The Gerontologist
cite as: *Gerontologist*, 2017, Vol. 57, No. 3, 396–408
doi:10.1093/geront/gnx010

Feature Article

Age Differences in Self-Continuity: Converging Evidence and Directions for Future Research

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Received August 16, 2016; Editorial Decision Date November 7, 2016

Decision Editor: Rachel Pruchno, PhD

Abstract

Life-span development is inherently linked to the perception of time and associated temporal construals. Such concepts are multi-faceted in nature and have important practical implications in areas such as time management, financial planning, or medical choices. A large body of research has documented age-related limitations in global time horizons, but age differences in other aspects of temporal construal are comparatively poorly understood. The present article draws attention to developmental trajectories of *self-continuity*, defined as perceived associations of one's present self with past and future selves. After considering historical roots and contemporary views on self-continuity, we turn to the life-span developmental literature and review several convergent streams of research that provide indirect evidence for age-related increases in self-continuity. We then consider a small body of recent studies which have directly assessed age differences in self-continuity and summarize our current understanding of this phenomenon including associations between explicit and implicit measures, symmetry between past and future self-continuity, and differentiation from other aspects of time perception. We conclude by highlighting open theoretical questions and considering the practical implications of an increased sense of self-continuity with advancing age.

Keywords: Aging, Self-continuity, Time perspective, Temporal horizons

Life-span development is inherently intertwined with the objective passing of time and with people's subjective perceptions of past and future horizons, temporal landmarks, and subtle or not so subtle changes in themselves (Baltes, Lindenberger, & Staudinger, 1998; Baltes, Reese, & Lipsitt, 1980; Löckenhoff & Rutt, 2015; Ryff, 1984). Such phenomena are not just of theoretical interest but have important practical implications: The way in which we perceive and conceptualize ourselves over time has been linked to consequential life outcomes ranging from everyday time management (e.g., Blouin-Hudon & Pychyl, 2015; O'Donoghue & Rabin, 2008), to long-term savings behaviors (e.g., Bryan & Hershfield, 2012; Ersner-Hershfield, Wimmer, & Knutson, 2009), and momentous medical choices (e.g., Chapman & Coups, 1999; Löckenhoff et al., 2013).

Time perceptions are multi-faceted (Klapproth, 2008; Löckenhoff, 2011; Wearden, 2016) and vary in *points of reference* (i.e., external markers vs. internal states), *perspective* (i.e., mapping time relative to the present moment or assuming a birds-eye perspective of the global life span), *temporal direction* (i.e., focus on past vs. future), *temporal extension* (i.e., ranging from seconds and minutes to years and decades), and *qualitative characteristics* (including emotional valence, episodic detail, and discontinuities relative to objective time). Although some of these components are related to each other, others appear to be relatively independent and show differential associations

with outcome variables (Rutt & Löckenhoff, 2016a; Wearden, 2016).

In spite of the multi-faceted nature of temporal construal, recent research on age differences in time perception has focused predominantly on perceived limitations in global future horizons (Carstensen, 2006; Carstensen, Isaacowitz, & Charles, 1999). In this article, we draw attention to a complementary concept—*self-continuity*—defined as the perceived associations between one's present sense of self and one's past and future selves. Regarding the taxonomy presented above, self-continuity focuses on internal states and personal characteristics that are mapped relative to the present self over years and decades into the past and the future. Self-continuity can be considered both in terms of its temporal extension and in terms of its qualitative characteristics including episodic detail and implicit feelings of connectedness.

A better understanding of age differences in self-continuity is sorely needed, because it confers a variety of benefits. With regard to mental health, Erikson (1959) was the first to report profound disruptions in self-continuity among traumatized war veterans. Self-continuity deficits have since been implicated in a wide range of other psychopathologies including depression (Grace, Dewhurst, & Anderson, 2016), suicidal tendencies (Ball & Chandler, 1989), schizophrenia (Raffard et al., 2016) and borderline personality disorder (Fuchs, 2007). In part, self-continuity appears to enhance mental health by fostering the development and maintenance of stable long-term relationships which in turn provide a steady source of social support (Bluck, Alea, Habermas & Rubin, 2005). Self-continuity has also been implicated in adaptive coping responses to challenging life events (Sadeh & Karniol, 2012), and it predicts beneficial behaviors across a range of domains: In the economic realm, for example, self-continuity has been linked to higher savings rates and retirement preparation (Bryan & Hershfield, 2012; Ersner-Hershfield, Garton, Ballard, Samanez-Larkin, Knutson, 2009). Those higher in self-continuity also show lower rates of delinquency (van Gelder, Hershfield, & Nordgren, 2013) and unethical behavior (Hershfield et al., 2012), and they are more likely to engage in healthy practices (Brotkin, 2015). Arguably, such protective effects are particularly important in later life when health concerns and other age-related challenges loom larger (Baltes, Lindenberger, & Staudinger, 1998).

