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SOEP — The German Socio-Economic Panel study at DIW Berlin 816-2016

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DIW SOEP

ISSN: 1864-6689 (online)

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Stability and Change in Risk-Taking Propensity Across the Adult Lifespan

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Author Note

A.K.J. has been funded by the International Max Planck Research School on the Life Course (http://www.imprs-life.mpg.de/). G.R.S.-L. has been supported by the US National Institute on Aging (K99-AG042596), G.G.W. by the Federal Department of Education and Research (VDI/VDE–16SV5537), and R.H. by the Swiss National Science Foundation (CRSII1_136227). The authors thank Jürgen Schupp for innovative survey management of the German Socio-Economic Panel Study (SOEP); Monika Oppong for help with data management; Jutta Mata and Stefan Schmukle for help with data analysis methods; and Susannah Goss for editing the manuscript.

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Abstract

Can risk-taking propensity be thought of as a trait that captures individual differences across domains, measures, and time? Studying stability in risk-taking propensities across the lifespan can help to answer such questions by uncovering parallel, or divergent, trajectories across domains and measures. We contribute to this effort by using data from respondents aged 18 to 85 in the German Socio-Economic Panel Study (SOEP) and by examining (1) differential stability, (2) mean-level differences, and (3) individual-level changes in self-reported general (N = 44,076) and domain-specific (N =11,903) risk-taking propensities across adulthood. In addition, we investigate (4) the correspondence between cross-sectional trajectories of self-report and behavioral measures of social (trust game; N = 646) and nonsocial (monetary gamble; N = 433) risk taking. The results suggest that risk-taking propensity can be understood as a trait with moderate stability. Results show reliable mean-level differences across the lifespan, with risk-taking propensities typically decreasing with age, although significant variation emerges across domains and individuals. Interestingly, the mean-level trajectory for behavioral measures of social and nonsocial risk taking was similar to those obtained from self-reported risk, despite small correlations between task behavior and self-reports. Individual-level analyses suggest a link between changes in risk-taking propensities both across domains and in relation to changes in some of the Big Five personality traits. Overall, these results raise important questions concerning the role of common processes or events that shape the lifespan development of risk-taking across domains as well as other major personality facets.

Keywords: risk taking, individual differences, lifespan development, domain specificity, differential stability

Max(words) = 250; Actual(words) = 244

Stability and Change in Risk-taking Propensity Across the Lifespan

Definitions of risk and risk taking abound (Aven, 2012; Schonberg, Fox, & Poldrack, 2011). This conceptual diversity may be partly responsible for ongoing debates regarding the construct of risk-taking propensity, including how to best measure it (Friedman, Isaac, Duncan, & Sunder, 2014; Schonberg et al., 2011) and whether to conceptualize it as a general or a domain-specific trait (Weber, Blais, & Betz, 2002). An important issue in this regard is the development of risk-taking propensity across the lifespan, including its stability and change across measures and domains (Mata, Josef, Samanez-Larkin, & Hertwig, 2011; Rieger & Mata, 2013). Crucially, any insights into lifespan changes in risk-taking propensity may depend on how change is conceptualized. Personality research has distinguished between different types of change, with conceptually and empirically distinct implications (Briley & Tucker-Drob, 2014; Roberts & DelVeccino, 2000). For example, differential stability, or rank-order stability, a defining feature of a trait, can be independent from mean-level or normative age-related changes in the same trait.

Past work on adult age differences in risk taking has focused on mean-level changes estimated from cross-sectional comparisons, thus precluding a direct investigation of other conceptualizations of stability/change (e.g., rank-order stability). In our work, we explore different conceptualizations of stability and change in risk-taking propensity across the adult lifespan by drawing on a unique data set from the German Socio-Economic Panel Study (SOEP) (Wagner, Frick, & Schupp, 2007). This multi-cohort study combines longitudinal self-report data on both general and domain-specific risk-taking propensity with cross-sectional behavioral measurements of risk taking. Specifically, we investigate (1) differential stability, (2) mean-level differences, and (3) individual-level differences in change in both general and domain-specific self-report measures of risk-taking propensity, and relate (4) mean-level changes in self-report to mean-level changes in behavioral measures of social and nonsocial risk taking. Our goal is to advance the understanding of risk taking by evaluating the role of both domain (e.g., financial, social) and measure (self-report vs. behavior) on the stability of risk-taking propensity across adulthood.

In what follows, we first provide an overview of some of the constructs of change that have been investigated in the personality literature. Second, we review previous work on risk-taking propensity against the background of different conceptualizations of change. Third, we describe the present study and the main research questions addressed.

Characterizing Lifespan Changes in Personality

There are several conceptually and empirically distinct approaches to personality stability/change. We highlight three main types: differential stability, mean-level stability, and individual-level stability (Briley & Tucker-Drob, 2014; Roberts & DelVecchio, 2000). First, *differential stability* refers to consistency in the rank ordering of individuals over time. The idea that individuals differ systematically from one another and that those differences are maintained over time echoes the concept of a trait. A number of meta-analyses have found that key personality traits, the Big Five personality traits, show considerable rank-order stability (Briley & Tucker-Drob, 2014; Ferguson, 2010; Roberts & DelVecchio, 2000). However, differential stability of personality traits undergoes systematic changes across the lifespan, with correlations ranging from 0 in infancy to .7 in adulthood (Briley & Tucker-Drob, 2014). There is still debate concerning whether there is some decrease in stability at the end of the lifespan. Meta-analytic results show only a trend toward decreasing stability in old age (Briley & Tucker-Drob, 2014); but a few studies with large numbers of older individuals have found clear inverted U-shaped patterns in differential stability for all Big Five personality traits (Lucas & Donnellan, 2011; Specht, Egloff, & Schmukle, 2011; Wortman, Lucas, & Donnellan, 2012). From a developmental perspective, it seems reasonable to expect an inverted U-shaped pattern, because periods marked by significant biological, cognitive, or social changes—that is, young adulthood and old age—could lead to marked changes in phenotypes, including personality traits such as risk-taking propensity, and their adaptation to these changes at different phases of the lifespan.

Second, *mean-level stability* refers to consistency in the *average* level of traits over time, and thus reflects normative/general patterns that apply to large numbers of individuals. Importantly, personality traits with high differential (rank-order) stability show systematic mean-level changes across the lifespan. For example, a number of studies coincide in their finding that average levels of agreeableness and conscientiousness show increasing mean-level trends across the lifespan, while neuroticism and openness to experience, in contrast, show reliable mean-level decreases with age (Lucas & Donnellan, 2009, 2011; Roberts, Walton, & Viechtbauer, 2006; Specht et al., 2011). The mean-level developmental trends observed for personality traits are typically thought to be adaptive in the sense of improving individuals' capabilities to fulfill adult roles such as increased relationship stability and quality, or success at work, among others (i.e., the maturity principle of personality development; Caspi, Roberts, & Shiner, 2005). There is considerable debate, however, about the role of biological (Costa & McCrae, 2006) and social factors (Roberts, Wood, & Smith, 2005) in engendering mean-level personality change.

Third, *individual-level stability* refers to the consistency of a trait at the level of the individual person. One typical way of detecting this kind of stability is to test for individual differences in change in a growth-modeling context: Significant variance in slopes confirms the presence of exceptions to the normative (mean-level) trend for the sample. Note that, on the whole, a lack of mean-level change does not preclude individual-level variation or individual differences in change across time: A trait may increase across the lifespan in some individuals, but decrease in others, resulting in no overall mean-change at the group level despite significant individual-level changes (i.e., variance in slopes). One issue related to individual-level change is whether individual differences can be accounted for by other endogenous or exogenous variables, that is, specific predictors that may be associated with individual differences in change. For example, Chopik, Kim, and Smith (2015) show that within-person changes in optimism across the lifespan are systematically related to within-person changes in self-reported levels of health, consistent (albeit not conclusively) with the hypothesis that individual differences in the former are caused by the latter. The investigation of individual changes and their predictors (e.g., cognitive ability, health, life events) can thus be important for gaining greater insight into the individual dynamics of personality development across the lifespan.

The Concept of Risk-Taking Propensity and Potential Changes Across the Lifespan

The literature offers various definitions of risk and risk taking (Aven, 2012; Schonberg et al., 2011). One characterization of risk-taking propensity is the tendency to engage in behavior that bears the chance of losses (e.g., financial losses, physical harm) as well as gains (e.g., financial gains, excitement). Disciplines such as economics and psychology have developed different measures of such tendencies (Appelt, Milch, Handgraaf, & Weber, 2011). In economics, for example, individual risk-taking propensity is often estimated from choices between monetary lotteries with varying probabilities of gains and/or losses (Holt & Laury, 2002; Markowitz, 1952). Other measures integrate the social context, with individual outcomes and their probabilities depending on another person (Ben-Ner & Halldorsson, 2010; Berg, Dickhaut, & McCabe, 1995; Fehr, Fischbacher, Schupp, Rosenbladt, & Wagner, 2002; Houser, Schunk, & Winter, 2010; Lönnqvist,Verkasalo, Walkowitz, & Wichardt, 2011; Nickel & Vaesen, 2012). In psychology, there have been two common approaches to measuring risk-taking propensity: The first employs behavioral measures of risk taking, including the monetary lotteries described above, but also tasks that try to capture learning and experience (e.g., Hertwig & Erev, 2009), such as *n*-armed bandit tasks (Bechara, Damasio, & Damasio, 1994) or other sequential decision tasks (Lejuez et al., 2002). The second approach employs self-report measures to elicit individual risk preferences in hypothetical scenarios or real-world behavior (Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005; Weber et al., 2002; Wortman et al., 2012).

