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The role of age and time horizon in affect–meaning relations

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I hereby declare that this PhD dissertation is my original work and it has been written by me in its entirety.
I have duly acknowledged all the sources of information which have been used in this dissertation.

This PhD dissertation has also not been submitted for any degree in any university previously.

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Abstract

Extant research has demonstrated robust positive relations between positive affect (PA) and meaning, although the strength of this relationship has been found to vary as a function of both chronological age and time horizon (Hicks et al., 2012). This can be explained by the Socioemotional Selectivity Theory (SST), which posits that both older adults and those with a limited time horizon (i.e., perceive less remaining in life) tend to focus on emotional goals over knowledge goals. In the current paper, I sought to extend SST's findings to the level of activities by examining how chronological age, time horizon (both existing and manipulated), and one's focus on emotional/knowledge goals influenced the strength of the relationship between the enjoyableness and meaningfulness of specific activities. These hypotheses were tested using an older (Study 1) and a younger adult sample (Study 2). Although none of the hypothesized relations were fully supported, interesting relations were uncovered through exploratory analyses that examined specific activities in terms of their experiential qualities and the joint effects of both positive (PA) and negative affect (NA) on activity-related meaning perceptions. In older adults, I found that for those with a limited time horizon, high-PA activities were less meaningful when also accompanied by NA. In contrast, for those with an expansive time horizon, high-PA activities remained meaningful even when accompanied by NA. In younger adults, I found that those who prioritized emotional goals experienced less meaning from uniformly negative activities compared to those who prioritized knowledge goals. Theoretical and practical implications of the current study are discussed.

Contents

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Introduction

While meaning researchers have not been able to come to a complete consensus on what meaning in life entails, it has been argued that two components are key (Steger et al., 2006). The first is purpose – a motivational component of meaning often represented by the pursuit of worthwhile goals, and the second is coherence – a cognitive component of meaning that refers to having a life that makes sense. While some early models of meaning have proposed a third affective component (i.e., feelings of satisfaction, fulfillment, and happiness; Reker & Wong, 1988, 2012), later models have focused mostly on examining significance – which refers to the feeling that one's life possesses value and is worth living (Martela & Steger, 2016).

Even though the difficulty in pinpointing what meaning comprises of may suggest – to some – that a sense of meaning is an extraordinary occurrence, research has suggested that meaning tends to arise out of fairly ordinary life experiences, such as being in a positive mood or having good social relations (King et al., 2016). Additionally, a positive mood has also been found to compensate for the lack of several essential "ingredients" necessary for the experience of meaning. When relational needs have been thwarted, for instance, people have been shown to rely increasingly on positive affect for their meaning judgments (Hicks et al., 2010). This suggests that happy people, even those with poorer social relationships, can feel like life is meaningful. Past research has also found positive affect to be directly related to one's perception of meaning in life (Hicks et al., 2010, 2012; Hicks & King, 2007, 2008, 2009; King et al., 2006; Tang et al., 2013) – suggesting that, in general, people who experience positive feelings also tend to feel that their lives are meaningful. Notably, this relationship has been demonstrated at both the trait- (e.g., King et al., 2006) and state-level (e.g., Tov & Lee, 2016) – providing strong empirical evidence that even short-term happiness can enhance people's perceptions of meaning in the here-and-now.

Two possible mechanisms could explain the strong direct relations between positive affect and meaning. The first explanation suggests that being in a positive mood sensitizes people towards the broader significance of an activity (King et al., 2006). For instance, people in a positive

(compared to neutral) mood found meaningful activities (i.e., reading an essay about how people are connected) to be *more* meaningful and meaningless activities (i.e., counting the number of *e's* in a passage) to be *less* meaningful (King et al., 2006). This suggests that being in a positive mood did not exert blanket effects on meaning perceptions, but rather, made people more sensitive to specific meaningful (or meaningless) aspects of life. A second explanation is one related to reflection and introspection. According to Wong's (2013) PURE model, happiness is one of four important ingredients of meaning (i.e., purpose, understanding, responsible action, and evaluation). Specifically, he posits that when evaluating specific situations or life in general, one looks inwards to find the answer. By asking themselves: "*How happy am I with my life?*", a person could get a sense of how meaningful their life is – with a positive response serving as a strong indicator of life's meaningfulness and a negative response triggering a desire to search for alternative sources of meaning.