To gain a comprehensive understanding of developmental trends in self-continuity, we begin with a brief overview of historical and contemporary perspectives of this phenomenon. We then turn to the life-span developmental literature and review several convergent streams of research that provide indirect evidence for a greater stability in the sense of self with advancing age. Next, we consider the small set of recent studies which have directly assessed age differences in self-continuity and summarize our current understanding of this phenomenon including associations between explicit and implicit measures, symmetry between past and future self-continuity, and differentiation from other aspects of time perception. We conclude by highlighting open theoretical questions and considering the practical implications of an increased sense of self-continuity with advancing age.

In reviewing the prior literature, we integrate findings from a wide range of fields which often differ in sampling conventions and age cut-offs. For consistency, we refer to samples with a mean age of up to 10 years as children, 11 to 17 years as adolescents, 18–39 as young adults, 40–64 as middle-aged adults, and 65 and over as old adults. Whenever a study deviates from these broad age ranges we provide further specification as appropriate.

From Historical Roots to Contemporary Perspectives

Historically, the phenomenon of self-continuity has been discussed in the philosophical literature, and, according to Parfit (1987) and Chandler et al. (Chandler, Lalonde, Sokol, Hallett, 2003), relevant theories can be broadly categorized in two types: *Ego or essentialist theories* propose the existence of some inner agent or entity corresponding to a continuous self. Examples of this perspective range from Descartes' (1649) notion of the pineal gland as the seat of the eternal soul to Baars' (2003) proposition of a left-prefrontal self-system which "maintains expectations and intentions across many specific situations" (Baars, 2003, page 1). *Bundle theories*, in contrast, trace back to Hume's (1738) observation that "I never can perceive this self without some one or more perceptions; nor can I ever perceive anything but the perceptions. 'Tis the composition of these, therefore, which forms the self." (Hume, 1738, Appendix). This view of the self as an illusion, emerging from multiple interconnected processes finds its contemporary echo in philosopher Daniel Dennett's notion of the self as an illusory "center of narrative gravity" (Dennett, 1992), which is maintained through an ongoing process of autobiographical self-narration.

Irrespective of ongoing debates concerning the physical substrates of self-continuity, there is general agreement that, from a subjective point of view, human beings experience a sense of the self that is separate from the surrounding world and continuous from past to present and into the future. This idea is inherent in one of the earliest definitions of personal identity, proposed by British empiricist John Locke (1689). He considered "continuity of consciousness" (as opposed to bodily substance or immortal soul) as the defining feature of identity, and emphasized the mind's ability to "consider itself as itself, the same thinking thing, in different times and places" (Locke, 1689, Chapter 17, Section 11). In the 19th century, William James' "Principles of Psychology" (1890) built upon these ideas to propose that personal identity emerges from a sense of community across present and past selves. According to James, this unbroken "stream of selves" is linked through a sense of "intimacy" or "warmth" conveyed by the recall of past bodily sensations, sensory experiences, and emotional responses (James, 1890, page 335).

Although James' (1890) propositions set the stage for systematic psychological explorations of self-continuity,

the topic remained in the philosophical realm for the first half of the 20th century—presumably because prevalent psychodynamic perspectives considered key aspects of the self as not accessible to conscious thought, and the rise of behaviorism led researchers to discount subjective experience in favor of observable events and behaviors. In the 1950s the psychological literature finally returned to the topic and recognized self-continuity—along with self-definitions and social roles—as a key component of a person's sense of identity (Block, 1961; Erikson, 1959). Subsequent work on self-schemata, defined as beliefs and ideas relating to the self (Markus, 1977), emphasized similarities and contrast between the present self and temporally distant selves (Albert, 1977; Parfit, 1971) including possible future self states (Markus & Nurius, 1986).

The last two decades have finally seen a surge of research related to temporal self-continuity, although this work is distributed across multiple fields and much of it touches on the subject in an indirect fashion (for an overview see Sani, 2008). In broad terms, the contemporary literature on self-continuity can be differentiated into structural and process perspectives. *Structural perspectives* emphasize self-related knowledge structures and the degree to which the present self incorporates past and future selves. This line of thinking is captured in Neisser's (1988) taxonomy of self-knowledge which includes the temporally "extended self" as one of five types of self-specifying information. *Process perspectives,* in turn, focus on the dynamic processes, including mental time travel and self-narration, by which a sense of self-continuity is created (Addis & Tippett, 2008; Bluck et al., 2005; McAdams, 2013; Rice & Pasupathi, 2010).

