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Age Patterns in Mental Representations of Time: Underlying Constructs and Relevant Covariates

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Abstract

Background/Study Context—Research suggests that mental representations of time encompass multiple distinct aspects that vary with age, but prior studies rarely assessed more than one aspect of time perception and did not systematically consider relevant covariates. This lack of integration across studies hampers theory building and limits a deeper understanding of underlying constructs.

Methods—Five widely used and conceptually distinct measures of time perception (i.e., perceived life position, global future horizons, future orientation and planning, self-continuity, and the temporal extension of episodic future thought) were administered to a demographically stratified adult life-span sample. Theoretically implicated covariates including cognition, current affect, personality, and subjective health were also assessed.

Results—Principle component analyses suggested a four-component solution. Perceived life position and global future horizons formed a single component reflecting subjective life span; the remaining measures each constituted separate components. The life span component and episodic future thought were negatively associated with age, self-continuity was positively associated with age, and future orientation did not vary by age. Among the covariates, mental and physical health showed the most pronounced associations with time perceptions, but the direction of effects varied across components.

Conclusion—Findings suggest that mental representations of time encompass multiple components that show distinct age patterns and associations with covariates. Implications for theory building and practical applications are discussed.

Keywords

Aging; time perception; future time perspective; time horizons; self-continuity; subjective health; self-rated mental and physical health; emotion

A growing body of research indicates that the way people perceive and structure their time and envision their future varies systematically across the adult life span (for reviews see Löckenhoff, 2011; McFadden & Atchley, 2001). These age-related shifts in mental representations of time have been linked to consequential outcomes including social partner preferences (Lang & Carstensen, 2002), financial decisions (Löckenhoff, O'Donoghue, &

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Dunning, 2011), and medical choices (Löckenhoff & Carstensen, 2007; Löckenhoff et al., 2013). However, our current understanding of such effects is limited in several respects. First, time perception has been defined and assessed in multiple ways. Because most studies selectively examine one of these aspects at a time, it is not clear to what extent age patterns in different measures of time perception are related to each other. This hampers integration across studies because age differences in the same underlying concept may be assessed with different measures and reported in disjoint streams of literature. As a result, researchers may be replicating each other's efforts without knowing it. Second, because explanatory frameworks have disproportionately focused on age-related limitations in actuarial life expectancy (e.g., Carstensen, 2006; Hancock & Rausch, 2010), the role of other theoretically implicated covariates is poorly understood. This limits theory building because it is not clear whether any observed age differences reflect age per se or age-associated changes in other variables.

In response to these open questions, the present study examined age differences in five widely used and conceptually distinct measures of time perception in an adult life-span sample. We also assessed a range of theoretically implicated covariates. To put our research into context, we now review prior evidence for age-related shifts in different aspects of time perception and consider relevant explanatory factors. We then present the rationale and hypotheses for the present study.

Age Differences in Mental Representations of Time

The existing literature on age differences in time perception can be classified broadly into four categories: global time horizons pertaining to the life span as a whole, general thoughts about the future and one's future self, construals of concrete future events, and the estimation of actual time intervals (Löckenhoff, 2011). Because the present study seeks to examine age differences in *mental representations* of time, we focus on the first three of these categories (for reviews of age differences in estimations of actual time, see Block, Zakay, & Hancock, 1998; McAuley, Jones, Holub, Johnston, & Miller, 2006).[1]

Global time horizons refer to a person's general perspective on their position within the entirety of their psychological past, present, and future—constituting their "life space" (Lewin, 1951, p. 246). At the most basic level, this includes the representation of one's perceived location in the life span, which is typically assessed using a straight line anchored by the terms 'birth' and 'death' on which participants are asked to mark their current standing (Cottle & Pleck, 1969; Hancock, 2010). Not surprisingly, aging is linked with a tendency to perceive oneself as farther advanced on this continuum; although, relative to their actuarial life expectancy, older adults tend to underestimate their life position to a greater extent (Hancock, 2010; Kleinspehn-Ammerlahn, Kotter-Grühn, & Smith, 2008).

[1]Of course, perceptions of time encompass both the past and the future (Lewin, 1951). However, past perceptions draw heavily on age differences in memory processes which have been the focus of decades of intensive research (for reviews see Craik & Salthouse, 2008; Salthouse, 2010). The present study therefore prioritizes age differences in perceptions and conceptualizations of future time that remain comparatively underexplored.

A complementary approach to conceptualizing global time horizons has emphasized the extent to which individuals experience time as limited versus expansive (Carstensen, 2006; Carstensen, Isaacowitz, & Charles, 1999). This perspective not only considers perceptions of lifetime per se, but also captures the implications of expanded versus limited time horizons for future opportunities and goal pursuit (Carstensen & Lang, 1996). Consistent with age patterns in life position, older as compared to younger adults were found to perceive their global time horizons and future possibilities as more limited (Carstensen, 2006; Carstensen et al., 1999; Fung, Carstensen, & Lutz, 1999; Fung, Lai, & Ng, 2001).