There is ongoing debate about how these different behavioral and self-report measures relate to each other as well as to real-world behavior. Past work suggests that the behavioral and self-report measures are only weakly correlated, and that correlations to real-world behavior are, at best, small (Anderson & Mellor, 2008; Berg, Dickhaut, & McCabe, 2005; Dohmen et al., 2011; Friedman et al., 2014; Schoemaker, 1990). One potential contributor to the poor correlation between measures is the extent to which risk-taking propensity is specific to particular domains (Weber et al., 2002). Some empirical investigations of self-report measures suggest that it is possible to separate distinct factors of risk taking (i.e., social, financial, health) and that these factors can characterize risk-taking propensities of distinct groups of individuals (Hanoch & Gummerum, 2011). Hanoch, Johnson, and Wilke (2006), for example, demonstrated that targeted subgroups of individuals (e.g. investors or smokers) scored highest in risk-taking propensity in the respective risk domain (e.g. financial or health) relative to other life domains. Partly due to the lack of systematic quantitative reviews estimating the links between different risk measures and domains, it remains unclear whether domain specificity can fully account for the small correlations observed among risk-taking measures and real-world outcomes.

In this study, we examine whether lifespan changes unfold in similar ways across different domains and measures of risk taking, thus providing further insights into the anatomy of risk taking. In the following, we briefly review past research based on the three conceptualizations of change outlined above. We focus on research on adulthood and aging rather than early and adolescent development, which has received considerable attention elsewhere (Braams, Duijvenvoorde, Peper, & Crone, 2015; Defoe, Dubas, Figner, & van Aken, 2014; Figner, Mackinlay, Wilkening, & Weber, 2009; Harden, Quinn, & Tucker-Drob, 2011; Shulman, Harden, Chein, & Steinberg, 2014; Steinberg, 2008).

Rank-order stability in risk-taking propensity

As mentioned above, there is evidence for an inverted U-shaped link between age and rank-order stability in many personality traits. This pattern could represent the effects of biological, cognitive, or social changes that occur at both ends of the lifespan (Lucas & Donnellan, 2011; Specht et al., 2011). Does this pattern extend to risk-taking propensity? Does it generalize across domains? Findings of domain-specificity in rank-order stability functions could provide insights into different causes in the development of risk taking in different domains of life.

Data on the rank-order stability of risk taking propensity are scarce and little to nothing is known about changes across the lifespan. Only very few studies have examined behavioral measures of risk across longer time spans (see Chuang & Schechter, 2015, for an overview). Even at short time spans, however, the rank-order stability of behavioral measures seems to vary considerably across measures and studies. Some studies have found evidence for moderate rank-order stability of behavioral measures over short periods of time of days or weeks (Harrison, Johnson, McInnes, & Rutström, 2005; Lejuez et al., 2002), while other studies have reported poor rank-order stability across short delays and between different risk measures collected at the same measurement occasion (Anderson & Mellor, 2008; Berg et al., 2005; Dave, Eckel, Johnson, & Rojas, 2010; Friedman et al., 2014; Reynaud & Couture, 2012; Schoemaker, 1990; Szrek, Chao, Ramlagen, & Peltzer, 2012). The few published studies using longer delays suggest low to moderate rank-order stability (Anokhin, Golosheykin, Grant, & Heath, 2009; Chuang & Schechter, 2015; Lönnqvist et al., 2011).

More studies have used self-report data to assess risk taking or related constructs, such as sensation seeking and impulsivity that show moderate levels of stability over time (Collado, Felton, MacPherson, & Lejuez, 2014; Niv, Tuvblad, Raine, Wang, & Baker, 2012; Roth, Schumacher, & Brähler, 2005; Zuckerman & Kuhlman, 2000). For self-reported risk-taking propensity measures, studies suggest high rank-order stability across short intervals (Blais & Weber, 2006) and medium to high levels of rank-order stability across longer periods of years (Sahm, 2012). However, most studies have typically focused on adolescents (Niv et al., 2012), have not included large numbers of older adults, or failed to provide analyses of developmental issues (Benjamin et al., 2012; Chuang & Schechter, 2015; Jung & Treibich, 2014; Mandal & Roe, 2014). Consequently, little is known about patterns of rank-order stability in risk taking across the adult lifespan, and nothing about the domain-specificity of such patterns.

Mean-level differences in risk-taking propensity

Biological theories view the propensity for risk taking as a behavioral strategy or functional adaptation to maximize reproductive success (Campbell, 1999; Mishra, 2014; Sih & Del Giudice, 2012). Risk taking thus serves an adaptive function that may vary across the lifespan. According to behavioral ecology, in young adulthood, risk behaviors may be instrumental in gaining access to potential mating partners via resource control and status. Consequently, risky and competitive behaviors can be expected to be more prevalent among young males than among females and older individuals (Daly & Wilson, 1997; Mishra, 2014). Later in the life cycle, individuals are expected to place higher value on objectives such as guarding their own lives because their offspring's survival depends on parental and, in particular, maternal care and defense (Campbell, 1999). Behavioral ecology would further predict that patterns of lifespan changes in risk taking vary as a function of domain to the extent that different domains are more or less instrumental to survival and reproductive success across adulthood. To our knowledge, however, there has been no explicit theorizing about domain-specific differences in the lifespan trajectory of risk taking.

The bulk of empirical research on risk taking across adulthood has investigated mean-level changes. Findings based on behavioral measures of risk taking have been mixed, with some measures indicating a reduction in risk taking with age and others showing no differences or even increases. Most notably, recent meta-analyses report more pronounced age differences in behavioral risk tasks that require learning of the relationship between outcomes and probabilities such as in the Iowa Gambling Task (IGT) or the Balloon Analogue Risk Task (BART) relative to standard gamble paradigms (Best & Charness, 2015; Mata et al., 2011). This heterogeneity as a function of measures also mirrors results from research summarized in a meta-analysis on adolescent risk taking (Defoe et al., 2014). Against this background, there is considerable interest in task characteristics (e.g., memory and learning demands) that may engender specific patterns of age differences in behavioral measures of risk taking (Frey, Mata, & Hertwig, 2015). Another avenue has been to investigate self-reported risk taking, for which results seem more consistent, showing a decrease in risk-taking propensity across adulthood (Bonem, Ellsworth, & Gonzalez, 2015; Mata, Josef, & Hertwig, in press; Roalf, Mitchell, Harbaugh, & Janowsky, 2012; Rolison, Hanoch, Wood, & Liu, 2013; Rosman, Garcia, Lee, Butler, & Schwartz, 2013; Schwartz et al., 2013). Importantly, investigations of age differences in self-reported risk-taking propensity in different domains suggest that the overall reduction in risk-taking propensity plays out somewhat differently as a function of domain (e.g., financial, health, social). That is, financial and recreational risk-taking propensity showed steeper declines relative to risk-taking propensity in the social, ethical and health domains (Rolison et al., 2013).

It is important to note that this work on mean-level changes in risk taking has been conducted using cross-sectional designs. To our knowledge, there has been no assessment of longitudinal change in self-reported risk-taking propensity as a function of domain. Consequently, it remains unclear whether the cross-sectional findings generalize to longitudinal change in risk-taking propensity. Finally, the link between self-report and behavioral patterns of risk taking across adulthood remains to be studied. Some studies have investigated this link in young populations and provide evidence for only small correlations between the two types of risk measures (Mishra, Lalumière, & Williams, 2010; Szrek et al., 2012). It remains unclear whether self-report and behavioral measures capture similar mean-level changes in risk taking across the lifespan, and do so similarly across domains.

Individual-level differences in risk-taking propensity

A number of hypotheses have been formulated on the link between individual differences in risk taking and other individual characteristics. Classic economic theories suggest that situational characteristics, such as fluctuations in individual's wealth (Bernoulli, 1954; Brunnermeier & Nagel, 2008; Chiappori & Paiella, 2011), play an important role in individual differences on risk taking. More recently, there has been an attempt to ground theories of individual differences in economic behavior in personality theory (Borghans, Duckworth, Heckman, & Weel, 2008). In line with these efforts, various studies have investigated the relation between risk taking and the Big Five personality factors. Although the results are mixed, there is some evidence that individual differences in personality may be related to risk-taking behavior: Risk taking has been found to be positively associated with openness to experience, extraversion, and sensation seeking; and negatively associated with agreeableness and neuroticism (Becker, Decker, Dohmen, Falk, & Kosse, 2012; Deck, Jungmin, Reyes, & Rosen, 2012; Mishra & Lalumière, 2011; Nicholson et al., 2005; Prinz, Gründer, Hilgers, Holtemöller, & Vernaleken, 2014). There are also some findings linking personality variables to performance on behavioral measures of risk taking, such as the Iowa Gambling or the Balloon Analogue Risk Task. Yet, the pattern of results is also mixed, partly due to the use of different personality and temperament measures as well as behavioral tasks (Hooper, Luciana, Wahlstrom, Conklin, & Yarger, 2008, Lauriola, Panno, Levin, & Lejuez, 2014; Suhr & Tsanadis, 2007). To our knowledge, however, there have been no attempts to directly link *change* in situational and personality variables to individual-level *change* in risk-taking propensity or to examine whether such effects vary across domains. Identifying parallels between the development of major personality traits and risk-taking propensity is an important step in relating these constructs.

The Present Study

Using an extensive longitudinal data set representative of the population living in Germany, we aim to assess stability in risk-taking propensity across adulthood, and the domain-generality (or specificity) thereof. To this end, we examine the following research questions: Are there systematic lifespan differences in (1) differential and (2) mean-level stability of both general and domain-specific self-report measures of risk-taking propensity? Are there (3) intraindividual differences in change in risk-taking propensity and what are their predictors? Also, (4) do any mean-level changes in self-reported risk-taking propensity correspond to those observed in behavioral measures of social and nonsocial risk taking? We thus examine the nature of risk taking by evaluating the role of both domain (e.g., financial, social) and measure (self-report vs. behavior) on stability of risk-taking propensity across adulthood.