Despite the robust relationship between positive affect and meaning in the extant literature, some studies have demonstrated that the strength of this relationship can vary as a function of certain personal characteristics. For instance, Hicks and colleagues (2012) found that the relationship between positive affect and meaning is stronger among older adults and those who are primed to perceive less time remaining in life. This finding aligns with a central prediction of the Socioemotional Selectivity Theory (SST), which posits that goal priorities shift from focusing on knowledge acquisition toward the regulation of one's emotions as one age and begin to perceive increasingly limited remaining time in life (Carstensen et al., 1999). For those with emotion regulatory goals, positive affect is not just a pleasant state concomitant with the experience of goal fulfillment, but rather, a goal itself. In this case, positive affect not only serves as an indication of goal progress but also signals the attainment of a valued goal, which can further enhance the meaningfulness of an experience (Carver & Scheier, 1990; King et al., 2006).

Despite being a theory that is used to describe human goals, the SST is – at its core – a theory about human behavior. Importantly, there is a presumption that humans are agentic beings

who are motivated to engage in behaviors in service of their goals (Bandura, 2001, 2008). According to SST, however, the goals that people have are determined in large part by their perception of remaining time in life. In other words, by predicting the type of goals that people may have, the SST makes specific predictions about the type of behaviors that people may be motivated to engage in. Despite this, the underlying tenet of the SST regarding behavior has rarely been tested.

In the following sections, I will first provide an explicit definition of the term "time horizon". Next, I provide a brief review of extant research on SST, in which I explain why age and time horizon may moderate the relationship between positive affect and meaning perceptions. I also briefly discuss the SST's complementary approach, the Strength and Vulnerability Integration (SAVI) model, which provides some insights into the role of negative affect and how its presence/absence may affect the extent to which positive affect influences meaning perceptions. Following that, I make a case for why it may be useful to examine these relationships within the context of daily activities. After, I present the studies, along with an analysis plan. Lastly, I briefly discuss the theoretical and practical implications of the proposed studies.

Defining Time Horizon

In the literature, the term "future time perspective" has been used to refer to two separate constructs. The first construct relates to one's *tendency* to be concerned with the future and is an individual difference that remains relatively stable across the lifespan (Zimbardo & Boyd, 1999). The second construct refers to one's *perception* of remaining time in life, which is not only subject to changes across the lifespan (Carstensen et al., 1999; Liao & Carstensen, 2018) but can also be experimentally manipulated (Demeyer & De Raedt, 2014; Tanaka, 2019). In this proposal, I adopt the second definition of future time perspective – as an age-graded perception of one's remaining time in life. For the rest of this paper, I will use the terms: *limited time horizon* and *expansive time horizon* – rather than future time perspective – to refer to the perception that one has of their remaining time in life. In contrast to those with a limited time horizon, those with an expansive time horizon

tend to perceive more remaining time in life, and thus, should prioritize goals that prepare them for the future.

Socioemotional Selectivity Theory (SST)

SST is a lifespan theory of motivation that has been proposed to explain age-related changes in one's goals and behaviors (Carstensen et al., 1999). While it has primarily focused on the role of chronological age in earlier conceptualizations (Carstensen, 1991, 1995), increasing emphasis has been placed on the role of time horizon (Carstensen et al., 1999; Lang & Carstensen, 2002). The primary tenet of SST states that when goals related to emotion regulation compete with goals related to knowledge acquisition, the goal that is given greater importance depends on one's perception of how much time remains in one's life. Importantly, this leads to specific predictions about the goals – and behavior – people prioritize (Carstensen et al., 1999).

According to SST, people who are younger – and likely to expect a longer runway in life – tend to have more goals related to knowledge acquisition, preparation for the future, and the development of new social connections (Fung & Carstensen, 2004; Lang & Carstensen, 2002; Penningroth & Scott, 2012; Scheibe & Carstensen, 2010). For these people, future possibilities are a key consideration and are more likely to take greater precedence over emotional satisfaction. This means that knowledge-enhancement goals are often pursued at the cost of current emotional satisfaction. For example, students may seek feedback about a paper from their professor even if they do not expect unqualified praise, as it may prepare them for a (likely) future where they benefit from these helpful criticisms.

In contrast, people who are older – and likely to expect limited remaining time in life – are more likely to have goals that emphasize emotional rewards and satisfaction in the moment (Carstensen et al., 1999; Scheibe & Carstensen, 2010). Because they are more likely than younger people to anticipate impending ends, preparing for the future is relatively less attractive compared to optimizing the present (Fung & Carstensen, 2004; Lang & Carstensen, 2002). For people facing foreshortened futures due to certain medical conditions, for instance, future-optimizing goals may

also be less sought-after due to uncertainties about whether they may live long enough to enjoy the realization of these goals (e.g., Sullivan-Singh et al., 2015). For example, older adults – more so than younger adults – are more likely to remain indifferent in the face of interpersonal tensions, to be less aggressive, and more conciliatory (Birditt et al., 2005; Blanchard-Fields & Cooper, 2003; Lazarus, 1996). Older adults are also more selective in their choice of social partners; preferring to engage with a smaller network of people to whom they are emotionally close (Bruine de Bruin et al., 2020; Carstensen et al., 1997). Both lines of research suggest a desire for older adults to maintain the status quo by avoiding conflict and negative emotional experiences, and to promote positive emotional experiences by choosing to spend time around close others (Carstensen, 1995; Lang & Carstensen, 2002; Penningroth & Scott, 2012).