Converging Evidence for Age Differences in Self-Continuity

With increasing interest in the general phenomenon of self-continuity, questions about developmental changes in its components began to emerge. Initial efforts to understand developmental trajectories of self-continuity focused primarily on the period ranging from childhood to young adulthood (Erikson, 1959; James, 1890). Evidence suggests that the sense of self-continuity develops gradually over the course of childhood as children acquire the necessary cognitive prerequisites including formal operational thought (Chandler, Lalonde, Sokol, & Hallett, 2003), complex self-related knowledge structures (Harter, 1998), the capability for mental time travel (Coughlin, Lyons, & Ghetti, 2014; Wang & Koh, 2015), and the ability to develop autobiographical narratives (Fivush, 2011). Importantly, there appears to be more than one path towards self-continuity (Chandler et al., 2003) with some children focusing on the self as an enduring entity (akin to ego perspectives) and others perceiving the self as emerging from a network of narratives and relationships (akin to bundle theories). Within each of these perspectives, however, normal development is characterized by increasing complexity in self-representations and a growing ability to acknowledge the co-occurrence of sameness and change (Chandler et al.). After a period of gradual growth throughout childhood, adolescence is characterized by a phase of instability fueled by processes of identity formation and role socialization which require active efforts by the developing individual to forge a strong sense of adult identity along with a coherent life story (Chandler, et al., 2003; Erikson, 1968; Habermas & Bluck, 2000; Kroger, Martinussen, & Marcia, 2010; Waterman & Archer, 1990).

With regard to adult development, there is general agreement that the integrity of the self remains strong over the course of healthy aging (Troll & Skaff, 1997) and that maintaining a sense of continuity in the face of age-related change is an important prerequisite for well-being in later life (Atchley, 1989; Baltes, Lindenberger, & Staudinger, 1998; Erikson, 1959). Until recently, however, there were few attempts to directly study adult age differences in the temporal extension of the self, although studies from a range of different fields have provided indirect evidence for age-related changes in self-continuity. Below we review these streams of work, including research on age differences in time horizons, the stability of personal characteristics, autobiographical thought, and economic choices.

Time Horizons

At the most basic level, conceptions of ourselves as continuous or changing are likely to be associated with our perception of time itself. With regard to the subjective speed of time, there are countless literary references, tracing back to Virgil's realization that time flees ("tempus fugit," Virgil, 29 B.C.), bemoaning that subjective time passes too quickly and appears to further accelerate as we age. Although systematic empirical tests of such effects are still scarce (Janssen, Naka, & Friedman, 2013; John & Lang, 2015; Wittmann & Lehnhoff, 2005), the available evidence generally supports an age-related acceleration in the subjective speed of time. This would point towards increases in temporal self-continuity: If time appears to pass more quickly with advancing age, past and future self states should be perceived as subjectively closer.

The exact pattern of such effects, however, may depend on the temporal intervals involved. Research on younger adults suggests that the perceived length of time intervals depends on their distance from the present with more distant intervals being perceived as more compressed (Kim & Zauberman, 2009; Zauberman, Kim, Malkoc, & Bettman, 2009). According to recent data from our laboratory, this compression effect is even more pronounced in middle-aged and older adults (Rutt & Löckenhoff, 2012) suggesting that age differences in self-continuity might be particularly evident for longer time intervals.

People's global orientations towards past, present, and future, appear to vary by age as well. Contrary to the common stereotype that older adults are "living in the past,"

they were instead found to endorse an *open present perspective* that is, a present-focused perspective that is open towards the future without posing any specific temporal boundaries (Nuttin, 1985). Socioemotional selectivity theory (Carstensen, 2006), goes one step further in suggesting that older adults' emphasis on the present moment leads to a motivated shift in goal priorities. Specifically, as people get older and perceive their global time horizons as more limited, they are thought to actively reorient their goal priorities from preparing for the future towards optimizing the present. Conceivably, older adults' emphasis on current experiences could blur subjective boundaries between past, present, and future self and thus promote greater self-continuity.

Taken together, research on age differences in various aspects of time perception consistently points towards age-related increases in self-continuity, but it is not clear whether such effects are driven by one factor or a bundle of mechanisms and whether they would equally affect past and future and proximal and distal time intervals alike.

Stability and Change in Personal Characteristics

Further evidence for age differences in self-continuity comes from research on the developmental trajectories of personal experiences and characteristics which generally points to greater stability with advancing age. Studies examining the dynamics of everyday affective experiences across the adult life-span have found that age is associated with fewer fluctuations over the course of hours and days (Lawton, Kleban, Rajagopal, & Dean, 1992), and this pattern bears out in samplings of everyday experience (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Carstensen et al., 2011) as well as laboratory assessments (Röcke, Li, & Smith, 2009).