We used longitudinal data from the German Socio-Economic Panel Study (SOEP; Wagner et al., 2007) to examine lifespan trajectories in self-reported domain-general and domain-specific risk-taking propensity. To our knowledge, this is the longest-term and most complete multi-cohort dataset available to model risk-taking trajectories across the lifespan using within-person data. First, from 2004 on, and for up to nine years, over 44,000 SOEP respondents answered a question on their domain-general risk-taking propensity (Dohmen et al., 2011). Second, a subsample of over 11,000 respondents answered six additional questions concerning their propensity to take risks in the driving, financial, recreational, occupational, health, and social domain in up to three waves at five-year intervals (specifically, in 2004, 2009, and 2014). These data from a large number of individuals of different ages, followed up over time, allow us to discern between mean-level population trends, as investigated in cross-sectional studies, and individual differences in change in risk-taking propensity over time. Third, we were able to connect these rich data on risk-taking to individual personality measurements (i.e., the Big Five; openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) assessed in 2005, 2009, and 2013 (Lang, John, Lüdke, Schupp, & Wagner, 2011) and other potentially relevant variables (e.g., current income) to investigate sources of individual differences in change in risk-taking in different domains across adulthood. Fourth, and finally, we compared results based on self-report measures with results from behavioral experiments, using data from two subsamples of SOEP respondents who participated in two behavioral tests thought to measure social and nonsocial forms of risk-taking behavior, respectively: a trust game assessed in 2004 (*N* = 646) and a monetary lottery assessed in 2005 (*N* = 433; Fehr et al., 2002; Holt & Laury, 2002; see Method for details).

Method

German Socio-Economic Panel (SOEP), 1984–2014

The German Socio-Economic Panel (SOEP, www.leibniz-soep.de) is a large longitudinal multi-cohort survey collected in households in Germany that has compiled data by means of face-to-face and computer-assisted personalized interviews (CAPI) since 1984 (Wagner et al., 2007). Private households are sampled to be representative of the population living in Germany in terms of several demographic and occupational characteristics and geographical region. Moreover, active efforts are made to maintain the representativeness of the sample by interviewing split-offs from the original households. For example, when a young person leaves the parental household, his/her new household becomes part of the study. The SOEP thus provides information about a large number of individuals over several time points and can be used to investigate the dynamics of important economic, social, and psychological variables across the lifespan. Approximately 20,000 individuals (11,000 households) were interviewed in each wave between 2004 and 2014. This includes both attrition and the inclusion of new respondents from refresher samples, which have been added to the original sample in each wave since 1984. Informed consent was obtained from all respondents before data collection in all waves. Because the SOEP assesses data from individuals in the same household, it is likely that data are more similar within households. We control for this non-independence by clustering the survey data on the household level in our analyses.

Measures

Self-reported risk-taking propensity. A question on general risk-taking propensity was included in nine waves of the survey spanning 10 years (2004, 2006, 2008, 2009, 2010, 2011, 2012, 2013, and 2014). It was worded as follows: "Are you generally a person who is willing to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value **0** means **not at all willing to take risks** and the value **10** means **very willing to take risks**." Six questions on risk-taking propensity in specific domains (driving, financial, recreational, occupational, health, and social) were included in three waves (2004, 2009, and 2014). The wording was as follows: "People can behave differently in different situations. How would you rate your willingness to take risks in the following areas? Please tick a box in each line of the scale!"

All seven items were rated on a 0–10 Likert-type scale from *not at all willing to take risks* to *very willing to take risks* (see Supplemental Materials for original items used). The items are part of the risk aversion scale that was first piloted in a pretest within a subset of the SOEP population in 2003 (Dohmen et al., 2011). Since their first administration in the main questionnaire in 2004, the items—particularly the general risk-taking propensity item—have been used in other scientific analyses on risk taking (e.g., Benjamin et al., 2012; Bonin, Dohmen, Falk, Huffman, & Sunde, 2007; Dohmen, Falk, Huffman, & Sunde, 2009; Lönnqvist et al., 2011; Szrek et al., 2012), where they have shown good internal consistency (α = .85) and, to some extent, correlations with self-reported real-world risk behavior (Dohmen et al., 2011). Analyses on the dimensionality of risk-taking propensity suggest that a single-factor model captures the ratings reasonably well (see Supplemental Materials). Nevertheless, in our analyses, we opted to analyze each item separately to delineate domain-specific patterns of change and stability across adulthood.

For general risk-taking propensity, the longitudinal sample analyzed here consists of 44,076 individuals between 18 and 85 years of age (*M* = 44.1, *SD* = 14.0; 52% female), who were interviewed on their self-reported general risk propensity in up to nine waves of assessment between 2004 and 2014. For the six domain-specific risk propensity items, the longitudinal sample consists of *N* = 11,903 individuals with the same age range (*M* = 44.1, *SD* = 14.0; 51% female) who answered domain-specific items in at least two of the three waves of assessment (domain-specific risk-taking propensity was assessed in 2004, 2009, and 2014).

Behavioral measures: Social and nonsocial risk taking. In addition, we analyzed behavioral data from subsamples of SOEP respondents between 18 and 85 years of age who participated in experiments assessing social (646 individuals, *M* = 50.0, *SD* = 16.8; 51% female) and nonsocial behavioral measures of risk taking (433 individuals, *M* = 48.8, *SD* = 17.5; 52% female).

Nonsocial risk taking. In 2005, a subset of randomly selected (random route sampling method) respondents from the SOEP population played a lottery game presented in their homes on a survey computer as part of a pretest for the SOEP interview. Respondents were asked to make up to 20 choices between a risky lottery (win €300 or €0 with 50% probability, expected value €150) and a safe amount of money (Holt & Laury, 2002). The lottery stayed constant in all trials and the safe amount offered increased after each trial in which the lottery was chosen (€0–€190 in €10 increments). Individual risk preferences can thus be determined by identifying the trial in which a respondent switches from preferring the lottery to the safe amount (thus narrowing down the person's certainty equivalent). Respondents who prefer a safe amount of money that is smaller than the expected value of the lottery is typically considered to be risk averse; respondents who choose the lottery even when the safety equivalent exceeds the expected value of the risk option (€150) are considered to be risk seeking.

Respondents' choices were incentivized. Specifically, they were instructed that one in every seven participants would be randomly picked and win a monetary payment. The computer determined the value of the payment (which varied between €0 and €300) by randomly choosing one of the outcomes of the participant's 20 decisions. All winners were paid by check after the experiment was completed.

Social risk taking. In 2004, a subset of respondents selected randomly from the SOEP population (sample F) participated in a trust game as part of the annual SOEP interview. Each respondent was assigned to one of two groups (group 1 = player 1; group 2 = player 2), endowed with 10 points, and instructed that he/she would participate in a "give and take" game that he/she would play with another anonymous respondent from the SOEP population. In total, N = 1,295 respondents participated in this experiment. N = 646 respondents were randomly assigned to group 1, and n = 649 individuals to group 2.

To play the game, both players decided how much of their endowment to transfer to their opponent (0–10 points). First, player 1 decided how many points to transfer to player 2 (measure of trust) and wrote a number between 0 and 10 on a sheet of paper. Each point transferred was then doubled as an income for player 2. In response to this received income, player 2 decided how many points of his/her endowment to back-transfer (measure of fairness) and wrote a number between 0 and 10 on a sheet of paper. This amount was then doubled as an income for player 1. Both players received instructions about the incentive structure of the game before making their transactions: Each point they kept increased their own income by €1; each point they transferred increased the other's income by €2. Because the game was conducted as part of the SOEP interview at respondents' homes, no real-time interaction was possible. Endowments that player 2 received from player 1 were therefore automatically sampled from a simulation of players in a pretest. All respondents were paid by check after the experiment. We used the number of points transferred by player 1 (group 1, $n = 646$) as a measure of trust and social risk taking (Fehr et al., 2002; Lönnqvist et al., 2011).

The Big Five. In 2005, 2009, and 2013 the SOEP used a short version of the Big Five personality inventory (BFI-S) to measure openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Gerlitz & Schupp, 2005; John, Donahue, & Kentle, 1991; Lang et al., 2011). The BFI is a 15-item self-report questionnaire (3 items per dimension) requiring a 1 (*does not apply at all*) to 7 (*applies perfectly*) rating. The shortened version of the BFI (used due to time limitations) has shown reasonably high correlations with the original version of the questionnaire (Donnellan & Lucas, 2008). It has also been used in scientific work on the lifespan development of personality traits (Donnellan & Lucas, 2008; Lucas & Donnellan, 2011; Specht et al., 2011). The scale was developed and validated within a pretest-sample of the SOEP population (see Lang et al., 2011, for information on internal consistency and test–retest reliability). To investigate correlated change between the Big Five personality traits and risk-taking propensity, we analyzed data from $N = 11{,}903$ respondents who answered both items on risk-taking propensity and completed the personality inventory.

Ethics Statement

The German Institute for Economic Research (DIW), Berlin, contracted TNS Infratest Sozialforschung GmbH and TNS Infratest GmbH & Cp. KG in Munich to carry out the SOEP survey “Leben in Deutschland (Living in Germany)”. Data collection, processing, and storage were in full accordance with German data protection regulations. Research was overseen by the DIW scientific advisory board. The ethics committee of the Max Planck Institute for Human Development additionally approved the authors’ use of the data for research purposes in accordance with German data protection regulations. German data privacy laws necessitate that all users sign a data user contract with the DIW Berlin. The survey data files are provided in anonymous form only. The institutes listed above do not provide third parties with any data that would permit individuals to be identified. The same applies to the follow-up surveys. Individual data from separate interviews are linked by a code number.

Analytic Approach

As outlined before, our analyses addressed the following research questions: Are there systematic lifespan differences in (1) differential and (2) mean-level stability of both general and domain-specific risk-taking propensity? Are there (3) intraindividual differences in changes and what are their predictors? Also, (4) do any mean-level changes in self-reported risk-taking propensity correspond to those observed in behavioral measures of social and nonsocial risk taking?

Differential stability of risk-taking propensity. To address question (1), we first calculated rank-order stability coefficients between each of the waves in which domain-general and domain-specific risk propensity was assessed. Specifically, we calculated test–retest correlations *(r)* across three waves (2004, 2009, and 2014) of assessment. These correlations reflect the degree to which the relative ordering of individuals within the sample was maintained over time.

Second, to investigate the effect of age on rank-order stability, we divided the domain-specific sample into ten 5-year age cohorts and calculated rank-order stability in these cohorts for the two 5-year periods (2004–2009; 2009–2014) and the 10-year period (2004–2014). Because the number of old individuals in the sample was limited, the oldest age group comprised individuals aged from 73–85 years. To quantify the effect of age, we fitted a locally smoothed regression line as well as a regression line fitted to all test–retest correlations from the different cohorts by predicting differential stability from age and age squared across the 10 cohorts. To control for the fact that the test-retest correlations stem from different time intervals, we included a cluster variable within a mixed-effects regression model framework.