Taken together, the literature suggests that chronological age is associated with both a more advanced life position and more limited future horizons, but the association between these concepts has yet to be systematically examined.

General future-directed thought differs from global time horizons in that it captures broad cognitive frames of thinking about the future (relative to the present or the past) without any references to specific endpoints or concrete future events. Specifically, Zimbardo and Boyd (1999) conceptualize future orientation as the degree to which individuals emphasize forward planning and the achievement of future goals. Although future orientation is considered as a learned tendency, once established, it is thought to remain relatively stable over time (Zimbardo & Boyd, 1999). To date, research on adult age differences in future orientation is equivocal: Data from a U.S. student sample and a French sample of older adults suggest that future orientation increases with age (Gana, Klein, Saada, & Trouillet, 2013; Zimbardo & Boyd, 1999), data from a U.S. community sample indicate a curvilinear age pattern with highest future orientation scores in midlife (Guthrie, Lessl, Ochi, & Ward, 2013), and data from a U.S. patient sample reveal no age effects (Laguette et al., 2013).

Beyond generalized measures of future orientation, one specific aspect of future thought that has garnered recent interest is self-continuity, defined as the degree to which individuals perceive themselves as similar to their future self. This concept has been explored *implicitly* by asking people to indicate whether or not a series of trait adjectives describes them at present and in the future (e.g., Wakslak, Nussbaum, Liberman, & Trope, 2008, Study 4; Ersner-Hershfield, Garton, Ballard, Samanez-Larkin, & Knutson, 2009; Ersner-Hershfield, Wimmer, & Knutson, 2009, Study 2; D'Argembeau et al., 2010) and *explicitly* by asking participants to indicate the degree of overlap between their current and future selves on a visual scale of overlapping circles (Ersner-Hershfield, Garton, et al., 2009). So far, research on age differences in future self-continuity is limited, with one study suggesting that older age is associated with greater perceived continuity with one's future self (Hershfield, 2011) and another suggesting that when asked to generate future selves, older adults create selves that are temporally closer than those of their younger counterparts (Chessell, Rathbone, Souchay, Charlesworth, & Moulin, 2014).

In summary, research on age differences in future directed thought is very limited, findings are inconsistent, and associations between future orientation (as defined by Zimbardo & Boyd, 1999) and continuity with one's future self remain to be explored.

Episodic future thought, finally, refers to people's construal of concrete future events. Typical scenarios ask participants to list a number of specific and personal events that they are likely to encounter in the future and to indicate at which point in time they expect each event to occur (Fellows & Farah, 2005; Schacter, Addis, & Buckner, 2007; Schacter, Gaesser, & Addis, 2013; Spreng & Levine, 2006; Wallace, 1956). The distribution of generated events usually follows a power function with the majority of events clustered in the near future (Spreng & Levine, 2006), but for older as compared to younger adults this function appears to have a steeper slope with an even smaller number of events reported in the distant future (Schacter et al., 2013; Spreng & Levine, 2006).

To recapitulate, the existing literature on age differences in mental representations of time suggests that compared to younger adults, older adults view their global horizons as more limited, perceive their future selves as more proximal and more continuous with their current selves, and engage in episodic future thought about less distant events. Although these age patterns are generally consistent with each other, there are some exceptions (future orientation, for instance, shows a mixed pattern of age effects), and correlation patterns among specific aspects of time perception have yet to be systematically examined. For instance, Cottle and Pleck's (1969) life position measure and Carstensen and Lang's (1996) Future Time Perspective Scale appear to tap into closely related concepts and show similar age patterns, but it remains unknown whether the two assessments are empirically related. Moreover, relatively little is known about the role of potential covariates.

Covariates

Prior research has considered a range of correlates of individual differences in mental representations of time. However, the empirical record is somewhat disjointed, as some aspects of time horizons and some types of correlates have been more thoroughly researched than others.

Demographic variables

Given the inherent association between advanced chronological age and mortality, the majority of studies examining demographic predictors of time horizons have focused on the role of actuarial life expectancy (for a review see Löckenhoff, 2011). Apart from its association with mortality, age may affect mental representations of time by shifting the ratio of a specific future time interval relative to the years already lived (e.g., five years represent 1/4 of lived years for a twenty-year-old but 1/16 of lived years for an octogenarian; Lemlich, 1975). Other demographic variables may play a role in mental representations of time as well. Women are more accurate than men in estimating their position in the life span relative to their actuarial life expectancy (Hancock, 2010), but show lower levels of future orientation than their male counterparts (Padawer, Jacobs-Lawson, Hershey, & Thomas, 2007). Further, being societally disadvantaged or part of an underrepresented minority limits not only actuarial life expectancy (Murray et al., 2006), but also future thought and planning (Padawer et al., 2007; Sirin, Diemer, Jackson, Gonsalves, & Howell, 2004).