People's personality traits also become more stable with age. Cross-sectional and longitudinal studies agree that after a period of rapid change in adolescence, traits remain comparatively stable in young and middle adulthood although more gradual change is seen into old age (Roberts, Walton, & Viechtbauer, 2006; Soto, John, Gosling, & Potter, 2011; Terracciano, McCrae, Brant, & Costa, 2005). Other self-relevant characteristics show similar age trends towards greater stability, including life philosophies, value systems, consumer and nutritional habits, and life satisfaction (Lachman, Röcke, Rosnick, & Ryff, 2008; Quoidbach, Gilbert, & Wilson, 2013; Schewe & Meredith, 2004). Finally, people's physical and social environments become more stable with age. Geographic mobility peaks in people's 20s and declines thereafter (U.S. Census Bureau, 2015), older workers are less likely to change employers or occupations than their middle-aged and younger counterparts (Bureau of Labor Statistics, 2014), and people's social networks—especially close social relationships to significant others—show fewer fluctuations in later life (Charles & Carstensen, 2010). Accordingly, both the frequency of significant life events (Habermas & Köber, 2015) and the likelihood of taking on new roles (Rathbone, Moulin, & Conway, 2008) are negatively associated with age.

Older adults appear to be well aware of these trends towards greater stability. In a sentence-completion task assessing people's perceptions of life-span development, respondents in their 70s and 80s showed a greater emphasis on stability than those in their 40s, 50s, and 60s (Timmer, Steverink, Stevens, & Dittmann-Kohli, 2003). Also, when asked to describe lifespan changes in personal characteristics for themselves and others, younger adults expected age-related increases in detrimental characteristics in their own and others' development—perhaps reflecting negative societal stereotypes of aging. Older adults, in contrast, expected stability (Heckhausen & Krueger, 1993).

Similarly, studies assessing self-rated well-being and life satisfaction in the past, present, and future (e.g., Lachman et al., 2008; Ryff, 1991; Staudinger, Bluck, & Herzberg, 2003) found that younger adults perceived their well-being to be on an upward trajectory whereas older adults reported stability along with some decline (Lang, Weiss, Gerstorf, & Wagner, 2013). Interestingly, the age-related tendency to assume fewer fluctuations in life satisfaction over time makes older adults' self-reports of their past and future life satisfaction more accurate than those of younger adults who tend to overestimate rates of change (Lachman et al., 2008).

In summary, older age is characterized by higher objective stability across a wide range of self-relevant characteristics, and since people appear to be aware of such developmental trends, this is likely to bolster subjective self-continuity in later life. In fact, the age-related tendency to evaluate one's future less optimistically and more realistically may be an active self-regulatory strategy to manage expectations in the face of age-related challenges (Lang et al., 2013). Thus, age-related increases in the stability of personal characteristics are likely to be driven by a combination of internal factors and environmental contingencies lending support for bundle perspectives on self-continuity.

Autobiographical Thought

Insights about long-term trends in the structure and stability of personal characteristics are complemented by process perspectives on self-continuity in autobiographical thought where two distinct components of self-continuity can be differentiated.

The first of these components, *phenomenological continuity* or mental time travel, refers to episodic simulations of temporally distant states that relive the past and anticipate the future.

It is typically examined by presenting participants with a set of cue words and asking them to describe corresponding events that have occurred to them in the past or are likely to occur to them in the future. Researchers can then assess the temporal extension of these episodes along with qualitative characteristics (e.g., emotional valence and vividness) and narrative cohesion (Schacter, Gaesser, & Addis, 2013).

With regard to temporal extension, most responses tend to cluster in the near past and future, but—not surprisingly—older adults' autobiographical thought extends farther into the past, whereas younger adults project farther into the future (Addis, Musicaro, Pan, & Schacter, 2010; Gaesser, Sacchetti, Addis, & Schacter, 2011; Schacter & Addis, 2008; Schacter et al., 2013) with middle-aged adults falling somewhere in-between (Spreng & Levine, 2006). This would suggest that age differences in self-continuity are asymmetrical with older adults reporting greater self-continuity for the past than their younger counterparts but lower continuity for the future.

The qualitative characteristics of mental time travel vary by age as well. Specifically, older adults' report less episodic detail and more generalized semantic content than their younger counterparts—both when recalling the past and when anticipating the future (Addis et al., 2010; Cole, Morrison, & Conway, 2013; Old & Naveh-Benjamin, 2008; Schacter et al., 2013). If past and future are construed in less concrete and vivid terms as people get older, this may imply that self-continuity decreases as well.