Mean-level changes in risk-taking propensity. To answer question (2), we used latent growth curve models (McArdle & Nesselroade, 2003) to estimate change in domain-general and domain-specific risk-taking propensity across the lifespan. Specifically, we employed a separate latent growth curve model for each domain. Each domain was measured by one item at each measurement point. Each model included a latent intercept factor *(i)* and a latent slope factor *(s)*. The latent intercept factor was fixed to 1 at each measurement point and reflected individual differences at the first point of measurement (2004). The latent slope factor *(s)* was fixed to 0 for the first measurement point and reflected the amount of mean-level linear change per time unit increase. Weights for the other measurement points were selected such that they reflected the estimated mean difference between two neighboring measurement points. Means and variances were estimated for both the slope and the intercept. Mean values of *(i)* represent the average risk-taking propensity at the population level. The variance in *(i)* shows whether individuals already differed at the first wave of assessment. Mean values of *(s)* represent the average rate of change. The variance in *(s)* shows whether individuals differed in their rates of change (see Figure 1 A & B, for a model representation of domain-general and domain-specific risk propensity).

We were particularly interested in estimating the effects of age. In addition, because theoretical predictions (Mishra, 2014) and empirical results (Byrnes, Miller, & Schafer, 1999) suggest sex differences in risk taking, we also estimated the effects of sex. To this end, we included sex (female = 1, male = 0) and age, age^2, age^3 as covariates and estimated linear, quadratic, and cubic effects of age on intercept and slope parameters. To test effects of age, sex, and their interactions on mean risk-taking propensity *(i)* and change thereof *(s)*, we adopted a stepwise approach: Higher-order terms of age and interactions of age and sex were included only if they were significant at $p < .05$ and increased model fit. We applied this method to intercept and slope separately. Age was mean-centered before higher order terms were calculated. Age and sex were included as linear predictors if their effect on intercept or slope was not significant in order to nevertheless show and discuss their effect for these particular risk domains. Model fit evaluation was based on full information maximum-likelihood estimates that allow for missing data across measurement points (Schafer & Graham, 2002). Because traditional chi-square model test statistics are influenced by sample size, we relied on additional measures of fit, such as comparative fit index (Bentler, 1990), root-mean-square error of approximation (Steiger, 1990), and standardized root-mean-square residual (Bentler, 1990) with cut-off values of CFI > .95, RMSEA < .06, and SRMR < .08 for reasonable model fit (Hu & Bentler, 1999).

Individual-level changes in risk-taking propensity. To answer question (3), we tested whether the latent growth curve models showed significant variation in levels of change on the individual level (significant estimates of slope variances). In addition, we investigated whether within-person changes in risk-taking propensity were associated with within-person changes in the variables of interest (i.e., the Big Five personality traits and income). Specifically, we estimated bivariate latent growth curve models in which a latent growth curve of each personality trait (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) was linked to a latent growth curve of risk-taking propensity (general, driving, financial, recreational, occupational, health, and social) by correlating the respective intercepts and slopes (see Figure 2 for model representation). Correlations between intercept estimates can be interpreted in the same way as correlations from cross-sectional data, whereas correlations among slopes represent how two variables change together over development. The key parameter of interest in this parallel process model was thus the correlation between the slope factors of risk taking and personality/income. For example, positive correlated change would indicate that those respondents who show changes in risk-taking propensity show concordant changes in the respective personality trait. Because the rate of change is often correlated with initial status, we also included correlations between intercepts. To control for cross-sectional age differences, age (centered) was included as a covariate. We estimated models for each domain of risk taking with each personality trait separately. A similar model was used to investigate correlated changes with income. In these models, change in income at each measurement point was correlated with within-person change in risk-taking propensity.

Mean-level trajectory of behavioral measures of risk taking. To answer question (4), we used regression models of the cross-sectional data from the experiments conducted in 2004 and 2005 to estimate age-related mean-level change in social and nonsocial risk taking. Age was centered to the sample means. Again, higher order terms of age were included only if they were significant at $p < .05$, and linear effects of age were reported if the effect of the higher order terms was not significant. We computed Pearson product-moment correlations between behavioral and self-report measures of risk taking to assess the link between the two types of measures.

All analyses were run in R (R Core Team, 2015), and latent growth curve modeling was performed using the lavaan package (Rosseel, 2012).

Results

Differential Stability of Risk-Taking Propensity

Table 1 shows the test–retest correlations for domain-general and domain-specific risk propensity (from 2004–2009, 2009–2014, and 2004–2014) in the whole sample. For domain-general risk propensity, rank-order stability ranged between r = .45 and .53. For domain-specific risk-taking propensity, rank-order stability was likewise moderate to high, with *r*s ranging from .42 to .53 between 2004 and 2009, from .45 to .58 between 2009 and 2014, and from .38 to .50 between 2004 and 2014. These results show that individuals who reported high (or low) levels in risk-taking propensity remained relatively high (or low) in risk-taking propensity levels compared with others over time. To put these numbers in perspective, many personality variables have shown stabilities of more than .70 over periods of 1 to 5 years in adult samples (Briley & Tucker-Drob, 2014; Costa & McCrae, 1994). Mean stability in risk propensity was thus slightly lower than has been found for standard personality variables.

Figure 3 shows the effect of age on rank-order stability for different age cohorts, as measured by the test–retest correlations across the three waves of assessment (see also Table 2). Although there is some heterogeneity across domains, the typical pattern is lower test–retest correlations in young adulthood (18–30 years of age, r = .30–.40), rising to a plateau in middle adulthood (r = .40–.60), and decreasing again in older age (70–85 years of age, r = .25–30). Quadratic models of age best described the patterns obtained from the test–retest correlations, and locally smoothed lines deviated little from the quadratic model. The quadratic pattern matches results of studies on the stability of personality traits, with peak stability between the ages of 50 and 60 (Briley & Tucker-Drob, 2014; Specht et al., 2011). The inverted U-shaped pattern is typically attributed to social and biological changes that generally occur at both ends of the lifespan, leading to increased variation in phenotype in these phases. Findings in Figure 3 suggest that this pattern extends to risk-taking behavior and similarly across domains.

Mean-Level Changes in Risk-Taking Propensity

We used latent growth curve models with up to nine (domain-general) or three (domain-specific) measurement points to delineate the effect of age and sex on mean level as well as mean-level change in domain-general (N = 44,076) and domain-specific risk-taking propensity (N = 11,903). Table 3 shows the parameter estimates. All parameters were standardized to the first measurement. Age was centered to the sample mean of 44.1 years of age. Parameter estimates are given in 10-year units. All models took nesting of individual data within households into account to correct for underestimation of standard errors due to clustered sampling. Column one of Figure 4 (intercept) depicts the lifespan trajectory of mean-level risk taking on a smoothed color density representation of a scatterplot of age and risk-taking propensity, obtained through a kernel density estimate (kernel width used for density estimation = 75). The second column (slope) of Figure 4 illustrates the effects of age and sex on slope estimates. The arrows in the third column (intercept + slope) represent a combined display of cross-sectional and longitudinal changes for separate five-year cohorts.

Domain-general risk-taking propensity

Cross-sectional effects. Overall, the results suggest that both age and sex affect mean-level domain-general risk-taking propensity (see Table 3, Figure 4a). Regarding age, the trajectory shows a decline in risk taking across adulthood, with an average decrease in risk-taking propensity of –0.17 points across 10 years. Females consistently reported lower levels of risk taking across the lifespan than males (–0.81 at the sample mean of 42.1 years of age). The steepest declines were evident between 20 and 30 years of age (–0.23 points decrease on the 11-point Likert scale).

Longitudinal effects. Age and sex also had a significant effect on mean-level change in risk-taking propensity over time (see Figure 4b, slope). Specifically, age had a quadratic effect on change in risk-taking propensity, with an overall decline across the lifespan: Decline in risk-taking propensity was shown to diminish until the age of about 60, after which change in risk-taking propensity showed larger decreases again. As Figure 4c (intercept + slope) shows, the cross-sectional results largely coincided with the longitudinal analysis, in that change in slope across the lifespan substantially corresponded with the cross-sectional pattern of mean-level change. Towards the end of the lifespan, however, slight deviations emerged between the longitudinal and cross-sectional results, with considerable stability in risk propensity for individuals older than 60 years but differences between cohorts (i.e., consecutive arrows for each 5-year cohort do not exactly match-up). One interpretation of this mismatch is that these findings represent "survivor" effects—that is, a type of cohort or attrition effect, whereby the least risk-taking respondents survive and continue to participate in the panel.

Domain-specific risk-taking propensity

Cross-sectional effects. Overall, the results show strong effects of age and sex on mean-level risk-taking propensity (see Table 3; Figure 4 column 1, intercept). Regarding age, the results show that mean risk-taking levels decreased across the lifespan in all domains. However, age-related changes followed different mean trends depending on the domain. In the social domain, risk-taking propensity followed a linear trend across the lifespan, decreasing –0.16 points on the Likert scale over 10 years (Figure 4s). In the driving domain, it showed a quadratic pattern of decline, with the highest risk-taking levels between 20 and 30 years of age and steady, but accelerating, decreases over the following decades. In the financial, recreational, occupational, and health domains, risk-taking propensity followed a cubic pattern across the lifespan (Figure 4g/j/m/p): Financial and health risk-taking propensity showed only slight mean-level decreases until age 55 years but a steeper decrease in the following decades. Recreational risk-taking propensity showed continuous declines across the lifespan, but the steepest decline was evident until about 40 years of age. Occupational risk taking also showed a continuously declining pattern until the age of 65 years. Interestingly, the smallest mean-level decreases in risk-taking propensity emerged in the social domain (linear decrease of –0.16 points on the 11-point Likert scale per decade). Regarding sex, women consistently reported lower average levels of risk-taking propensity than men across all domains: –1.21 points lower in driving, –0.97 in financial, –1.02 in recreational, –0.83 in occupational, –0.85 in health, and –0.26 in social risk-taking propensity at age 42.1 (see Table 3).