The shift in goals that occurs with age (and ultimately, the perception of one's time horizon) may alter the extent to which meaning is derived from or connected to positive emotional experiences. One way to think about this is by considering the characteristics of goals relating to knowledge acquisition. Goals related to knowledge acquisition, unlike those related to emotion regulation, often co-occur with – and occasionally benefit from – negative feelings. For example, while students who receive negative feedback on their work may initially experience some negative feelings, such experiences may aid the fulfillment of knowledge-acquisition goals by enhancing future performance. Indeed, research has found that the experience of certain negative emotions (e.g., stress, shame) can lead to improved learning and work outcomes (Duncko et al., 2007; Podsakoff et al., 2007; Xing et al., 2021). Additionally, negative information may play an important role in helping people anticipate future stressors, especially those that can be avoided (Aspinwall & Taylor, 1997) – suggesting the utility of negative feelings for people with a far-sighted view of their life. Negative experiences that have implications for one's future can be regarded as meaningful whether they are accompanied by positive affect or not (Tov & Lee, 2016). If younger people are more likely to hold an expansive view of future time, they may be more inclined to perceive meaning in negative as well as positive experiences. As negative experiences are often inversely associated

with positive affect (Feldman Barrett & Russell, 1998; J. A. Russell & Carroll, 1999), links between positive affect and meaning could be relatively weaker among younger adults relative to older adults.

Strength and Vulnerability Integration (SAVI)

A complementary approach to the SST is the Strength and Vulnerability Integration (SAVI) model, which describes how aging is related to both strengths and vulnerabilities that occur with time (Charles, 2010). Relative to younger adults, older adults benefit from well-developed emotion regulation strategies that arise from their lived experiences (Urry & Gross, 2010). According to the SAVI model, age-related advantages in well-being are most evident when older adults successfully avoid emotional distress. However, when distress is intense, unavoidable, and/or sustained, age-related advantages often disappear or may even be related to worse emotional outcomes. One explanation for this phenomenon has been attributed to age-related diminishments in physiological flexibility which can make it more difficult for older adults to modulate affect and attention because of prolonged physiological arousal (e.g., prolonged elevations in blood pressure after a stressful arousing event; Wirtz et al., 2008) and delayed recovery from negative experiences (e.g., elevated blood pressure across both stressful and less stressful work periods; Ritvanen et al., 2006).

The SAVI model complements the prediction of SST in highlighting the value that older adults may place in *avoiding* negative affective experiences along with pursuing emotional rewards. Although the model makes no predictions about how meaning and affect are related to each other, an implication of the model might be that the preference for uniformly positive experiences (i.e., experiences that are both high on positive affect and low on negative affect) increases with age and represents an ideal objective of emotion regulation. In other words, the extent to which positive affect contributes to meaning may increasingly depend on the presence or absence of negative affect as adults age.

Examining Activities

The tendency to favor emotionally rewarding experiences (i.e., greater positive affect and less negative affect) among people with a limited time horizon has been demonstrated across several different domains. For instance, older adults tend to have a greater proportion of actual to total friends on Facebook – which is associated with lower levels of loneliness (Chang et al., 2015), suggesting that the curation and trimming of one's online social networks may be attempts at staving off negative feelings, such as social isolation. Older adults, compared to younger adults, have also been shown to express a greater preference for watching meaningful television shows and a greater aversion towards those that are negatively-valenced (i.e., scary and violent; Mares et al., 2016) – suggesting that goals to attain emotional meaning are present even in mundane daily activities.

Although the focus of SST is on goal shifts within an individual's goal hierarchy (Carstensen et al., 1999), people can hold on to the same goals across their lifespan. For example, a person may hold on to the goal of learning how to code (knowledge acquisition goal), but as one age, this goal is likely to be accompanied by the desire to attain emotional gratification (emotion regulatory goal). This could lead to a situation where knowledge acquisition goals remain important throughout the lifespan, even as an increasing focus and emphasis on emotional satisfaction eventually displace the importance of the pursuit of knowledge.