A second component of autobiographical continuity, *narrative continuity*, refers to the weaving of a coherent life story which assigns personal meaning to autobiographical events and reconciles discontinuities among past, present, and future self-states (Addis & Tippett, 2008; McAdams, 2013; Bluck et al., 2005; Rice & Pasupathi, 2010). The life-story first emerges in adolescence and consolidates in young adulthood, but it is continuously updated with ongoing life experiences throughout the adult years (e.g., Habermas & Bluck, 2000; McAdams, 2013; Pasupathi, Mansour, & Brubaker, 2007). Several studies have suggested that personal narratives become more coherent with age. Reese and colleagues (2011), for example, examined three aspects of coherence—context, chronology, and thematic clarity—in the personal stories of a cross-sectional sample ranging from preschool to middle-age. They found that while all three aspects of coherence were positively associated with age over the course of childhood, context and chronology peaked in early adulthood and leveled off in midlife whereas thematic coherence was highest among middle-aged adults. Similarly, McLean and Fournier (2008) analyzed self-defining memories among younger and older adults and found that although age groups did not differ in reflective or self-relevant processing, older adults' stories showed greater thematic coherence than those of younger adults and focused more on stability as opposed to change.

In fact, the very reasons for engaging in autobiographical thinking may differ by age. Bluck and Alea (2008, 2009) asked younger and older adults why they thought and talked about the past. Both age groups were equally likely to engage with the past to maintain social bonds, but older adults were less likely than younger adults to pursue future planning or foster a sense of self-continuity—presumably because they had already achieved a clear and stable sense of self. Consistent with this idea, Rice and Pasupathi (2010) asked younger and older adults to provide narratives of self-relevant memories and found that older adults' showed lower evidence of self-construction than younger adults, especially when recalling self-discrepant events.

In combination, the literature on age differences in autobiographical thought reveals a complex picture: Phenomenological continuity shows age decrements in the vividness and concreteness of past and future selves, narrative continuity shows age-related increases in the coherence and stability of one's life story, and research on the temporal extension of past and future thought points towards asymmetries in age effects for past and future continuity.

Behavioral Economics

An independent line of evidence with potential implications for self-continuity comes from the behavioral economics literature. Some economic choices can be conceptualized as conflicts between present, past, and future selves (Hershfield, 2011; O'Donoghue & Rabin, 2000) and people's responses to such conflicts appear to differ by age.

One prominent stream of research has examined age differences in "temporal discounting," the tendency to value proximal outcomes (i.e., outcomes that benefit the current self) more highly than distal outcomes (i.e., outcomes that benefit the future self). Typical scenarios require participants to choose between a smaller amount of money offered sooner (e.g., $10 today) and a larger amount offered at a later point in time (e.g., $15 in 1 year). Multiple studies have found that younger adults are more likely than older adults to discount future outcomes by selecting the smaller but sooner payout (Green, Fry, & Myerson, 1994; Halfmann, Hedgcock, & Denburg, 2013; Jimura et al., 2011; Löckenhoff et al., 2011; although see Harrison, Lau, & Williams, 2002) and people's insight into their future emotions appear to play a role in such effects. Although younger adults expect weaker emotional responses to future gains and losses than to immediate ones, this bias is reduced in middle aged and older adults, and such trends can partially account for age differences in temporal discounting (Löckenhoff et al., 2011). Moreover, research on younger adults points to a direct association between low self-continuity and a tendency to discount or devalue future events, although such effects have yet to be examined in middle-aged and older adults (Bartels & Urminsky, 2011b; Ersner-Hershfield, Garton et al., 2009). In combination, these results suggest that continuity with one's future selves increases with age.

However, such effects do not necessarily extend to past selves. The "sunk cost fallacy" occurs when people keep investing in an option to which they have committed in the past, even if these investments by their past selves have no bearing on future success. Typical scenarios ask participants whether they would keep watching a boring movie or continue eating a poorly tasting meal because they have already paid for it. Growing evidence suggests that age is

associated with a reduced tendency to be swayed by such "sunk costs" that have been incurred by one's past self (Bruine de Bruin, Parker, & Fischhoff, 2007; Strough, Karns, & Schlosnagle, 2011; Strough, Mehta, McFall, & Schuller, 2008). Research further suggests that the age-related tendency to focus on the present moment—as opposed to the past or future—contributes to older adults lower susceptibility for sunk costs (Karlsson, Juliusson, Grankvist, & Garling, 2002; Strough, Schlosnagle, & DiDonato, 2011; Strough, Schlosnagle, Karns, Lemaster, & Pichayayothin, 2014). These findings are consistent with Nuttin's (1985) idea that older adults' focus on an "open present" and imply that perceived continuity with past selves decreases with age. Taken together, the behavioral economics literature suggests that age differences in self-continuity vary for past and future with older adults a showing higher self-continuity for the future but lower self-continuity for the past than younger adults.

Direct Assessments of Age-Differences in Self-Continuity

In combination, the prior literature offered multiple indirect lines of evidence supporting the notion that self-continuity changes with age, but many open questions remained. Most importantly, prior research focused on age differences in behavioral correlates and process aspects of self-continuity and did not directly capture the perceived overlap of the present self with past and future selves. The lack of integration across different streams of research also limited insights about common mechanisms contributing to age effects. Further, although many prior findings pointed towards age-related increases in self-continuity, it was not clear whether such effects equally pertained to past and future and to close versus distant time intervals. Finally, prior work prioritized comparisons between extreme age groups and did not test for curvilinear age trajectories.