Longitudinal effects. Figure 4 (column 2, slope) illustrates the effects of age and sex on mean-level change in domain-specific risk-taking propensity. The effects of age on change in risk-taking propensity in the occupational and recreational domain were best described by a cubic pattern. Change in occupational risk taking has its point of largest decrease at about 50 years of age. Change in recreational risk taking decreased across the lifespan but the smallest decreases were at about 40 years of age. For both domains, the longitudinal findings are largely consistent with the cross-sectional results: Changes in slope mapped onto the pattern of mean-level change (see Figure 4l/o). For recreational risk-taking propensity, however, slight discrepancies emerged between cross-sectional and longitudinal change, possibly due to dropout of older adults or to older adults ceasing to engage in risky recreational activities. Importantly, age was not a significant predictor of changes in financial, health, and social risk-taking propensity, with individuals of all ages showing only very small but constant change in risk-taking propensity over time (change of –0.049 in financial, –0.006 in health, and +0.009 in social risk taking over 10 years).

For health risk-taking propensity, slight discrepancies between longitudinal and cross-sectional results emerged towards the end of the lifespan (Figure 4r; starting ~60 years of age). These results may again point to a survivor effect, with respondents who took fewest risks in these domains also living longer. In the domain of driving, change in risk-taking propensity was linear and generally increased over time at all ages but less so in older ages. One possible interpretation of this increase is that it reflects an effect of increased perceived competence in driving on risk taking: Over time, individuals may change their perceptions of risk or their individual level of perceived control over their driving skills and thus report riskier behavior; this tendency, however, diminishes in old age. Future work is necessary that replicates and tests this admittedly speculative interpretation.

Individual-Level Changes in Risk-Taking Propensity

Analysis of the latent growth curve models above suggested that there were considerable individual differences in change in risk-taking propensity (significant variance of slope estimates). We now examine to what extent individual differences in variation in change were associated with changes in personality and situational (i.e., income) variables. The rationale for these analyses is that understanding the covariates of change may help to understand the mechanisms underlying lifespan changes in risk-taking propensity.

We used bivariate latent growth curve models to estimate correlated change between domain-specific risk-taking propensity and variables of interest (i.e., the Big Five, income). Standardized estimates of covariance between slopes are shown in Table 4. The results show that within-person change in risk-taking propensity was positively associated with within-person change in extraversion and openness to experience and negatively correlated with change in conscientiousness, neuroticism, and agreeableness. These associations showed variation across domains, with no strong patterns of association between specific risk-taking domains and personality factors. For example, change in openness to experience was positively correlated with change in recreational (r = .28), occupational (r = .21), and social domains (r = .21) and in general risk taking (r = .24). To put these numbers into perspective, intercorrelations of slope estimates between the different risk domains ranged between .42 and .72 (see Table 4).

In sum, these results suggest that within-person changes in standard personality factors are linked to within-person changes in risk-taking propensity, although less strongly than the changes found across risk-taking domains. In contrast, within-person changes in risk-taking propensity showed no significant associations with changes in individual income over time. Overall, these results suggest that—and this may be surprising from a classic economic expectation about the relationship between risk aversion and wealth—lifespan changes in risk-taking propensity are more closely related to lifespan changes in personality than to changes in economic factors such as income.

Lifespan Trajectory of Social and Nonsocial Risk Taking in Behavioral Tasks

We used regression models to probe for age differences in the cross-sectional samples of respondents who completed behavioral risk measures (Fehr et al., 2002; Holt & Laury, 2002). Figure 5 shows the lifespan trajectories. In the monetary lottery, we found a significant quadratic relation between age and risk taking (i.e., choosing the risky over the safe option) with evident decreases in risk taking from about 30 years of age. Respondents aged between 18 and 30 years, switched from preferring the lottery to the safe amount when the latter amounted to, on average, €93.6; for respondents aged between 70 and 85 years, the safe amount preferred over the lottery shrank to about half this amount (€44.7). In the trust game, in contrast, we found linear effects of age but overall relatively stable levels of risk taking across the lifespan (i.e., entrusting money to the other party and hoping for reciprocation).

These results suggest that, similar to self-reported risk propensity, behavioral risk taking shows different trends across different economic tasks (see Table 5). Furthermore, the overall pattern of mean-level differences in risk taking in the respective domains roughly matches between self-report and behavioral measures. Most interestingly, for both self-report and behavioral measures, we find no discernable link between age and risk taking in the social domain. Note, however, that the correlations between the two types of measures are small. For the subset of individuals for whom we have data on both the trust game and self-reported risk-taking propensity (N = 676), we found only small correlations between self-report on risky (trust) behavior, rs = [.08–.18] in 2004. The correlation between domain-general risk-taking propensity and risky behavior in the gamble experiment collected in 2005 was only slightly higher, r = .24. With regard to correlations with the Big Five personality traits the pattern is similar, with highest correlations between openness to experience and behavior in the gamble experiment, r = .15 (see Table 6).

Discussion

How does risk-taking propensity change across adulthood? We examined this question by analyzing (1) differential stability, (2) mean-level differences, and (3) predictors of individual-level change in self-reported risk-taking propensity across adulthood, as well as (4) the correspondence between the lifespan trajectories of self-report and behavioral measures of social and nonsocial risk taking. We took advantage of data from a longitudinal multi-cohort survey of individuals between 18–85 years of age including subsamples of respondents who provided self-report ratings of general and domain-specific risk-taking propensity (driving, financial, recreational, occupational, health, social) and completed behavioral measures of social (trust game) or nonsocial risk taking (monetary gamble). Next, we discuss the results in light of the four main issues outlined above, discuss some of the limitations of the current investigation, and suggest broad implications and directions for future work.

Differential Stability of Risk-Taking Propensity

Differential stability represents the degree to which relative differences between individuals are preserved over time. To our knowledge, our study is the first to systematically investigate stability in rank-order positioning of self-reported risk propensity across adulthood. We also investigated differential stability in specific domains. The results echo the inverted U-curved pattern of stability from young to old adulthood that has been reported for major personality factors (i.e., Big Five; Briley & Tucker-Drob, 2014; Ferguson, 2010; Roberts & DelVecchio, 2000). Across all domains, stability coefficients in risk-taking propensity increased from young to middle adulthood before declining again in older age. This trajectory is largely consistent with the idea that lower stability is to be expected in developmental periods involving significant biological, cognitive, and social changes/demands.

More work is necessary to uncover the specific biological and environmental factors that lead to this particular lifespan pattern. One possible conclusion from our results is that lifespan differences in rank-order stability are relatively homogenous across risk-taking domains. Consequently, future studies may want to consider factors that are common to different areas of life—be they biological changes due to maturation and senescence or the adoption of specific social roles.

Mean-Level Changes in Risk-Taking Propensity

Our study is unique in capturing general and domain-specific risk taking longitudinally across multiple waves spanning up to 10 years. Importantly, our results allowed us to compare longitudinal and cross-sectional estimates of mean-level change in risk-taking propensity: The results suggest that cross-sectional and longitudinal data roughly coincide in showing a decrease in risk-taking propensity with increased age. Indeed, driving was the only domain that yielded a substantial discrepancy between cross-sectional and longitudinal trends (with the latter showing an atypical increase in risk taking over time). Consequently, taken as a whole, our results suggest that previous estimates obtained from cross-sectional data largely capture longitudinal changes in risk-taking propensity (Bonem et al., 2015; Dohmen et al., 2011; Roalf et al., 2012; Rolison et al., 2013; Rosman et al., 2013; Schwartz et al., 2013). Importantly, the normative decreases of mean-level trends in risk-taking propensity are consistent with what behavioral ecology would predict about age (and sex) differences in risk taking against the background of differential incentives for reproductive competition across the lifespan (and between the sexes) (e.g., Daly & Wilson, 1997).

The pattern of normative age-related decline varied as a function of life domain, with some domains (e.g., social) proving relatively stable across adulthood. Future work needs to provide a theoretical rationale for potential qualitative differences between domains. One possibility is to determine the extent to which particular domains or risky activities should and can be avoided in different phases of life. For example, abstaining from climbing ladders or standing on chairs can reduce the risk of falls at home and may be an adaptive strategy in older age (Brandtstadter, Wentura, & Rothermund, 1999; Duke, Leventhal, Brownlee, & Leventhal, 2002). In contrast, interpersonal exchange is a key domain that people hardly can escape from with age. These results also fit ideas about social and emotional involvement across the lifespan, at large. That is, past research has shown that social and emotional information remains prioritized with respect to broader life goals across adulthood (Carstensen, 1995; Carstensen, Isaacowitz, & Charles, 1999). In addition, despite thinning of social network size, there is evidence that older individuals continue to be socially engaged more frequently and more emotionally with their closest relationships compared to younger adults (Fredrickson & Carstensen, 1990). Overall, it may be important to investigate whether patterns of stability in social risk taking are related to the cultural and biological roles of seniors as both recipients of social support (Baltes, 1997) and donors of care to progeny (Coall & Hertwig, 2010). More generally, going forward, studies that investigate specific risk-taking behaviors and assess the causes underlying the adoption or cessation of these behaviors across adulthood are warranted.

Individual-Level Changes in Risk-Taking Propensity

Identifying covariates of age differences in risk taking may offer insights into the mechanisms underlying change in risk propensity across the lifespan. We have contributed to this effort by assessing the link between change in risk-taking propensity and situational or psychological characteristics hypothesized to vary with risk taking: income (Dohmen et al., 2011) and personality (Becker et al., 2012; Borghans et al., 2008). Individual-level change in risk-taking propensity was weakly and not significantly correlated with within-person changes in income. However, within-person change in risk-taking propensity was moderately correlated with within-person change in some Big Five personality factors. More concretely, we found positive associations between within-person change in extraversion and openness to experiences and negative associations between within-person change in conscientiousness, neuroticism, and agreeableness and within-person change in risk-taking propensity.