Despite positing changes in goal importance across the lifespan, the SST makes few predictions about the actual activities that constitute those goals. Nevertheless, examining activities allow us to test SST in several ways. First, time spent performing different activities could be used to index goal shifts in one's personal goal hierarchy. For instance, people who spend more time on enjoyable activities could be thought of as prioritizing emotion regulatory (over knowledge acquisition) goals. Conversely, people who prioritize knowledge acquisition goals may not necessarily exhibit this pattern, since the extent to which an activity is enjoyable is less (or not) important for the fulfillment of these goals.

Second, the examination of daily activities provides a way to test the external validity of SST's central tenets. As past studies have focused mostly on one's preferences for social partners (e.g., Lang & Carstensen, 2002), it is unclear whether the assertions made by SST are generalizable to other domains, such as in their daily lives. Examining activities allow us to potentially separate an activity's enjoyableness from the effects of social interaction. As daily activities are diverse in both their affective experiences and extent of social interaction, the independent consideration of both aspects allows for delineation of its effects on meaning from each other. For instance, we can consider the idea that meaning could come from any positive experiences (e.g., enjoying a meal alone), any social experiences (e.g., having a meal with friends), or from positive experiences that also contain a social element (e.g., enjoying a meal with friends). The source of meaningful experiences could better inform us of whether the SST should continue to be applied in studies examining close social relationships, or if it is better to expand it to consider all enjoyable endeavours.

Lastly, there are issues associated with making context-free affect judgments that can be mitigated when one examines these constructs at the level of activities. Since past theorizing about the nature of emotions often converges on the idea that emotions are instigated in response to important and personally relevant stimulus events (Frijda, 1986; Scherer, 2005), it is important to consider how affect and meaning judgments relate to specific activities. Without considering the important role of context (e.g., activities that one is engaged in), affective judgments may simply be an indicator of one's feelings in general across several different types of activities. Respondents making a judgment about their affective feelings and meaning perceptions over the past day, for example, are likely to be aggregating their judgment across several qualitatively different activities. As such, attempts at understanding how affect and meaning perceptions covary in the "real world" without an anchoring experience (i.e., an activity from which affect and meaning may be derived) may lead to ambiguities about the source of those judgments.

Present Studies

The present studies aim to examine and test SST at the *activity* level – a previously underexplored, yet immensely important, aspect of human life. I propose to do so by examining how chronological age and time horizon influence the relationship between positive affect and meaning perceptions. For these studies, time horizon will be operationalized in two ways: *(1)* survival expectations and *(2)* experimentally manipulated time horizon. While indirectly related, chronological age and time horizon represent two different constructs: with the former being a representation of time since birth while the latter is a representation of time until death. Importantly, the subjective nature of time horizon perceptions makes them susceptible to experimental manipulation.

Past studies have found that age, survival expectations, and manipulating the perception of time left in one's life are valid operationalizations of perceived time horizon within the framework of SST. With chronological age, for instance, older adults have been found to report more emotion-focused goals and less knowledge-focused goals compared to younger adults (Carstensen et al., 2003; Charles & Carstensen, 2003; Penningroth & Scott, 2012). Second, survival expectations have also been found to influence how people think about social partners. For instance, people with more severe AIDS symptomatology (i.e., increased closeness to death) tend to think about potential social partners in terms of affective dimensions (e.g., family members and close friends are associated with more positive affect), rather than in terms of potential future contact or information seeking (e.g., Carstensen & Fredrickson, 1998). Third, when time horizon is experimentally manipulated – such as when older people perceive an expansive future – age differences in social goals are largely reduced (e.g., Fung et al., 1999).

Building on findings by Hicks and colleagues (2012), I propose a set of two studies. In the first study, I aim to test the premise that differential strength of association between positive affect and meaning perceptions extends to the behavioral domain (i.e., the activities that people engage in). That is, enjoyable activities should be more meaningful for people who are either older (compared to younger) or possess a limited (compared to expansive) time horizon. To do so, I ask

people to rate, for one meaningful activity and one meaningless activity, the extent to which they experience *(1)* meaning, *(2)* positive feelings, and *(3)* negative feelings. I then compare how affective states and meaning perceptions within these activities differ across older adults.

In the second study, I seek to provide stronger causal evidence for the influence of perceived time horizon on the relationship between positive affect and meaning perceptions. I do so by experimentally manipulating time horizon in a younger adult sample, then examining whether their motivation to engage in more enjoyable activities increases. To examine activities in this study, we co-opt time-use methodology (Harvey & Pentland, 2002) and day reconstruction method (Kahneman et al., 2004) to examine how people spend their time in a typical day across different categories of activities. Because people can differ in how they experience different activities, I adopt an idiographic approach to examine how people's subjective experiences (i.e., meaningfulness, positive feelings, negative feelings) of different activities is related to how much time they choose to spend on these activities.