Recent work by ourselves and others has begun to address some of these questions by directly assessing age differences in the perceived overlap between present and temporally distant selves for both past and future selves and across multiple time intervals. One important step that paved the way for this research was the availability of appropriate assessment tools. In the extant literature, two primary strategies for capturing perceived associations between present and past/future selves have emerged.

The first approach (henceforth referred to as *explicit self-continuity*) directly asks participants to indicate the proximity of their present self to temporally distant selves. This can be accomplished with questionnaires assessing similarity, familiarity, and sense of "sameness" with past and future selves (e.g., Habermas & Köber, 2015; Sedikides, Wildschut, Routledge, & Arndt, 2015). However, verbal descriptions can be cumbersome when examining multiple temporal distances within the same individual. Our recent work therefore relied on a visual scale (Aron, Aron, & Smollan, 1992; Ersner-Hershfield, Garton, et al., 2009) which represents the present self and temporally distant selves as pairs of partially overlapping circles. Participants are simply asked to select the degree of overlap they perceive between their present self and specific past or future selves (Bartels & Urminsky, 2011a; Ersner-Hershfield, Garton, et al., 2009; Hershfield, Cohen, & Thompson, 2012; Rutt & Löckenhoff, 2016a, 2016b).

Implicit self-continuity, in turn, assesses overlap in the personal characteristics ascribed to present and temporally distant selves. In the me/not-me task (adapted from Kelley et al., 2002), participants see a series of trait words and are asked to indicate whether or not these words describe them at present and at past or future points in time (D'Argembeau et al., 2010; Ersner-Hershfield, Garton, et al., 2009; Ersner-Hershfield, Wimmer, et al., 2009; Pronin & Ross, 2006; Rutt & Löckenhoff, 2016b; Wakslak, Nussbaum, Liberman, & Trope, 2008). For further analyses, the percentage of overlap in trait ratings between present and temporally distant selves can be computed.

Since both types of measures are relatively recent, evidence for reliability and validity is still scarce. The visual scale to assess explicit self-continuity has a 2-week retest reliability of .66 (Ersner-Hershfield, Garton, et al., 2009) and shows convergent validity with increased certainty about one's future preferences (Bartels & Urminsky, 2011a) and discriminant validity from impulsivity, perceived change in life circumstances, present-bias, perceived length of future time intervals, future planning, limitations in global time horizons, and the extension of episodic future thought (Bartels & Urminsky, 2011a; Rutt & Löckenhoff, 2016a). Implicit self-continuity, assessed with the me/not-me rating task, shows convergent validity with the explicit self-continuity scale and discriminant validity from limitations in global horizons (Ersner-Hershfield, Garton, et al., 2009; Rutt & Löckenhoff, 2016b).

With the help of these assessment tools, a clearer understanding of age differences in the structure of self-continuity has begun to emerge. Using the visual scale to assess explicit self-continuity one decade into the future, Hershfield (2011) reported a positive association between self-continuity and age in an adult life-span sample. We used the same visual scale to assess self-continuity 3 months into the future (Rutt & Löckenhoff, 2016a). Again, there was a positive association across the adult life span between self-continuity and age and the age effect appeared to be linear (as opposed to curvilinear) in nature. Questionnaire-based measures of explicit self-continuity yielded convergent effects for past self-continuity. Age was positively associated with past self-continuity for a 4-year interval (Habermas & Köber, 2015) and for the past in general (Sedikides et al., 2016; Study 6). However, insights into age differences in explicit self-continuity remained limited because only a single past or future interval was assessed in each of these studies and, until recently, age differences in the implicit me/not-me task had not been examined at all.

To integrate findings across types of measures, temporal directions, and intervals of varying length, we recently examined age differences in implicit and explicit self-continuity, for both future and past, over six time intervals (ranging from 1 month to 10 years), in an adult life-span sample (Rutt & Löckenhoff, 2016b). We found that age was positively associated with both explicit self-continuity (assessed with a visual scale, Figure 1, top) and implicit self-continuity (assessed with a me/not-me task, Figure 1, bottom) and the effect size and pattern of age differences was the same for past and future. Further, both explicit and implicit self-continuity showed a linear association with age and no evidence of curvilinear trends was found.

When comparing ratings of self-continuity across time intervals, however, we found that there was an interaction between age and interval length. Both younger and older adults perceived a relatively steep drop off in self-continuity within a year from the present moment, but whereas younger adults' self-continuity ratings continued to drop off for more distant intervals, older adults' self-continuity ratings began to stabilize around 1 year into the past or future. This maps onto our earlier findings suggesting that older adults are more likely than younger adults to compress the subjective length of more distant time intervals (Rutt & Löckenhoff, 2012). It may also account for some apparent inconsistencies in the prior literature: Researchers are more likely to observe age-related increases in self-continuity when they examine longer as compared to shorter intervals.