One limitation of our work is that we did not analyze further variables that have been suggested to be associated with individual differences in risk taking, such as cognitive ability (Dohmen et al., 2009), numeracy (Reyna, Nelson, Han, & Dieckmann, 2009), affect (Peters, Hess, Västfjäll, & Auman, 2007), and risk perception (Bonem et al., 2015). The SOEP either does not include these variables or has not yet gathered enough longitudinal data (i.e., cognitive ability) for correlated changes to be estimated. Future work including additional measurements in the SOEP and use of other longitudinal surveys will be helpful in uncovering predictors of change in risk taking over time.

Lifespan Trajectories of Self-Report and Behavioral Measures of Risk Taking

One of our goals was to assess whether self-report and behavioral measures of risk taking converged in the estimated patterns of lifespan mean-level trajectories in risk taking. We found that there were indeed parallels between the trajectories of the self-report measures and the two behavioral measures. Specifically, the decline in self-reported risk-taking propensity in the financial domain was matched by behavior in the monetary gamble. Similarly, a relatively flat trajectory of risk-taking propensity in the self-reported social domain matched results obtained from the behavioral trust game. However, when we estimated the cross-sectional correlations between self-report and behavioral results, we found that most correlations between self-report and behavioral measures were small. Naturally, the small correlations between behavioral and self-report measures of trust could stem from confounds present in the specific behavioral games used, such as the trust game, because factors such as mentalizing abilities and altruistic preferences may trump or confound the role of risk-taking preferences (Rilling & Sanfey, 2011). More broadly, although our work raises the possibility that both self-report and behavioral measures capture similar aspects of mean-level changes in risk-taking propensity with increased age, further work is needed to quantify the overlap between different behavioral and self-report measures (see Appelt et al., 2011; Friedman et al., 2014; Mishra & Lalumière, 2011; Szrek et al., 2012).

Limitations

One main limitation of our work is that we have not investigated the links between risk preferences and real-world outcomes. To our knowledge, there has only been one past effort to use one wave of the SOEP database to predict real-world behavior in the financial domain (Dohmen et al., 2011) but these efforts could be extended to include other waves. A limitation of both past work and any future efforts with these data will be that they do not include objective measures of respondents' real-world behavior. The SOEP, for instance, relies almost exclusively on self-report assessments of behavior rather than on observational or registry data. Recent studies have shown the feasibility of complementing self-report assessments with objective real-world assessments, such as health markers (Moffitt et al., 2011) or financial reports (Li et al., 2015). Showing predictive value of current risk-taking propensity measures for real-world behavior would remove potential doubts about the validity of the single-item measures in the present investigation. Future work with large representative longitudinal surveys should therefore combine self-report and behavioral measures with objective measures of risk-taking behavior, such as those associated with financial behavior.

Implications for Conceptions of Risk Taking and Future Research

What is risk taking? Our results may not afford a definite answer but they suggest some more and some less surprising regularities that a comprehensive theory of risk taking will have to meet. First, they suggest that risk taking is not a purely situation-specific response pattern and can, instead, be considered a trait with a level of rank-order stability across individuals that is only slightly below that of major personality dimensions (Briley & Tucker-Drob, 2014; Roberts & DelVecchio, 2000). Furthermore, like those personality dimensions, its pattern of differential stability obeys an inverted U-shape such that the periods of young adulthood and old age reveal least stability. Second, like other personality dimension—such as openness to experience—it shows mean-level decreases with age (Lucas & Donnellan, 2011; Specht, Egloff, & Schmukle, 2011). This, however, only holds as long as the risk-taking propensity is probed in an abstract and domain-general fashion. Notable variations in mean-level risk taking emerge across domains, such as in the relatively stable pattern of risk taking across the lifespan observed for the social domain. To what extent these variations stem from a stable trait but changing domain-specific perceptions of costs and benefits or rather from domain-specific traits with somewhat unique age trajectories remains an open question for future research. Third, and finally, we found that lifespan changes in risk-taking propensity are more closely related to lifespan changes in personality than to changes in economic circumstances such as income. All in all, these results highlight the need for a better understanding of the links between risk-taking propensities, personality structure, and the mechanisms or sources of personality development at large.

Although risk-taking tendencies have long been within the purview of personality theories, they have, regrettably, been investigated under different banners, including sensation seeking (Cross, Cyrenne, & Brown, 2013; Zuckerman & Kuhlman, 2000) and impulsivity (Cross, Copping, & Campbell, 2011; Sharma, Markson, & Clark, 2014). Understanding the relationship between the different constructs and how they are linked to major personality factors will require both theoretical and empirical work. As mentioned above, we see potential for convergence by examining the empirical links between major (i.e., Big Five) personality factors and risk-taking propensity. For example, there has been considerable progress in understanding individual differences in life events (Specht et al., 2011; Kandler et al., 2015), cognitive development (Klimstra, Bleidorn, Asendorpf, van Aken, & Denissen, 2013), and cross-cultural variation in social roles (Bleidorn et al., 2013). Such methods could also be applied to understanding the development of risk taking and to determine parallels between the development of Big Five personality factors and specific risk-taking behaviors. We have partly initiated this effort by investigating how age differences in risk taking vary across different countries and thus are a function of the affordances of local ecologies (Mata et al., in press), a message that matches previous results on the lifespan development of major personality dimensions (Bleidorn et al., 2013). Yet another possible future step in understanding the development of risk-taking propensity and links to other personality dimensions would be to assess the role of general proximal mechanisms that can account for global effects that we reported across domains and personality factors, including potential changes in neurotransmitter systems (Buckholtz et al., 2010; Düzel, Bunzeck, Guitart-Masip, Düzel, 2010) or hormonal profiles (Mehta, Welker, Ziliolic, & Carré, 2015).

Conclusion

We investigated the stability and change in risk-taking propensity across the lifespan and found that risk taking can be thought of as a trait that changes significantly across the lifespan and similarly, albeit with exceptions, across different domains of life. Future work is now needed to uncover the underlying sources of domain-specificity in the development of risk-taking propensity and assessing more closely the empirical and theoretical links between risk taking and other personality factors.

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Tables

Table 1. *Differential Stability (r) of Risk-Taking Propensity*

	(r)		
	04–09	09–14	04–14
General	.45	.53	.47
Driving	.53	.58	.50
Financial	.47	.50	.42
Recreational	.52	.56	.50
Occupational	.46	.49	.42
Health	.42	.45	.38
Social	.42	.46	.43

Note. All correlations were significant at $p < .001$.

Table 2. *Regression Models Predicting Differential Stability of Risk-Taking Propensity from Age Across 10 Cohorts*

	General		Driving		Financial		Recreational		Occupational		Health		Social	
R^2	.194		.358		.534		.287		.269		.225		.566	
	b	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*
Intercept	.232	.024	.180	.055	.035	.689	.339	<.001	.139	.135	.265	<.001	.092	.157
	[.096]		[.089]		[.087]		[.065]		[.090]		[.061]		[.063]	
Age	.009	.027	.015	<.001	.020	<.001	.007	.017	.012	.004	.007	.021	.016	<.001
	[.004]		[.004]		[.004]		[.003]		[.004]		[.003]		[.003]	
Age^2	–.0001	.043	–.0002	<.001	–.0002	<.001	–.0001	.008	–.0001	.004	–.0001	.014	–.0002	<.001
	[.00004]		[.00004]		[.00004]		[.00003]		[.00004]		[.0003]		[.00003]	
Age^3														

Note. Models contain age^2 only if their effect on intercepts and slopes were significant at $p < .05$. Values in brackets indicate standard errors. The total *n* for this analysis is 30, which is the number of cohorts by the number of test–retest correlations. Effects of the interval (2004-2009, 2009-2014, 2004-2014) on mean-level trends were controlled for a by a cluster variable within a mixed-effects framework.

Table 3. *Latent Growth Curve Models Describing the Effect of Chronological Age and Sex on Mean Level (Intercept) and Mean-Level Change (Slope) of Self-Reported Domain-Specific Risk Propensity*

	General		Driving		Financial		Recreational		Occupational		Health		Social	
	N = 44,076		*N* = 11,903		*N* = 11,903		*N* = 11,903		*N* = 11,903		*N* = 11,903		*N* = 11,903	
X2 (df)	2788.447 (69)		69.627 (5)		326.315 (7)		254.309 (5)		212.224 (5)		119.591 (7)		133.733 (3)	
CFI	.922		.990		.918		.958		.954		.968		.969	
RMSEA	.070		.045		.091		.089		.081		.050		.076	
SRMR	.048		.013		.029		.023		.022		.018		.022	
	b	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*	*b*	*p*
Intercept														
Mean	4.943	<.001	3.902	<.001	3.047	<.001	4.131	<.001	4.345	<.001	3.492	<.001	3.503	<.001
	[.035]		[.046]		[.039]		[.046]		[.049]		[.044]		[.039]	
Variance	2.057	<.001	2.948	<.001	2.047	<.001	2.514	<.001	2.759	<.001	2.205	<.001	2.686	<.001
	[.057]		[.132]		[.114]		[.135]		[.158]		[.163]		[.146]	
Age	–.129	<.001	–.412	<.001	–.068	.092	–.358	<.001	–.338	<.001	–.191	<.001	–.161	<.001
	[.027]		[.024]		[.040]		[.024]		[.053]		[.043]		[.024]	
Age^2	.015	.135	–.089	<.001	–.045	<.001	.015	.319	–.095	<.001	–.031	.013		
	[.009]		[.012]		[.011]		[.015]		[.017]		[.012]			
Age^3	–.023	<.001			–.017	.002	–.047	<.001	–.032	.005	–.018	.039		
	[.006]				[.007]		[.011]		[.011]		[.009]			
Sex	–.806	<.001	–1.206	<.001	–.973	<.001	–1.019	<.001	–.834	<.001	–.853	<.001	–.257	.732
	[.037]		[.054]		[.049]		[.052]		[.056]		[.053]		[.053]	
Slope														
Mean	–.018	.637	.205	.533	–.279	<.001	–.158	.002	–.475	<.001	–.096	0.041	.028	.533
	[.035]		[.045]		[.042]		[.051]		[.058]		[.047]		[.045]	
Variance	1.234	.085	1.545	<.001	.781	<.001	.861	<.001	1.380	<.001	.745	.007	.659	<.001
	[.085]		[.251]		[.224]		[.259]		[.304]		[.273]		[.278]	
Age	.089	<.001	–.057	.042	–.049	.063	–.104	.052	–.178	.004	–.006	.732	.009	.732
	[.017]		[.028]		[.026]		[.054]		[.061]		[.027]		[.026]	
Age^2	–.030	.004					–.060	<.001	.042	.034				
	[.011]						[.017]		[.020]					
Age^3							.025	.033	.027	.042				
							[.012]		[.014]					
Sex	–.084	.042	.215	<.001	.126	.031	.146	.012	.144	.013	.092	.161	.006	.929
	[.041]		[.061]		[.058]		[.057]		[.058]		[.065]		[.063]	

Note. Model parameters were standardized relative to the first measurement (i.e., the mean of the intercept was set to 0, and the variance was set to 1). Models contain age^2 and age^3 as well as effects for sex only if their effect on intercepts and slopes were significant at $p < .05$. Age was mean-centered at sample mean age = 42.1; sex was dummy coded (1 = female, 0 = male). Values for age are given in 10-year units. Values in brackets indicate standard errors. CFI = comparative fit index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual.