In Hicks and colleagues' (2012) study, they found that positive affect is more strongly related to meaning perceptions in older adults than in younger adults. To extend findings from their study, the first hypothesis seeks to examine whether these relations apply in the specific context of activities. Specifically, I predict that older adults will find enjoyable activities (i.e., activities that elicit more positive affect) to be more meaningful.

H_1: Age moderates the relationship between activity-related PA and activity-related meaning such that PA and meaning are more strongly associated as adults age.

Besides finding that positive affect is more strongly related to meaning perceptions in older adults (H_1), the same relation is also expected to hold in those with a limited time horizon, compared to those with a more expansive time horizon (Hicks et al., 2012). To extend previous findings, the second hypothesis seeks to examine whether these differential relations hold in the specific context of activities. Specifically, I predict that those with a limited time horizon (i.e., perception of less time

remaining in life) should find more enjoyable activities (i.e., activities eliciting higher positive affect) to be more meaningful.

H_2: Time horizon moderates the relationship between activity-related PA and activity-related meaning such that PA and meaning are more strongly associated among those with a limited time horizon than those with a more expansive time horizon.

According to the SST, age is merely a dimension along which temporal changes in time horizon are charted. The principal mechanism proposed as the main driver in goal selection is not chronological age, but perceived time horizon (Lang & Carstensen, 2002). As such, the third hypothesis was proposed to examine whether the moderating effect of age on the relationship between positive affect and meaning perceptions (H_1) is mediated by time horizon. That is to say, the moderating effects of age on the relationship between positive affect and meaning perceptions in activities are due, in part or wholly, to the associated age-related changes in one's time horizon (from an expansive to a limited perception of time), rather than due to age itself.

H_3: The moderating effect of age on the relationship between activity-related PA and activity-related meaning is mediated by time horizon.

The SST suggests that due to a limited time horizon, older adults derive more meaning from enjoyable activities. However, it is unclear how the experience of negative feelings affects this relationship. For instance, do people with a limited time horizon prefer uniformly positive experiences (i.e., high PA, low NA), or do they simply focus on the positive (while ignoring the negative) aspects of an activity? According to the SAVI model (Charles, 2010), age-related declines in physiological flexibility can interfere with one's ability to regulate intense and sustained emotional arousal. This suggests that for older adults (who tend to have a more limited time horizon), the presence of intense negative feelings may potentially affect the extent to which age and time horizon moderate the relationship between positive affect and meaning. Thus, the fourth hypothesis was proposed to test the idea that the presence of negative affect during an activity may hamper

the extent to which a limited time horizon moderates the relationship between positive affect and meaning.

H_4: The moderating effect of age and time horizon on the relationship between activity-related PA and activity-related meaning is attenuated when activity-related NA is high.

Although past studies have found much support for SST's assertion that a limited time perception motivates a shift toward emotionally meaningful goals, it is unclear if these shifts influence people's motivation to spend time on different activities. To test whether changes in time horizon led to goal shifts within a person's goal hierarchy, I will employ an experimental procedure to induce a limited time horizon in younger adults, which allows me to examine whether the perception of limited time motivates younger adults to spend more time on emotionally rewarding activities.

H_5: When a limited time horizon is made salient, people become more inclined to spend time on more enjoyable activities.

The SST posits that the moderating effects of time horizon occur through a shift in goals. Previous research has shown that older adults (with a more limited time horizon) tend to hold more emotion-focused goals while younger adults (with a more expansive time horizon) tend to hold more knowledge-focused goals (Carstensen et al., 2003; Charles & Carstensen, 2003; Penningroth & Scott, 2012). If the effects of age (H_1) and time horizon (H_2) occur through a shift in goals, then according to the SST, activity goal focus – defined as the tendency to engage in activities related to either knowledge acquisition or emotional regulation – could moderate the extent to which people perceive enjoyable activities as being meaningful. More specifically, those who tend to focus on emotional goals should experience more meaning from enjoyable activities compared to those who tend to focus on knowledge goals.

H_6: Chronic activity goal focus (measured before the experimental manipulation) moderates the relationship between activity-related PA and activity-related meaning such that PA and meaning

are more strongly associated among people with an emotional goal focus compared to those with a knowledge goal focus.

Study 1

Method

Participants

Data were obtained from the Singapore Life Panel (SLP), a monthly-panel survey of older adults representative of the Singapore population (n = 6,613, Age (mean) = 65.8, Age (SD) = 5.8, Age (range) = between 55.0 and 99.3, 52.4% female). The data was collected on April 2022 (wave 81) by the Center for Research on Successful Aging (ROSA) in Singapore Management University.

