what is the elicited state, i.e. momentary thought, feeling, behavior by the situation; (SE) whether there is a discrepancy from state to the current trait-level; (RA) what reaction accompanies the state, i.e. own emotion or the other's feedback; (3) how often a similar chain (TESSERA-sequence) is repeated; (4) which (self)-reflection processes take place; (5) which associative processes, e.g. habit formation takes place. All these factors may be crucial variables of personality stability and change across the lifespan. Especially reflective and associative processes could not be investigated in this dissertation, whilst may be the most decisive predictors for adult personality development (see also Costa, McCrae, & Löckenhoff, 2019).

5.3 Implications for Research on Adult Social Development

I address the implications of the findings of this dissertation which contribute to the understanding of adult social development in this section. Specifically, based on the results from Study 2 and Study 3 (see Chapters 3 and 4), I aim to highlight pivotal findings and open questions regarding the development of social participation across adulthood.

Research on adult social development traditionally focused on the description of changes in network sizes of different network circles. This process often involved distinguishing between family and other relationships. There is evidence for friendship networks decreasing in size, whereas family networks remain stable in size from adolescence to old age (e.g., English & Carstensen, 2014; Wrzus, Hänel, Wagner, & Neyer, 2013). The development of social network size and composition was explained theoretically by *personal* factors, e. g. by a shift in motivational goals (see Socio-emotional selectivity theory by

Carstensen, 1995, 2006) or age and gender and *environmental characteristics*, e. g. role demands, norms, context, and life events (see social convoy theory by Antonucci, Ajrouch, & Birditt (2014), Wrusz et al 2013).

However, social participation is more than just the size of the network. The feeling of being embedded and integrated also depends on how often people interact with others (Baumeister & Leary, 1995; Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Yang et al., 2016). Less was known regarding the development of frequency of (in-person) social contact frequency across the adult life span. Further, the extent to which social behavior depends on environmental factors such as life events and social roles or personal factors (e.g., genetics, health, individual traits, internal processes and motives) was sparsely investigated so far.

This dissertation showed that there is a normative development of social contact frequency similar to network size across adulthood (see Study 2). That is, frequency of in-person contact with family members remains rather stable across the life span. The frequency of visits to and from nonfamily members (i.e. neighbors, friends, and acquaintances) declines, following a cubic trajectory and a drop below the frequency of family visits between age 35 and 36. We interpreted these results as supportive of the evolutionary life history approach (Kenrick, Neuberg, & White, 2013; Neuberg, Kenrick, & Schaller, 2010), rather than being congruent with the more prominent socioemotional selectivity theory by Carstensen (1995, 2006). Socioemotional selectivity theory predicts decline of nonfamily contacts at the end of life only, due to change in motivational goals. The evolutionary life history approach would attribute the observed decrease of contact with nonfamily members during mid-thirties to already successful mating and reproduction.

In terms of antecedents of social behavior in adulthood, this dissertation found that environmental factors have a rather minor impact on its development (see Study 2). Relationship status exhibits a slight effect on both in-person contact frequency with family and nonfamily network. Yet employment status influenced the life span trajectory of nonfamily social contact only. Major life events, such as change of residence and the birth of a child, did not affect the life span trajectory of either family or nonfamily in-person contact frequency.

Personal factors appeared to have more of an effect than situational ones with regard to the development of social behavior across the life span. That is, gender had a slight effect on contact frequency with family and nonfamily network. Subjective current health status influenced the life span trajectory of nonfamily social contact. Additionally, we found

personality development to be both, a source and a consequence of change in frequency of socializing with family, friends and acquaintances (see Study 3). Especially in old age increasing neuroticism leads to decreasing social activity. Increasing openness of a person results in prospective increase in social activity. For socializing activity and a person's overall participation in leisure activity, we found a within-person feedback effect with extraversion, that is a positive prospective effect in both directions.

The evidence presented in this dissertation supports the idea that development of adult social behavior is influenced by internal sources such as gene regulation and expression (e.g. gender), biological structures and functions (e.g. health), and personality (e.g. traits). Thus, the development of social behavior across adulthood may be linked to personality development and its respective mechanisms (see also the Integrative Model of Sources of Personality Stability and Change by Wagner, Orth, Bleidorn, Hopwood & Kandler, 2020). Hence, this dissertation lays the groundwork for future research into various mechanisms of stability and change of people's social participation over time. Researchers should rely on a multi-method approach – with an increased focus on personal factors than is the case to date.

5.4 Limitations and Directions for Future Research

The individual discussion sections of Chapter 2 to 4 addressed specific limitations of each single study. I discuss additional, general limitations of this dissertation to derive further directions for future research on adult development of personality traits and social participation in this section.

A core strength of this dissertation is that all three published empirical studies were based on large and age-heterogenous samples. Thus, we were able to investigate adult lifespan development with longitudinal data. Additionally, we applied an advanced statistical methodology. That is, in Study 1 we used a multigroup latent change score model (LCSM; McArdle, 2009) to explore the change in personality facets, free of measurement error, due to a cognitive training intervention. In Study 2 we applied a cohort-sequential longitudinal study to examine cubic growth curve models that captured the development of frequency of family and visits across the entirety of adulthood. In this context, we added time-varying and time-constant covariates (Mehta & West, 2000; Preacher, Wichman, MacCallum, & Briggs, 2008). Study 3 used a random-intercept cross-lagged panel model (RI-CLPM, Hamaker et al., 2015; Zyphur et al. 2020) to distinguish between within-person and between-person effects, when investigating the bivariate development of leisure activities and personality traits.