Physical and emotional well-being

To some extent, the links between demographic variables and time perception may reflect shared variance with physical health (Guthrie, Butler, & Ward, 2009; Lasser, Himmelstein, & Woolhandler, 2006). On the one hand, physical health may influence time perception: Poor physical health places limitations on global time horizons – even among younger adults (Kooij & Van De Voorde, 2011; Rasmussen & Elverdam, 2007). Moreover, false feedback indicating to older adults that they physically outperformed their age peers on a grip strength task subsequently lowered their perceived life position (Stephan, Chalabaev, Kotter-Grühn, & Jaconelli, 2013). On the other hand, time perception may influence physical health: Individuals with lower levels of future-oriented thought and shorter future time horizons are less likely to engage in preventive health behaviors and more likely to engage in risky activities which may ultimately result in poorer health outcomes (Daugherty & Brase, 2010; Gellert, Ziegelmann, Lippke, & Schwarzer, 2012; Sansbury, Dasgupta, Guthrie, & Ward, 2014; Whitaker et al., 2011). Thus rather than being unidirectional, the relationship between mental representations of time and physical health appears to be reciprocal.

Mental health and emotional well-being are associated with time horizons as well, and, again, the pattern of associations appears to be complex. On the one hand, socioemotional selectivity theory, a life-span theory of motivation (Carstensen, 2006), argues that age-related limitations in future time horizons lead to a prioritization of emotional well-being in the present moment. Consistent with the theory, age-related limitations in global horizons were found to be associated with the pursuit of emotion regulatory goals, an emphasis on positively valenced stimuli, and—ultimately—more positive emotional states (Charles & Carstensen, 2010; Löckenhoff & Carstensen, 2008; Reed & Carstensen, 2012). However, whereas shorter global time horizons may benefit older adults' mental health, greater future orientation and planning have been linked to positive emotionality (Desmyter & De Raedt, 2012). Moreover, longitudinal decreases in future orientation portended subsequent declines in well-being in an older sample (Kotter-Grühn & Smith, 2011). Thus, associations between time perspective and well-being appear to show divergent patterns across different aspects of time perception.

Cognition and personality

Age-related changes in cognition (for a review see Craik & Salthouse, 2008), may affect perceptions and conceptualizations of time as well. Specifically, reductions in processing speed can partially account for age differences in the subjective speed of time (Baudouin, Vanneste, Pouthas, & Isingrini, 2006), age-related decrements in executive functioning may limit future planning (de Paula, Neves, Levy, Nassif, & Malloy-Diniz, 2012), and reductions in working memory capacity may limit the accurate mental simulation of future events (Cole, Morrison, & Conway, 2013).

However, not all aspects of cognition are negatively affected by age. Semantic world knowledge, for example, is fairly well-preserved with age (Craik & Salthouse, 2008) and may be used to derive accurate predictions about future events without having to rely on complex mental simulations. Moreover, healthy aging is associated with modest increases in conscientiousness (Roberts, Walton, & Viechtbauer, 2006), a dispositional tendency towards planful and organized behavior. This personality trait has been linked with increased future thought and planning (Prenda & Lachman, 2001; Zimbardo & Boyd, 1999) and may counteract some of the detrimental effects of age-related reductions in fluid intelligence on people's ability to anticipate their future.

The Present Study

In summary, prior evidence suggests that mental representations of time encompass several distinct concepts that appear to vary with age and show differential associations with relevant covariates. Because studies rarely examine more than one of these concepts at a time, correlations among them and their relative associations with age and other relevant covariates remain unclear. Thus the existing literature lacks integration—it is unknown how the various conceptualizations of time perception map onto each other. Consequently, theory-building is limited because overarching associations among age differences in different aspects of time perception remain elusive.

As a step towards addressing these questions, the present study examined age differences and patterns of associations among five widely used and conceptually distinct measures of time perception including perceived position in the life span (Hancock, 2010), future time horizons (Carstensen & Lang, 1996), general future orientation and planning (Zimbardo & Boyd, 1999), self-continuity (Ersner-Hershfield, Garton, et al., 2009), and the temporal extension of episodic future thought (Fellows & Farah, 2005). The measures were administered to a demographically stratified adult life-span sample along with assessments of relevant covariates including cognitive functioning, current affect, personality, and subjective health.