For the present analyses, only a subset of the SLP sample – consisting of adults aged 55 and older – was used. This lower age limit is based on the Singapore government's recognition of key financial milestones in an individual's life (i.e., at age 55, it is likely for one to have fully paid off one's home loans and have set aside an amount of retirement sum) – which serves as an indicator that one is progressing to the next stage of one's lives.

Material and Procedure

As the SLP is a monthly-panel survey, not all measures were collected at the same time. Where applicable, I have indicated the dates when these measures were collected.

Extraversion and Neuroticism. Extraversion and neuroticism was assessed using the Big Five Inventory (BFI; John & Srivastava, 1999). The extraversion (e.g., "*I am someone who is talkative*", α = .69) and neuroticism subscale (e.g., "*I am someone who is depressed/blue*", α = .79) contains 8 items each. Participants rated their agreement on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*), with higher scores reflecting higher extraversion and neuroticism, respectively. Extraversion and neuroticism were included to serve as proxies for trait-level positive and negative affect, respectively – both of which were related to meaning in life (Işık & Üzbe, 2015; Zika & Chamberlain, 1992). This measure was fielded in the SLP in August 2019.

Meaning in Life (Past-Year). Meaning in life was assessed using a single item that measured the extent to which participants experience a sense of meaning and purpose in their life over the past month. Participants rated their agreement to this item on a 6-point scale (1 = *none of the time*, 6 = *all of the time*), with higher scores reflecting higher meaning in life. As this item is monthly-recurring, scores from past measurement instances (i.e., past 12 months from May 2021 to April 2022) were aggregated into an index representing (past-year) meaning in life. Past-year meaning in life was included as a covariate to control for trait-level meaning.

Optimism. Optimism was assessed using the Revised Life Orientation Test (LOT-R; Scheier et al., 1994). Participants rate their agreement to six items (e.g., "*I'm always optimistic about my future*", $\alpha = .63$) on a modified 6-point scale (1 = *strongly disagree*, 6 = *strongly agree*), with higher scores reflecting higher optimism. As optimism was related to longevity (Diener & Chan, 2011; Lee et al., 2019), it was included as a covariate to rule out the explanation that observed effects of time horizon are due to a lack of optimism. In the full scale, four additional filler items were included in the LOT-R but were omitted in this study. This measure was fielded in the SLP in October 2021, but if a score was not available from then, the scores collected from an earlier timepoint (June 2021) were used instead.

Self-Rated Health. To provide a more holistic measure of health – which includes both physical and mental health components – a composite measure comprised of the following three measures was used to assess self-rated health: *(1)* a single-item measure assessing participants' subjective health status on a 5-point scale (1 = *poor*, 5 = *excellent*; Ware & Sherbourne, 1992), *(2)* physical health assessed by the presence of six chronic physical health conditions (e.g., hypertension, diabetes), and *(3)* mental health, assessed by five indicators of depression (e.g., stress, sad, $\alpha = .86$) on a 6-point scale (1 = *none of the time*, 6 = *all of the time*). The intercorrelations of the three measures were between .16 and .46 ($p < .001$). Following the procedure for computing a unit-weighted composite score (Song et al., 2013), the following steps were taken: *(1)* each of the three measures was transformed into a *z*-score, *(2)* the *z*-scores were reversed to be in the same direction

(i.e., higher scores represent better self-rated health), and *(3)* the *z*-scores were summed. Additionally, for easier interpretation, the *z*-scores were converted into the percent of maximum possible (POMP) scores, which range from 0 to 1. Perceptions of one's health status is an important covariate as it may explain how those with a limited time horizon may be using health information as an index of remaining time left in life. For instance, poorer self-rated health (in young and middle-aged adults) has been associated with perceptions of limited remaining time in life (Coudin & Lima, 2011; Kooij & Voorde, 2011). The inclusion of this covariate would thus rule out the possibility that the observed effects of a limited time horizon is due to perceived poor health specifically. This measure was fielded in the SLP in April 2022.