Table 4. *Correlated Change: Correlations Among Slopes in Bivariate Latent Growth Curve Models of Risk-Taking Propensity, the Big Five Personality Traits, and Income.*

	General	Driving	Financial	Recreational	Occupational	Health	Social
General							
Driving	.54***						
Financial	.58***	.65***					
Recreational	.61***	.66***	.64***				
Occupational	.59***	.54***	.59***	.72***			
Health	.51***	.58***	.56***	.65***	.64***		
Social	.47***	.42***	.49***	.56***	.42***	.55***	
Extraversion	.22**	.04	.03	.10	.15**	.10	.13*
Openness	.24***	.03	.04	.28***	.21***	.12*	.21*
Conscientiousness	.03	–.07	–.11	–.09	–.003	–.06	–.24***
Neuroticism	–.23***	–.01	–.04	–.19*	.06	–.02	–.23**
Agreeableness	–.11	–.12*	–.18*	–.28***	–.12*	–.10	–.02
Income	–.001	–.02	.05	–.08	–.01	.06	–.04

Note. Estimates were obtained from bivariate latent growth curve models and the respective correlation between slope estimates between a particular risk domain and the variable of interest (Big Five traits, income). * $p < .05$, ** $p < .01$, *** $p < .001$. Note also that the effects reported are ambiguous in direction as they represent correlations of changes.

Table 5. *Regression Models Describing the Effect of Chronological Age and Sex on Economic Games Involving Social and Nonsocial Risks*

	Lottery N = 433		Trust N = 646	
	b	p	b	p
Intercept	96.36 [4.958]	<.001	5.405 [.142]	<.001
Age	–7.597 [1.610]	<.001	–.205 [.060]	.001
Age^2	–2.803 [.943]	.003		
Age^3				
Sex	–5.36 [5.614]	.339	.078 [.200]	.696
AIC	4753		3044	
R^2	.064		.015	

Note. Sex was dummy coded (1 = female, 0 = male). Values in brackets indicate standard errors. Lottery = nonsocial risk, Trust = social risk. The age range of both samples was restricted to 18–85 years. Age was mean-centered at sample means. Values for age are given in 10-year units.

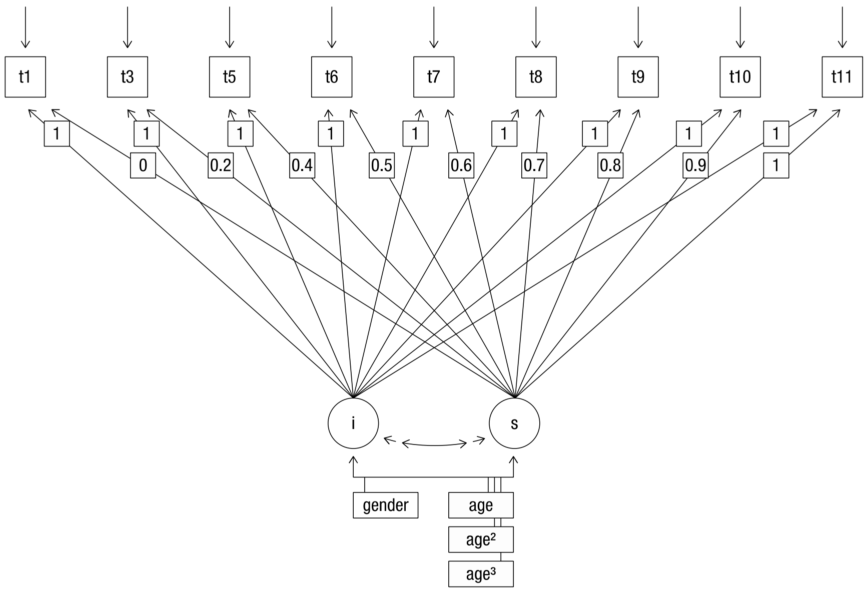
Table 6. *Correlations between Self-Reported and Behavioral Measures of Risk*

	Lottery		Trust	
	r	*n*	*r*	*n*
General	.24***	433	.13**	646
Driving	–	–	.14*	322
Financial	–	–	.13*	322
Recreational	–	–	.17*	322
Occupational	–	–	.18*	322
Health	–	–	.08	322
Social	–	–	.17*	322
Extraversion	.08	433	–	–
Openness	.15**	433	–	–
Conscientiousness	–.04	433	–	–
Neuroticism	.04	433	–	–
Agreeableness	–.09	433	–	–

Note. The lottery game was assessed together with the domain-general risk item in a pretest of the SOEP in 2005. We can therefore not provide correlations with the domain-specific risk-propensity items. The trust game was assessed in 2004 and allowed correlations with the domain-specific and the domain-general risk items but not the Big Five. n = cases used for the correlations. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figures

A



B

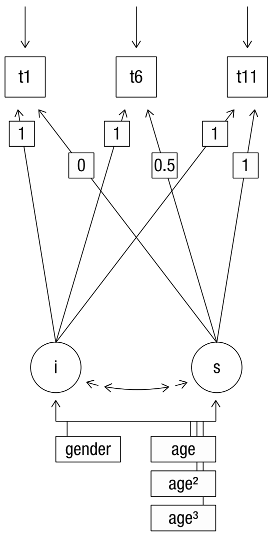


Figure 1. Model representation of the latent growth curve model used to analyze effects of age and sex on the mean level (intercept) and mean-level change (slope) of self-reported domain-general (A) and domain-specific (B) risk propensity (2004–2014). **A**. At each measurement point (t1 to t11) one item was assessed. The latent intercept (*i*) is fixed to 1 on t1, t3, t5, t6, t7, t8, t9, t10, and t11 and refers to the estimated mean frequency of risk-taking propensity at t1. The latent slope (*s*) is fixed to 0.00 on t1, to 0.20 on t3, to 0.40 on t5, to 0.50 on t6, to 0.60 on t7, to 0.70 on t8, 0.80 on t9, to 0.90 on t10, and to 1 on t11 and refers to the estimated mean difference between two neighboring measurement points. Two-headed arrows represent correlations; single-headed arrows, regression coefficients. Gender, age, age^2, and age^3 were included as predictors of (*i*) and (*s*). **B**. At each measurement point (t1, t6, t11) one item was assessed. The latent intercept (*i*) is fixed to 1 on t1, t6, and t11 and refers to the estimated mean frequency of risk-taking propensity at t1. The latent slope (*s*) is fixed to 0.00 on t1, to 0.50 on t6, to 1 on t11 and refers to the estimated mean difference between two neighboring measurement points. Two-headed arrows represent correlations; single-headed arrows, regression coefficients. Gender, age, age^2, and age^3 were included as predictors of (*i*) and (*s*).

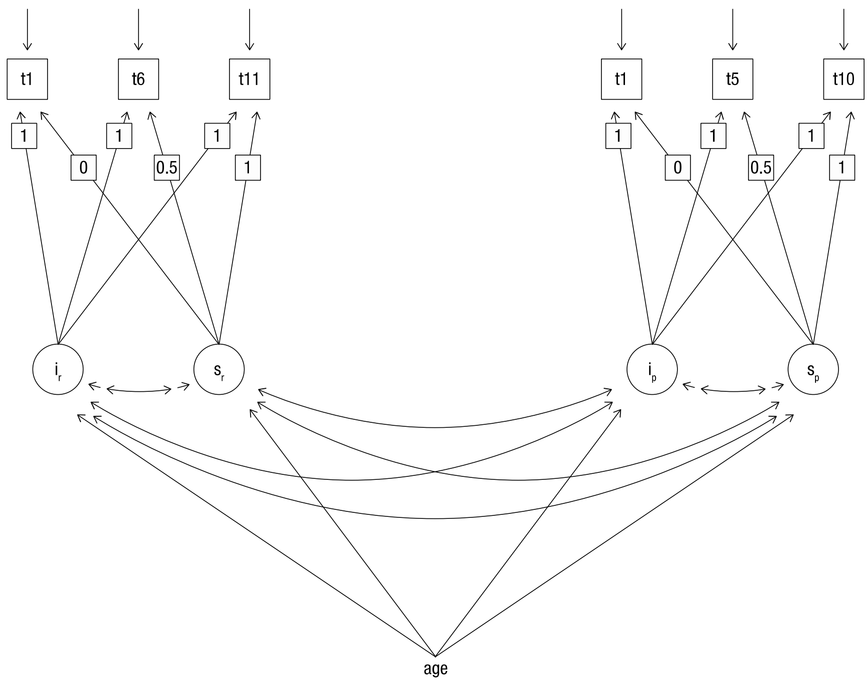


Figure 2. Bivariate latent growth curve model of risk-taking propensity and the Big Five personality traits. The observed variables t1, t6, and t11 (and t1, t5, and t10) represent the repeated measurements of risk-taking propensity (left) and the Big Five personality traits (right). Whereas risk-taking propensity was measured by one item, three items for each trait measured the Big Five. Therefore, for personality, the measurements at t1, t5, and t10 were again latent factors composed of these three items. Two-headed arrows represent correlations, single-headed arrows regression coefficients. The latent intercept (*i*) is fixed to 1 on t1, t5/t6, and t10/t11 and refers to the estimated mean frequency of risk-taking propensity at t1. The latent slope (*s*) is fixed to 0.00 on t1, to 0.50 on t5/t6, and to 1 on t10/t11 and refers to the estimated mean difference between two neighboring measurement points. Age was included as predictors of - (*i*) and (*s*).