Based on the prior literature, we expected that age would be negatively associated with life position, future time horizons, and the temporal extension of episodic future thought, positively associated with self-continuity, and unrelated to future-oriented thought and planning. A central goal of the present research was to uncover patterns of association among different assessments of time perception. Given the aforementioned similarities in theoretical conceptualizations and age patterns for life position (Hancock, 2010) and future time horizons (Carstensen & Lang, 1996), we suspected that the two measures might reflect the same underlying construct. We also examined potential associations among the remaining time perception measures although – based on the relatively distinct theoretical frameworks underlying each measure – we did not expect to find strong links among them.

Finally, we predicted that covariates would show differential associations with specific aspects of time perception but, because of the aforementioned gaps in in the research record, we focused on exploratory analyses without posing any specific hypotheses.

Method

Participants

Ninety community-dwelling participants (aged 21-89) from Tompkins County, NY were recruited through posted flyers, newspaper and internet advertisements, and through an existing database. Undergraduate students were explicitly excluded because they are in a unique life situation which could conceivably skew their time perceptions (especially in the case of graduating seniors who are about to undergo a major life transition; Fredrickson, 1995).

Participants were compensated $15 for their time. To obtain an adult life-span sample that was balanced with regard to gender and race, participants were recruited by age group (< 40 years, 40-59, 60 and over) and selectively enrolled to maintain the same proportion of demographic characteristics within each group. The final age distribution did not show any age clusters and subsequent analyses therefore treated age as a continuous variable.

The second column of Table 1 reports demographic characteristics and shows mean values in our sample for the time perception measures and potential covariates. Due to computer failure and/or experimenter error, four participants had missing data on the Digit-Symbol measure, three participants had missing data on the SF-12 measure and one participant had missing data on the life position measure. Cases with missing data were excluded pairwise for correlations and list-wise for all other analyses.

Measures

Life position was assessed with the Lines Test (Cottle & Pleck, 1969) following Hancock (2010). Participants were shown a horizontal line (160 mm in length), with birth marked on the left end and death on the right end. They were instructed to indicate their subjective position by drawing a vertical line at the appropriate point along the timeline. The distance (in mm) measured from the left end to the mark defined subjective position in the life span.

Future time horizon was measured with the Future Time Perspective Scale (FTP, (Carstensen & Lang, 1996; Lang & Carstensen, 2002). Participants rated the degree to which they agreed with ten statements using a 7-point Likert scale. Statements covered topics such as the extent to which participants felt they had many remaining future opportunities, expected to set new goals in the future, and perceived their future was open-ended versus time-limited (Lang & Carstensen, 2002). The scale was scored by reversing negatively worded items and summing the responses. Cronbach’s alpha was .94.

Future orientation was measured by the Future subscale from the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999). Items include the tendency to plan ahead, follow a predictable schedule, and make steady progress on long-term projects (Zimbardo & Boyd, p. 1287). After reversing negatively scored items, responses were summed. Cronbach’s alpha was .77.

Future self-continuity was assessed following Ersner-Hershfield and colleagues’ (Ersner-Hershfield, Garton, et al., 2009) modification of the Inclusion of Other in the Self Scale (Aron, Aron, & Smollan, 1992). Participants were shown 7 pairs of circles labeled “current self” and “future self” ranging from complete separation to nearly complete overlap. Participants indicated perceived similarity with their future self (3 months from now) on a scale from 1 (least similar) to 7 (most similar).

Episodic future thought was assessed following the procedure by Wallace (1956) as described in Fellows and Farah (2005). An experimenter asked participants to generate five events that might happen to them at some point in the future. After noting down all five events, the experimenter asked participants how far into the future they expected each event to occur. Subsequent analyses focused on the delay (in years) to the most proximal (minimum distance) and most distal event (maximum distance).

Cognitive ability was assessed with a battery capturing processing speed (Digit-Symbol Coding; Wechsler, 1981), working memory (letter-based N-Back; n = 2; Ragland et al., 2002), and vocabulary (Nelson-Denny Reading Test, 25-item vocabulary scale, Nelson, Denny, & Brown, 1960).

Current affect was assessed with two items adapted from Nielsen, Knutson, and Carstensen (2008) asking participants to rate their current emotional state on 7-point scales indicating valence (1 = very negative to 7 = very positive) and arousal (1 = not aroused at all to 7 very aroused).

Subjective health was assessed with the SF-12 (Ware, Kosinski, & Keller, 1998). This measure is widely used in psychological and clinical research and yields scores for both mental health and physical health. Scores were computed using the recommended scoring algorithms (Ware et al., 1998).

Personality traits were screened with a 10-item version of the Big Five Inventory (Rammstedt & John, 2007) assessing neuroticism, extraversion, openness, agreeableness, and conscientiousness with two items each. In spite of its short length, this measure was previously shown to have acceptable reliability and validity indices (Rammstedt & John, 2007). After reversing negatively scored items, we computed sums for each of the traits.