Survival Expectations. Survival expectations was assessed by asking respondents to estimate the probability of living to (and beyond) seven different age cut-offs (i.e., "What is the percent chance that you will live to be [75/80/85/90/95/100/105] or more?"). Participants below 65-years-old (*n* = 3,118) were asked to estimate how likely they think they will live beyond 75 years. For participants that are 65-years-old or older, survival expectations for living beyond different age cut-offs depended on their current age: *(i)* participants between 65 and 69 years old (*n* = 1,527) estimated their expectations to live beyond 80 years old, *(ii)* participants between 70 and 74 years old (*n* = 1,106) estimated their expectations to live beyond 85 years old, *(iii)* participants between 75 and 79 years old (*n* = 383) estimated their expectations to live beyond 90 years old, *(iv)* participants between 80 and 84 years old (*n* = 34) estimated their expectations to live beyond 95 years old, *(v)* participants between 85 and 89 years old (*n* = 9) estimated their expectations to live beyond 100 years old, and *(vi)* participants between 90 and 94 years old (*n* = 2) estimated their expectations to live beyond 105 years old. This measure was fielded in the SLP in July 2021.

Activity-Related Feelings. To assess activity-related feelings, respondents first had to choose – from a list of activities that they may perform in their daily life – the *most* and *least* meaningful activity to them (see Appendix B). For each of these two activities, they indicated how meaningful the activities were on a 6-point scale (1 = *not at all*, 6 = *extremely*), and how often they experienced

both positive (e.g., happy, relaxed, content) and negative (e.g., unhappy, uncomfortable, irritated) feelings on a 6-point scale (1 = *none of the time*, 6 = *all of the time*). This measure was fielded in the SLP in April 2022.

Results

All analyses were conducted with R version 4.1.3; *ltm* version 1.2-0 (for computing Cronbach alpha values), *Hmisc* version 4.6-0 (for correlational analyses), *geepack* version 1.3.3 (for generalized estimating equations), *lm.beta* version 1.5-1 (for computation of standardized regression coefficients), and *ggplot2* version 3.3.5 (for generating plots).

The analyses were conducted using generalized estimating equations (GEE) instead of multilevel models for two reasons. First, the data were clustered (i.e., each participant provided two responses: *most* and *least* meaningful activity). Second, with only two repeated measures per person (i.e., most and least meaningful activity), the ability to estimate random effects was limited. GEE accounts for clustered data by estimating a population-average model that is computationally simpler and does not model random effects across participants.

Descriptive analyses

Descriptive statistics (means, standard deviations) and correlations of all variables were reported in Table 1.

A bubble plot was generated using mean aggregated scores for meaning, positive affect, and negative affect for each of the 11 activities, excluding the "others" category (Figure 1). It should be noted that participants did not rate *all* relevant activities, but only reported scores for the activities they felt were either the *most* or *least* meaningful (frequencies and mean aggregated scores are reported in Table 2). The implications of this will be discussed in the limitations section.

In general, older adults appear to have a rather diversified emotional experience across a range of activities. Among the most enjoyable activities (i.e., high PA and low NA) for older adults were socializing with family and friends, physical activities, and personal care activities, and the most unenjoyable activities (i.e., low PA and high NA) were formal social activities and volunteering.

Additionally, older adults also seemed to experience certain activities with a mix of high PA and NA, such as work, caretaking of adult family members, and chores/errands.

Main analyses

To test the four hypotheses in this study, I estimated two GEE models. To test the moderating effect of age, the first model regressed activity-related meaning on *(1)* activity-related PA, *(2)* activity-related NA, *(3)* age, *(4)* all their cross-product terms, and the following covariates: *(a)* extraversion, *(b)* neuroticism, *(c)* past-year-meaning, *(d)* optimism, and *(e)* subjective health. The results for this model were presented in Table 3.

To test the moderating effect of perceived time horizon, the second model was similar to the first with the following exceptions: (1) age was replaced with survival expectations; and (2) three dummy-coded variables were included to account for different versions of the survival expectation question. Recall that the participants estimated the likelihood of surviving to a target age, but that this target age depended on their current age (see *Survival Expectations section*). Thus, the following dummy-variables were created (with those younger than 65 serving as the reference group): *d1*: 1 = 65 to 69 years old, 0 = everyone else; *d2*: 1 = 70 to 74 years old, 0 = everyone else; and *d3*: 1 = 75 to 79 years old, 0 = everyone else. Although there were more than four age groups (and corresponding versions of the question), the number of respondents in the other age groups were too small (i.e., *n* = 2 to 34). As such, they were not examined for this model. The results for this model are presented in Table 4.

Hypothesis 1. H_1 posits that age moderates the relationship between activity-related PA and activity-related meaning such that PA and meaning are more strongly associated as adults age (Figure 2). Contrary to the hypothesized relations, I found that the two-way interaction effect (PA × Age) on activity-related meaning was non-significant (p = .528, Table 3). The main effect of activity-related PA, however, is strongly associated with activity-related meaning (β = .84, *SE* = .16, Wald = 27.4-, p < .001). The overall pattern of results suggests that, at the activity-level, while PA is related to meaning, this relationship does not differ as a function of age in older adulthood. In other words,

older adults across all ages tend to regard enjoyable activities as meaningful to a similar extent. Thus, H_1 was not supported.