An examination of covariates found that age effects were not explained by global limitations in future time horizons, mental and physical health, big-five personality traits, or fluid and crystallized cognitive abilities. Instead, supplemental analyses (Rutt & Löckenhoff, 2015) indicated that decrements in structural self-continuity relative to the present moment can be modeled with the same mathematical models as temporal discounting or the perceived compression of future time intervals indicating that similar mechanisms may be at work.

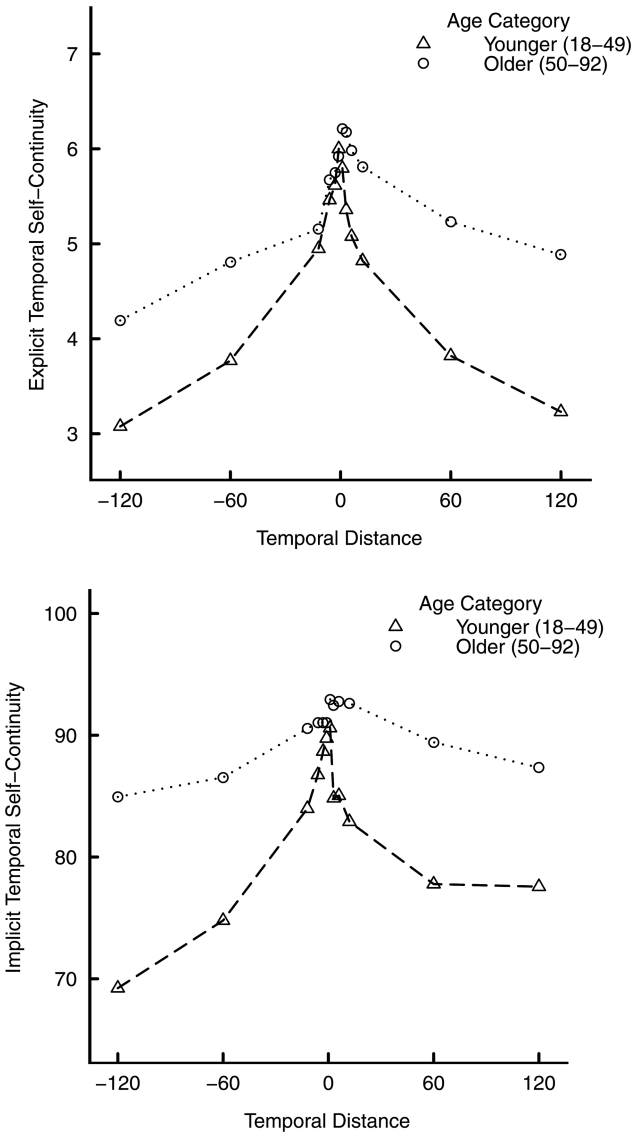

Figure 1. Age differences in explicit self-continuity (top) and implicit self-continuity (bottom) by temporal distance (in months). Copyright © 2016 by the American Psychological Association. Adapted with permission. The official citation that should be used in referencing this material is Rutt, J. L., & Löckenhoff, C. E. (2016). From past to future: Temporal self-continuity across the life span. *Psychology and Aging*, 31(6), 631–639. The use of APA information does not imply endorsement by APA.

Directions for Future Research

Taken together, the research outlined in the previous section provides a solid grounding for future investigations into age differences in self-continuity. Nonetheless, many open questions remain. First, further evidence for the reliability, validity, and age equivalence of explicit and implicit self-continuity assessments is needed. For instance, self-continuity for intervals that are contained within the adult life span may be qualitatively different from those that extend back into childhood or extend beyond one's expected life span. Future research should also examine a wider range of covariates as well as associations with process-oriented measures of self-continuity including mental time travel and life-story narration. Further, to rule out cohort effects in self-conceptualization, cross-sectional comparisons should be corroborated by longitudinal assessments. Finally, given evidence for cross-cultural differences in self-construal (Markus & Kitayama, 2010), patterns of age differences need to be compared across cultures.

Overcoming methodological challenges and addressing gaps in the assessment of self-continuity will set the stage for a systematic exploration of the underlying mechanisms behind age effects. A review of potential candidates reveals a wide array of theoretical perspectives that diverge considerably, even within a given field of research.

Explanations for age differences in *time perception*, for example, include cognitive decrements which may affect the perception of short-term intervals (Pan & Luo, 2012), the proportional argument (Janet, 1877) according to which a given time interval is not perceived in absolute terms but in proportion to the time one has already lived, and Carstensen's (1999; 2006) socioemotional selectivity theory, which holds that age-related limitations in global time horizons redirect motivational priorities towards the present moment.