Procedure

The study was conducted individually in a laboratory room. Participants provided informed consent, responded to demographic questions and ratings of current affect, and completed assessments of personality, self-rated health, and multiple aspects of time horizons. After a series of unrelated tasks involving decision making and regret, participants completed the cognitive measures. They were then debriefed and paid for their participation.

Measures were administered using E-Prime software (Version 2.0; Psychology Software Tools, 2009) with the exception of the Digit-Symbol measure and the life position measure (administered with paper and pencil), and the episodic future thought measure (administered orally).

Data Analyses

In preliminary analyses, we obtained descriptive information for each of the demographic characteristics, covariates, and time perception measures and examined their associations with age. This provided a general characterization of the sample and allowed us to assess whether the intended stratification of demographic characteristics across age groups was successful. We also computed raw correlations among all variables to assess whether previously observed age differences in time perception measures and covariates were replicated in the present sample.

Next, we examined the degree to which the different time perception measures assessed distinct constructs. To this end we conducted a principal component analysis (Suhr, 2005) with Varimax rotation and Kaiser Normalization. Finally, we conducted regression analyses to examine the role of covariates for age differences in each of the different components.

Results

Preliminary Analyses

Descriptive statistics are shown in the second column of Table 1. Participants ranged in age from 21 to 89 years. Because we intentionally oversampled older adults, our sample was older, less diverse, and more female than the local population in Tomkins County, NY (http://quickfacts.census.gov/). Sex and racial composition did not differ significantly by age indicating that age-stratification with regard to those characteristics was successful.

Correlations with age are shown in the third column of Table 1 and allowed us to examine whether previously observed age differences in covariates and individual time perception measures were replicated in the present sample. Consistent with the literature on cognitive aging (Salthouse, 2010), higher chronological age was associated with higher crystallized abilities (vocabulary scores) but lower fluid abilities (working memory and processing speed scores). Age differences in subjective health also showed typical patterns (Happell & Koehn, 2011) in that higher age was associated with better mental but worse physical health. There were no significant associations between age and current affective valence and arousal, but for personality traits, we observed common age-related patterns suggesting decreases in neuroticism and increases in agreeableness (e.g., Roberts et al., 2006; Terracciano, Costa, & McCrae, 2006), although these effects remained at the trend level ($ps = .1$). Finally, we replicated prior research on age differences in time perception: Age was associated with a more advanced life position, more limited global horizons, greater self-continuity, and a shorter extension of episodic future thought, but unrelated to general future orientation. In combination, these findings indicated that the present sample showed typically observed age patterns in time perceptions and relevant covariates and was therefore well-suited to conduct the intended analyses.

Associations Among Time Perception Measures

As seen in the bottom right portion of Table 1, there were significant correlations among the different aspects of time perception. As expected, there was a strong association between a more advanced position in the life span and a more limited future time horizon, but beyond that, each of the time perception measures under consideration was significantly associated to at least one of the other measures.

To further examine this pattern of associations, we conducted a principal component analysis. The Eigenvalue criterion suggested a 2-component solution, but this solution only accounted for 56% of the variance, and two of the variables (self-continuity and future orientation) did not load highly on either component. A four component solution supported by the Scree test offered a better fit explaining 85% of the variance (shown in Table 2). In this solution, life position and FTP scores constituted the first component reflecting global life span, the minimum and maximum extension of episodic future thought constituted the second component, and future self-continuity and future orientation each formed a separate component.

Associations with Age and Other Covariates

Figure 1 shows linear associations between chronological age and each of the 4 component scores. Adding quadratic and cubic effects of age did not yield a significant increase in explained variance (all ps > .5). As seen in the figure, Component 1 (reflecting global life span) showed a substantial age-related decrease. Component 2 (extension of episodic future thought) also showed a decrease with age although the effect was more moderate in size. Component 3 (self-continuity), in turn, showed a moderate increase with age, whereas Component 4 (future oriented thought and planning) did not vary by age.

Next, we examined the extent to which the different types of covariates could account for the observed age effects in Components 1, 2, and 3. Current affect and personality were not considered because correlational analyses indicated that they were not significantly associated with age in the present sample (see Table 1). For each of the three components, we computed a regression analysis with age entered in Block 1. To account for the potential influence of cognitive functioning on responses to time perception assessments, cognitive measures were entered in Block 2. To examine the role of subjective health, mental and physical health were added in Block 3. The results of these analyses are summarized in Table 3.

For Component 1 (global life span), cognitive variables did not explain any additional variance after chronological age had been accounted for, but subjective health added significantly to the explained variance, with better mental and physical health predicting a more extended view of the future.

Component 2 (minimum and maximum extension of episodic future thought) showed a different pattern: None of the covariates added to the explained variance, and the age effect was significant only for Block 1. After adding cognitive variables to the model in Blocks 2 and 3, age was no longer significant.