However, this dissertation is limited in that it relies on self-report data only. Self-report data are influenced by self-concepts and can thus deviate from the perception of other persons or objective measures. Moreover, self-reported traits and social participation data are not sufficient to capture the internal processes that lead to their development. Thus, a paucity of evidence on aspects of personality and social participation development based on other forms of data remains. Since multiple within-person (genes, self-regulatory processes) and external (environment, situation) sources interact and shape an individual's personality and social behavior, a more complex and exhaustive data collection may be necessary to successfully model its development.

A logical progression of this work is to further analyze the co-development of social behavior and personality development across adulthood. Study 3 showed that socializing is the only leisure activity studied that highlights within-person reciprocal effects with a personality trait, in this case extraversion. Apparently, extraverts generally behave more sociably. That is, extraversion predicts sociable behavior (e.g., Breil et al., 2019). However, a further investigation of the within-person relationship between the two constructs may be worthwhile exploring. In particular, the path through which social behavior affects the extraversion trait is unclear as of yet. The underlying processes of this link should be studied utilizing in-vivo data on thoughts, feelings and reactions centered around the socializing activities.

Up to now, the dynamic day-to-day interplay between personality traits and social participation remains unclear. Future research could assess the short-term effects of investigated environmental influences (e.g., cognitive training, life events, leisure activities) on personality development and social participation. One limitation of this thesis are the extensive time intervals (up to 4 years) between the measurement points in all studies. This may have resulted in effects being underestimated and short-term changes and correlations not being made visible. More objective and short-scale measures, e. g. via smartphone sensing and experience sampling methods, may provide better insight into the interaction of personality and social relationships.

Fundamentally, a test of recent theoretical frameworks on personality development such as the TESSERA framework (Wrzus & Roberts, 2017), the Revised Sociogenomic Model of Personality Traits (Roberts, 2018), or the Integrative Model of Sources of Personality Stability and Change offered by Wagner and colleagues (2020) (see Chapter 1.2.3 for details) appear to be informative for the research field of social relationships. That is, these frameworks predict, in addition to personality change, a person's selection of and behavior in

a situation, thus also social participation, by different internal processes, and thereby take environmental influences and biological processes into account. Study 1 and 2 of this dissertation were designed and conducted between 2015 and 2017. Ultimately, the more recent theoretical considerations mentioned could not be taken into account yet.

Our findings (see Study 2) and recent theoretical work (see Roberts, 2018, Wagner et al., 2020) re-emphasized the focus on evolutionary biology informed models of development. Further research is required to determine how internal biological and cognitive processes interact with external influences. Kandler and colleagues (2021) recently summarized the current knowledge on genotype-environment interplays. They explained that an individual's personality is not only a product of transactions between genetics and life experiences, but is also a driving and moderating part of their own development. In spite of its limitations, the thesis certainly adds to our understanding of the responsiveness of personality traits to the environment and of the development of social participation across adulthood.

5.5 Implications for Practical Application

The longitudinal analyses of this dissertation suggest that the examined external sources, considered on their own, are not, or only to a very limited extent, capable of influencing personality traits and social participation. As mentioned in the introduction, social participation and personality traits can predict important life outcomes, such as a person's well-being, good health, and longevity (Berkman, Glass, Brissette & Seeman, 2000; Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007; Soto, 2019; Ozer & Benet-Martinez, 2006). Thus, public interest in understanding the mechanisms of change is understandably considerable (Bleidorn et al., 2019). The consumer is tempted to "optimize" one's personality and thus possibly other life outcomes through cognitive training or stimulating leisure activities. Nevertheless, the results of the thesis warn not to succumb to false promises. Sheer repetition of putative trait-triggering activities does not necessarily result in personality change, as discussed in Study 1 and 3.

Yet the data reported in Study 3 appear to support the assumption that social participation and personality change are interwoven. Some evidence suggests that it might be fruitful to meet family, friends and acquaintances more often in order to enhance one's extraversion trait. This cross-lagged relation was shown for young, middle as well as in old adulthood. Yet, Study 2 revealed that in-person contact frequency to the nonfamily network declines in adulthood, and by the stage of mid-30s, the frequency of reciprocal visits is

already less than the one with family. According to the normative trajectory, extraversion decreases with age as well. Possibly, one could try to actively counteract the descending of nonfamily contacts to foster extraversion throughout the adult life span.

Furthermore, the results of Study 3, presented in Chapter 4, suggests that more frequent volunteering might increase a person's extraversion in young and old adulthood. Additionally, we found more frequent going-out activities, such as going to the cinema, may increase conscientiousness in young and old adulthood. However, this investigation was merely exploratory in terms of the relationship between changes in leisure activities and changes in personality. The results need replication before recommendations for practice can be derived.