In the field of *personality development,* in turn, some have argued that personality remains comparatively stable over adulthood because it is biologically based and undergoes little change after a period of rapid maturation during adolescence (Terracciano, Costa, & McCrae, 2006), yet others propose that personality change is triggered by investment in new social roles which people are most likely to take on in early adulthood (Lodi-Smith & Roberts, 2007).

Within the literature on *autobiographical thought*, researchers studying mental time travel have emphasized the role of age-related neurological decrements in the constructive memory system (e.g., Addis, Wong, & Schacter, 2008; Benoit & Schacter, 2015; Szpunar & McDermott, 2008), whereas researchers interested in narrative continuity have emphasized age-related variations in the strength of the self-concept and the role of lived experience (Bluck & Alea, 2008; Reese et al., 2011).

Age differences in *economic choices* about intertemporal trade-offs, in turn, are explained by some authors as the result of neurological decrements (Samanez-Larkin, 2015), whereas others emphasize the role of prior decision-making experience, insights into future emotional states (Löckenhoff et al., 2011), or shifting goal priorities (Strough et al., 2014)

Finally, *life-span developmental theories* propose that age-related shifts in developmental tasks and goals lead older adults to actively strive for self-continuity. Within Erikson's (1959) epigenetic framework, maintaining a continuous sense of self is considered important throughout life, but it becomes the primary focus in the last phase of life in which a sense of ego integrity is thought to pave the path to wisdom. Similarly, life-span theory (Baltes, 1997) argues that younger adults focus on growth and change whereas older adults focus on maintenance and continuity as age-related losses in health and other resources begin to loom large (Baltes et al., 1998; Ebner, Freund, & Baltes, 2006; Freund, Hennecke, & Riediger, 2010).

Any effort to develop an integrative theoretical framework to capture age differences in self-continuity has to contend with the ongoing philosophical debate about the underlying nature of this concept. It is of course possible that, akin to "ego" theories from the philosophical literature, age differences in self-continuity can be explained by a single underlying factor. The best candidate for such a factor would be neurological decrements and associated changes in cognition which are implicated in several of the theoretical frameworks reviewed above. However, in our own studies, controlling for cognition did not account for age differences in structural self-continuity (Rutt & Löckenhoff, 2016b), and age deficits in the episodic detail of mental time travel do not extend to positive memories (Comblain, D'Argembeau, & Van der Linden, 2005) or uncued memories recorded in everyday settings (Schlagman, Kliegel, Schulz, & Kvavilashvili, 2009) suggesting that motivational factors may play a role. Thus, instead of hinging on a single mechanism, age-related variations in self-continuity are most likely explained by a "bundle" of factors some of which may be inextricably linked with chronological age (e.g., Janet's, 1877, proportional argument) whereas others may be cohort specific, based on prior experience, or driven by environmental circumstances (e.g., reduced access to new social roles in later life).

Future research should also explore the practical and clinical implications of self-continuity in more detail. As noted in the introduction, a higher sense of self-continuity has been linked to a range of favorable outcomes, but it is not clear whether such benefits are maintained into later life, and whether explicit or implicit components of self-continuity play a larger role in real-life outcomes. Researchers should also consider potential pitfalls of age-related increases in self-continuity. Conceivably, having an overly strong sense of self-continuity could interfere with engagement in new social roles (Moen, Erickson, & Dempster-McClain, 2000), impede necessary changes in behavioral routines (Reich & Zautra, 1991), or lead older adults to accept chronic conditions as part of their identity instead of looking for treatment options (Löckenhoff et al., 2013).

In conclusion, after decades of research offering indirect evidence for age-related increases in self-continuity, the last 5 years have seen a surge in research directly testing for such effects. These recent studies provide consistent evidence for a positive association between chronological age and both explicit and implicit aspects of self-continuity. Importantly, age effects cannot be explained by cognitive decrements and they appear to be relatively independent of age-related limitations in global future time horizons, suggesting that self-continuity taps into a different dimension of age-related shifts in temporal construal. To integrate these findings with the broader life-span developmental literature and to identify possible pathways for intervention, further research is needed to examine associations among different subcomponents of self-continuity, uncover underlying mechanisms, and explore practical implications across the adult life span.

Funding

Preparation of this article was supported, in part, by National Institute on Aging grant 1R21AG043741 to C. Löckenhoff.

Acknowledgments

An earlier version of this article "Aging and Time Perceptions: A Tale of MultipleMechanisms" was presented as the 2014 Margret M. and Paul B. Baltes Foundation Award lecture on November 19 , 2015 at the 68th Annual Scientific Meeting of the Gerontological Society of America, Orlando, Florida.

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