For Component 3 (future self-continuity), adding cognitive covariates in Block 2 yielded a significant effect of vocabulary whereas age was no longer significant. However, ΔR^2 for Block 2 did not reach statistical significance. Block 3 adding subjective health did reach statistical significance indicating that better mental health predicted greater self-continuity.

Discussion

This study extended our understanding of age differences in temporal construal by examining age effects in five conceptually distinct aspects of time perception as well as their associations with each other and with relevant covariates in a demographically stratified life-span sample. We found that the five time perception measures represented four distinct components which differed in age patterns and specific covariates.

Associations among Time Perception Measures

The most prominent finding was a marked association between advanced life position and global future time horizons (as measured by the FTP scale). The two measures emerged as a single component in a principle component analysis. This does not necessarily imply that these concepts are interchangeable, but it suggests that the corresponding streams of literature might cross-fertilize each other. For instance, researchers interested in subjective life position may draw inspiration from the literature on global future time horizons (Carstensen, 2006) and begin to explore the implications of life position for goal priorities. Conversely, researchers studying global time horizons may consider recent findings examining discrepancies between actuarial and perceived life position (Hancock, 2010) and explore similar dissociations between chronological age and FTP scores.

The finding that episodic future thought, self-continuity, and future planning constitute separate components of time perception has important theoretical implications as well. Research on age differences in future self-continuity, for example, is relatively scarce, and it is relevant for researchers in this emerging area that self-continuity appears to be relatively independent from other aspects of time perception. Further, our findings support the notion that future orientation (as captured by Zimbardo et al.'s ZTPI) constitutes a generalized tendency to engage with the future that is only weakly associated with episodic future thought and unrelated to self-continuity and global position in the life span.

Associations with Age and Other Covariates

Our study also adds to the extant literature by reporting age differences for four different aspects of time perception within the same adult life span sample. Because the sample was stratified by age and ethnic composition, these factors could be ruled out as possible causes for the observed age discrepancies. Further, although the four components differed in specific age slopes, all of the observed age effects were linear as opposed to quadratic or cubic in nature. This suggests that the underlying factors shift gradually across the life span without any stepwise or curvilinear effects. This speaks against a role of distinct age-graded life events and time markers (e.g., retirement) and also indicates that age effects are not due to reversible changes in contextual factors (e.g., decreased spare time in midlife; Ginn & Fast, 2006).

Among the various covariates under consideration, only cognitive functioning and subjective health showed significant correlations with age and aspects of time perception and were therefore included in subsequent regression analyses. Adding cognitive variables did not yield a significant increase in explained variance for any of the components. This indicates that age differences in fluid or crystallized abilities cannot account for the observed age differences in time perception. However, we found that including subjective health significantly added to the explained variance in both global life span and future self-continuity. Specifically, better mental health was associated with both an extended life span and greater self-continuity. Better physical health, in contrast, was selectively associated with a more extended life span. These findings align with prior research indicating that variations in mental and physical well-being are linked to global time horizons (e.g., Stephan et al., 2013) and provide initial evidence that the influence of mental health extends to future self-continuity as well. The marginally significant effect of vocabulary on future self-continuity, in contrast, is more puzzling. However, if one considers vocabulary as a proxy for crystallized world knowledge and experience (Verhaeghen, 2003), one could argue that such knowledge may also entail the understanding that individual characteristics remain fairly stable over time.

Limitations and Future Research

Of course, our study has some important limitations that need to be considered when interpreting the results. First, the findings are cross-sectional and correlational in nature. Thus, cohort differences in life experiences may have skewed our findings, and further research is needed to establish longitudinal trajectories and examine causal associations between age, time perception, and covariates. Second, with the exception of cognitive assessments, we relied on self-report measures raising concerns about common method bias. Findings could be strengthened by adding measures of objective health, observer ratings of personality or mood, and implicit measures of time perception (e.g., D'Argembeau et al., 2010). Further, although we aimed to include a range of well-established and conceptually distinct assessments of time perception, there are, of course, other measures to consider. In particular, future work should include concepts that are more closely linked to behavioral implications (e.g, the tendency to discount future financial outcomes, Frederick, Loewenstein, & O'Donoghue, 2002) and measures that explore the symmetry between remembering the past and anticipating the future (Spreng & Levine, 2006). Finally, the present study does not control for the recent experience of significant life events or milestones. As noted previously, undergraduate students were purposely excluded to avoid the potential influence of life events associated with college life, but participants may have recently experienced other major life events (e.g., starting a new job, becoming a grandparent, or facing serious illness). Because life events may shift individuals' time horizons (Peetz & Wilson, 2014) and differ by age, controlling for such effects would be a valuable target for future studies.