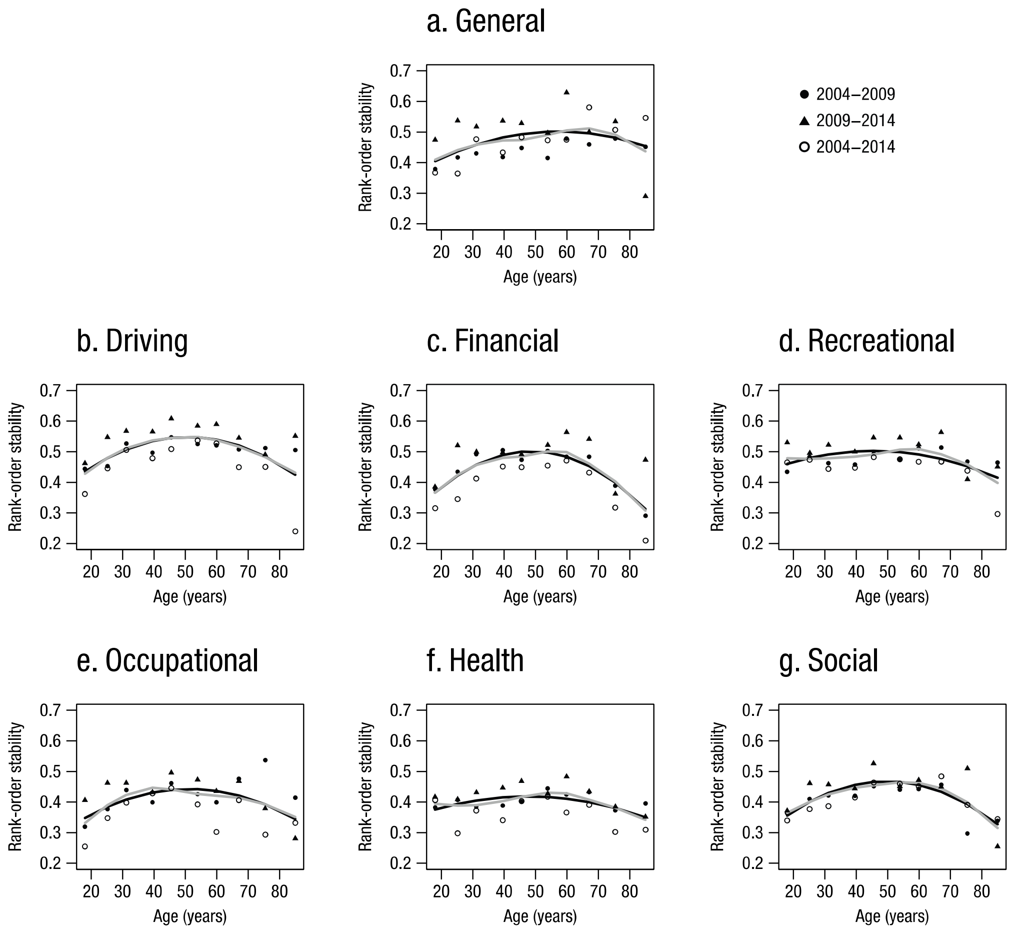


Figure 3. The Effect of Age on Rank-Order Stability of Risk-Taking Propensity.

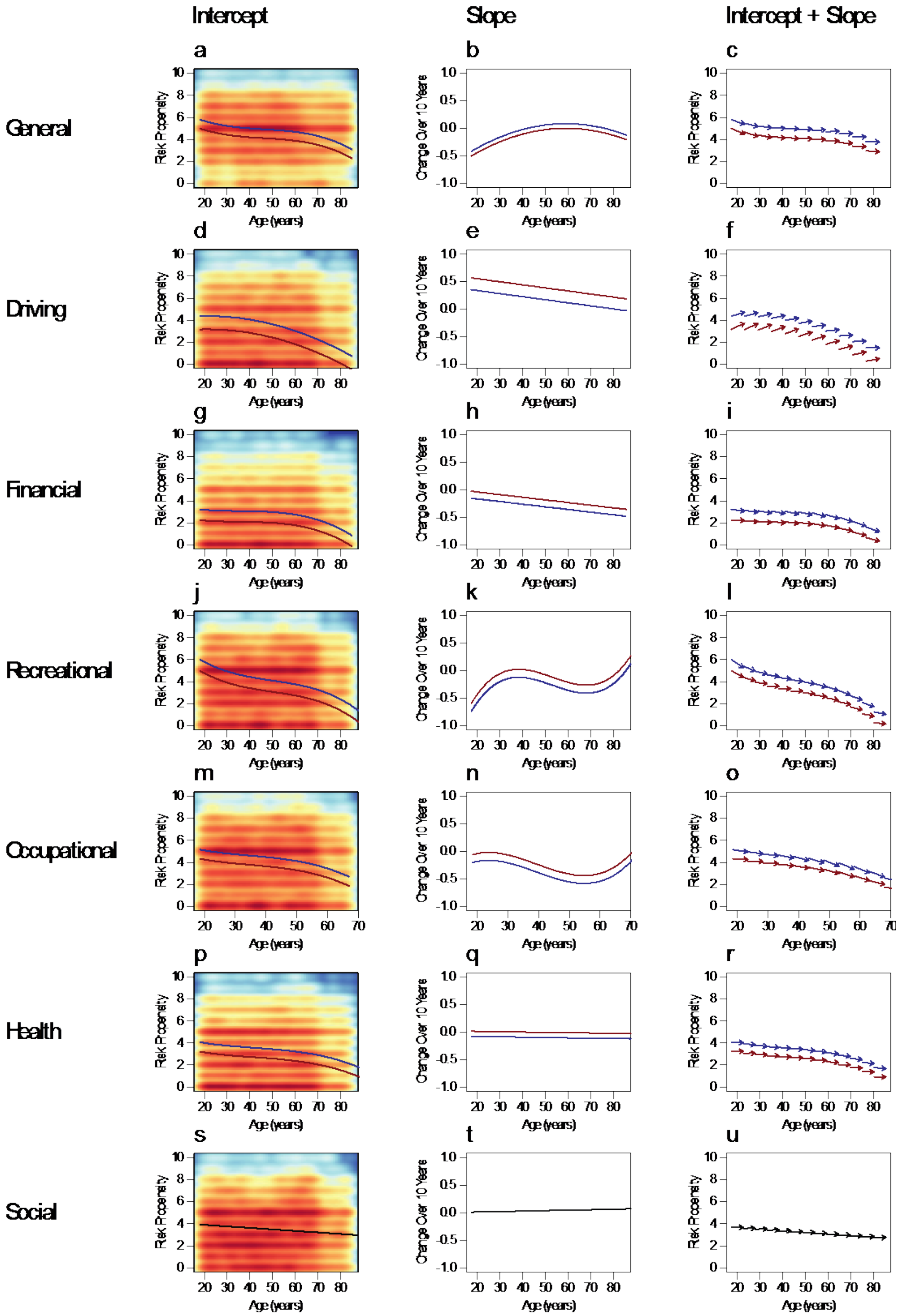


Figure 4. Age-differences in mean levels (intercepts) and mean-level changes (slopes). Arrows (intercept + slope) represent a combined display of age differences in intercepts and slopes for 11 different cohorts. Red line = female, blue line = male. Single black line = no sex difference. All curves in the Intercept plots (a, d, g, j, m, p, s) are plotted on a kernel density plot in which darker red colors indicate higher density of responses (kernel width used for density estimation = 75). General risk propensity (N = 44,076). Driving risk propensity (N = 11,903). Financial risk propensity (N = 11,903). Recreational risk propensity (N = 11,903). Occupational risk propensity (N = 11,903). Health risk propensity (N = 11,903). Social risk propensity (N = 11,903).

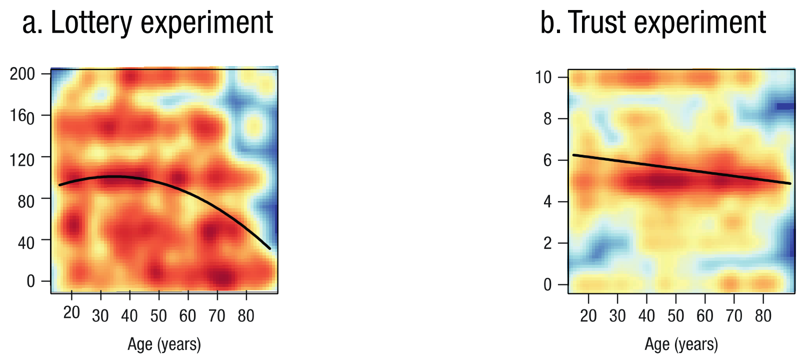


Figure 5. Age differences in mean-levels of behavioral risk taking (cross-sectional data). Single black line = no sex difference. a. Lottery experiment (*N* = 433). b. Trust experiment (*N* = 646).

Appendix

Table A1. Overview of assessment of self-report and behavioral measures of risk.

	2004	2005	2006	2008	2009	2010	2011	2012	2013	2014	*N*
Risk propensities											
General	x		x	x	x	x	x	x	x	x	44,076
Driving	x				x					x	11,903
Financial	x				x					x	11,903
Recreational	x				x					x	11,903
Occupational	x				x					x	11,903
Health	x				x					x	11,903
Social	x				x					x	11,903
The Big Five											
Extraversion		x			x				x		11,903
Openness		x			x				x		11,903
Conscientiousness		x			x				x		11,903
Neuroticism		x			x				x		11,903
Agreeableness		x			x				x		11,903
Income	x	x	x	x	x	x	x	x	x	x	11,903
Experiments											
Lottery game		x									433
Trust game	x										646

Note. The lottery game was assessed in a pretest of the SOEP in 2005 and also included the domain-general risk-taking propensity item but not the domain-specific items.