5.6 Conclusion

Grounded in an integration of the literature on personality and social adult development, the present dissertation investigated how average in-person social contact frequency develops across the adult life span, the accompanying external factors that may influence changes in personality and social participation and the ways in which both developments interact.

Analyses of longitudinal data suggest that the average level of frequency of social contact with family remains relatively stable. In contrast, frequency of social contact with nonfamily members declines, already during early adulthood. Surprisingly, life span trajectories of social contact frequency were rather unaffected by external sources, that is life events had no effect (birth of a child, change of residence). Environment and social roles, such as employment status or relationship status only partly or slightly influenced the development of social contact frequency. However, internal factors such as gender, health and personality traits showed some impact on social participation. Specifically, the results showed a prospective within-person feedback effect of change in socializing and overall participation in leisure activities with change in extraversion.

Overall, the impact of external factors on personality development was lower than expected as well. Results verified that even an extensive cognitive training did not serve as a sufficient intervention for enduring long-term changes in openness to experiences. Furthermore, this dissertation revealed that joint change of specific leisure activities with certain personality traits occurs solely with regard to certain age groups. Moreover, the direction of effects varies. Especially in young and old adulthood some leisure activities subsequently affect personality traits. For example, a positive cross-lagged effect of

volunteering on extraversion was significant in that direction and in young and old age groups only. In middle adulthood, this tends to be reversed and a change in personality traits leads to a change in frequency of certain leisure activities in rare cases but not vice versa.

Altogether, this thesis supports the idea that repetitive trait-triggering situations can lead to personality change. Still, considerably more research is required to determine which situations trigger specific traits in whom and how trait-triggering situations are processed to affect personality. Moreover, the present results indicate that the development of personality and social participation of adults are interrelated. Future studies are needed to investigate the interaction in more detail. One particularly interesting approach would be to examine both phenomena in one single model (see for example Wagner et al. 2020). A greater focus on the interplay of internal and external sources of adult lifespan development, common for personality and social behavior, could produce an even more extensive understanding and thus, at some point, more targeted interventions.

In conclusion, personality traits and social participations are subject to change across adulthood. Their development depends partly on external sources or environmental influences. However, important influencing factors within a person need to be considered, given that they are genetically determined and can be highly individual depending on the case. Interventions can be considered to favorably influence the course only after these underlying complexities are understood better.

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Lebenslauf

Julia Sander

Die biografischen Angaben des Lebenslaufs sind in der Online-Version der Dissertation aus Gründen des Datenschutzes nicht enthalten.

VERÖFFENTLICHUNGEN

*Peer-reviewed Journal Articles; * indicates that articles are part of the thesis.*

2021 **Sander**, J., Bolinski, F., Diekmann, S., Gaebel, W., Günther, K., Hauth, I., Heinz, A., Kleiboer, A., Riper, H., Trost, N., Vlijter, O., Zielasek, J., & Gerlinger, G. (2021). Online therapy: an added value for inpatient routine care? Perspectives from mental health care professionals. *European archives of psychiatry and clinical neuroscience*, 1–12. Advance online publication. https://doi.org/10.1007/s00406-021-01251-1

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KONFERNZBEITRÄGE

2016 **Sander**, J., Schmiedek, F., Brose, A., Wagner, G. G., & Specht, J. *Personality development and long-term effects of an extensive cognitive training*. Vortrag auf der 50. Konferenz der DGPs, Leipzig, 18.-22. September 2016

2016 **Sander**, J., Schupp, J. & Richter, D. *Development of social contact frequency across the life span*. Talk at the LIFE Spring Academy, Charlottesville (VA), USA, May 29th - June 2nd 2016

2016 **Sander**, J., Schmiedek, F., Brose, A., Wagner, G. G., & Specht, J. *Long-term effects of an extensive cognitive training on personality development*. Talk at the ECP18, Timisoara, Romania, July 19th-23rd 2016

2015 **Sander**, J., Schmiedek, F., Brose, A., Wagner, G. G., & Specht, J. *Cognitive training and personality development*. Poster at LIFE Fall Academy, Zürich, Schweiz, October 18th–22nd, 2015

2015 **Sander**, J., Schupp, J. & Richter, D. *Is Blood Thicker than Water? - Development of Social Contact Frequency across the Adult Life Span.* Poster at LIFE Spring Academy, Ann Arbor (MI), USA, May 18th–22nd, 2015

2015 **Sander, J.,** Schupp, J. & Richter, D. *Entwicklung von sozialen Kontakten über die Lebensspanne*. Vortrag auf der EPSY 2015, Frankfurt am Main, 31. August - 2. September 2015

2015 Specht, J., & **Sander, J**. *Am the life of the party? - Persönlichkeitsmessung im hohen Alter*. Vortrag auf der DPPD 2015, Mainz, 21.-23. September 2015

Erklärung zur Dissertation

Hiermit versichere ich, dass ich die vorliegende Arbeit selbstständig verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht verwendet. Die Arbeit ist in keinem früheren Promotionsverfahren angenommen oder abgelehnt worden.

Berlin, 06. Dezember 2021
Julia Sander