In conclusion, our findings set the stage for integrating divergent streams of the literature on age differences in time perception. Beyond their theoretical contributions, our results also have practical implications. Time perspective has been linked to various aspects of financial and decision making and health behavior (Gellert et al., 2012; Löckenhoff & Rutt, in press). Given that our findings implicate subjective health as a key covariate of time perceptions, it may be feasible to shift time perceptions by counteracting perceptions of age-related decline (e.g., via targeted social comparisons, Cheng, Fung, & Chan, 2007, or implicit priming, Levy, Pilver, Chung, & Slade, 2014). As discussed in the introduction, associations between time perception and subjective health appear to be reciprocal and it may be possible to initiate 'virtuous circles' by which better subjective health results in shifting time horizons which in turn stimulate health-promoting behavior.

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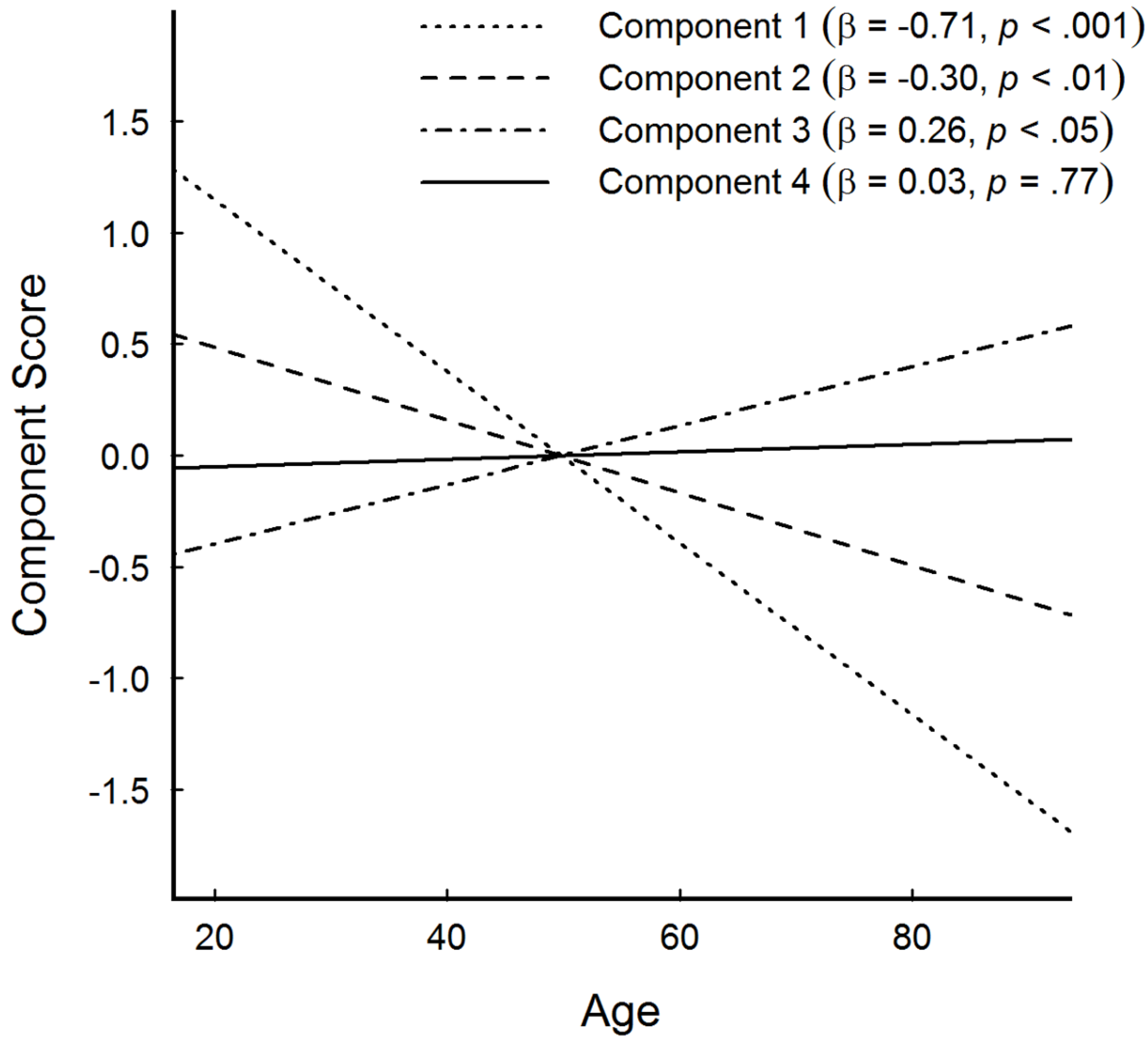

Figure 1.
PCA regression scores, for each of four components, by age. Component 1 = global life span; Component 2 = extension of episodic future thought; Component 3 = future self-continuity; Component 4 = future planning and orientation.

Table 1

Participant Characteristics and Correlations with Age and Time Perspective Measures for All Potential Covariates

	M(SD) / %	r_{Age}	$r_{LifePosition}$	r_{FTP}	r_{ZPTI}	$r_{Self\text{-}Continuity}$	$r_{Episodic(Min.)}$	$r_{Episodic(Max.)}$
Demographics								
Age	49.81 (18.71)		.86**	-.51**	-.06	.26*	-.12	-.43**
Sex (% female)	64%	-.04	-.02	.08	.10	-.15	-.12	-.04
Race (% White)	86%	.07	.07	-.21*	-.07	.09	-.08	.01
Cognition								
Vocabulary	17.98 (4.90)	.36**	.31**	-.34**	-.02	.35**	-.09	-.13
Working memory	.78 (.23)	-.37**	-.31**	.18	-.02	.02	.09	.19
Processing speed	56.81 (14.17)	-.68**	-.60**	.32**	.03	-.16	.04	.40**
Affect								
Valence	5.02 (1.23)	.19	.10	.26*	.22*	-.03	-.08	-.15
Arousal	3.33 (1.57)	.10	.06	.05	-.02	-.09	-.06	.03
Subjective health								
Mental	47.25 (12.13)	.30**	.13	.12	.15	.30**	.11	-.08
Physical	50.26 (9.25)	-.33**	-.39**	.39**	.10	-.07	.11	.09
Personality								
Neuroticism	5.83 (2.03)	-.18	-.06	-.05	.04	-.28**	-.20	.06
Extraversion	6.60 (1.95)	.13	.13	.02	-.03	.04	-.07	-.09
Openness	7.79 (1.78)	-.09	-.07	.12	.09	-.05	.13	.07
Agreeableness	7.08 (2.04)	.18	.04	.17	.02	.06	.01	-.18
Conscientiousness	8.03 (1.54)	.09	.02	.26*	.20	.01	.10	-.15
Time perspectives								
Life position	.59 (.22)	.86**						
FTP	46.80 (15.45)	-.51**	-.60**					
ZPTI	3.79 (0.56)	-.06	-.03	.08				
Self-continuity	5.62 (1.76)	.26*	.23*	-.12	.08			
Episodic (Min.)	1.30 (2.10)	-.13	-.07	.03	.21*	.11		

	M(SD) / %	r_{Age}	$r_{LifePosition}$	r_{FTP}	r_{ZPTI}	$r_{Self\text{-}Continuity}$	$r_{Episodic(Min.)}$	$r_{Episodic(Max.)}$
Episodic (Max.)	15.00 (15.27)	-.43**	-.32**	.13	.16	.06	.41**	

Note. Correlations for sex and race are point-biserial, all others are Pearson correlations. FTP = Lang and Carstensen's (1996) Future Time Perspective Scale, ZTPI = Zimbardo Time Perspective Inventory, Future Orientation Scale.

** p < .01,

* p < .05

Table 2

Rotated Component Matrix for Principal Component Analysis Examining Patterns of Association Among Time Perception Measures

	Component			
	1	**2**	**3**	**4**
FTP	**.90**	-.03	.02	.09
Life position	**-.86**	-.20	.19	.05
Episodic (Min.)	-.08	**.83**	.02	.18
Episodic (Max.)	.24	**.83**	.06	-.02
Self-continuity	-.11	.07	**.99**	.04
ZTPI	.04	.13	.04	**.98**

Note: Rotation converged in five iterations. Loadings over .3 are shown in bold font. FTP = Lang and Carstensen’s (1996) Future Time Perspective Scale, ZTPI = Zimbardo Time Perspective Inventory, Future Orientation Scale.

Table 3

Regression Analyses Examining the Role of Covariates for Age Differences in Components of Time Perception

	$\beta_{Component 1}$	$\beta_{Component 2}$	$\beta_{Component 3}$
Block 1			
Age	-.71**	-.30**	.26*
R^2	.51**	.09**	.07*
Block 2			
Age	-.66**	-.25	.20
Vocabulary	-.06	-.03	.24*
Working memory	.01	.04	.02
Processing speed	.04	.04	.02
ΔR^2	.00	.00	.06
Block 3			
Age	-.61**	-.30	.10
Vocabulary	-.05	-.02	.27*
Working memory	.05	.03	.01
Processing speed	.06	.03	.00
Mental health	.20*	.09	.31**
Physical health	.23**	-.03	.05
ΔR^2	.08**	.01	.09*

Notes.

** $p < .01$,

* $p < .05$.

Component 1 = global time horizons; Component 2 = extension of episodic future thought; Component 3 = future self-continuity.