Hypothesis 2. H_2 posits that time horizon (survival expectation) moderates the relationship between activity-related PA and activity-related meaning such that PA and meaning are more strongly associated among those with a limited time horizon than those with a more expansive time horizon. A PA x Survival Expectation interaction was not significant (p = .512). At this point, it may be tentatively concluded that H_2 is not supported. However, this two-way interaction was qualified by a three-way interaction (PA × NA × Survival Expectation; see Table 4). Thus, H_2 will be re-evaluated further below in conjunction with Hypothesis 4.

Hypothesis 3. H_3 posits that the moderating effect of age on the relationship between activity-related PA and activity-related meaning is mediated by time horizon. Since there was no support for H_1, H_3 was not tested.

Hypothesis 4. H_4 posits that the moderating effect of age and time horizon (survival expectation) on the relationship between activity-related PA and activity-related meaning is attenuated when activity-related NA is high. Because moderating effects were only observed for survival expectation and not age, H_4 was only tested with respect to survival expectations.

The results from the second model revealed a significant three-way interaction (PA × NA × Survival Expectations) on meaning (β = .12, SE < .01, Wald = 3.88, p = .049; Table 4) – suggesting the necessity of accounting for NA during specific activities. To probe the interaction, I conducted simple effects analysis to examine how the effects of PA on meaning varied across people with a limited vs. expansive time horizon at different levels of NA (Table 5). A simple slopes plot was also generated to visualize the interaction (Figure 3).

For people with a limited time horizon (i.e., low survival expectations), the effects of PA on meaning grew increasingly weaker as the level of NA increased. For example, at low levels of NA (−1 SD), β = .72, p < .001. At high levels of NA (+1 SD), β = .67, p < .001. In contrast, for people with an expansive time horizon (i.e., high survival expectations), the effects of PA on meaning remained

largely the same even as NA increased (*β's* = .73 to .75, all *p*s < .001). In other words, for people with a limited time horizon, enjoyable activities were less meaningful when also accompanied by NA. However, for people with an expansive time horizon, enjoyable activities remained meaningful even when accompanied by NA. Thus, H_4 was partially supported.

Table 5 also suggests that the PA x Survival Expectation interaction exists only at high levels of NA, but not at lower levels of NA. In activities that evoke high NA, PA has a smaller effect on meaning for those with a limited time horizon (*β* = .67) than those with an expansive time horizon (*β* = .75), *p*s < .001. As this is contrary to the prediction that PA would have stronger effects on meaning for those with a limited time horizon, H_2 is not supported.

Study 2

Past research has found that when a limited time horizon is induced, younger adults tend to focus on emotionally rewarding goals (e.g., preferring to interact with familiar social partners) much like older adults (Fredrickson & Carstensen, 1990; Fung et al., 1999; Fung & Carstensen, 2004). However, research that has manipulated perceived time horizon in the past has tended to focus on examining these goals in terms of one's preference for social partners. As such, it is unclear if prioritization of emotionally meaningful goals applies only within the social domain, or if changes in people's goal hierarchies can also be observed in other activities they choose to engage in – such as the way they allocate their time between different mundane daily activities.

In Study 2, I test the hypothesis that the manipulation of a limited time horizon in younger adults would lead them to prioritize emotionally rewarding goals. Importantly, this prioritization shift is expected to increase the motivation to spend more time engaging in enjoyable and/or meaningful activities. Examining activities provides a way for goal shifts to be quantified, such as by examining how actual time spent on different activities differs from the time they are motivated to spend. In this way, understanding the effects of a limited time horizon on one's goals can be done by examining whether participants increase the amount of time they *want* to spend on enjoyable activities (relative to how much they typically do).

To manipulate perceived time horizon, a mental imagery task involving two different types of scenarios (i.e., long-term future and short-term future scenarios) was administered. Mental imagery scenarios have been successful in manipulating time horizon in different samples of undergraduates (Demeyer & De Raedt, 2014; Tanaka, 2019). The stimulus materials were modified from an existing mental imagery task (Tanaka, 2019) to make them more applicable to a Singaporean sample. The scenarios meant to induce a limited time horizon ask participants to imagine themselves in situations where they hold different adult roles; as husbands/wives (e.g., celebrating birthdays with a spouse), parents (e.g., considering sending your daughter overseas for her undergraduate studies), and as managerial-level employees (e.g., conducting performance reviews for staff). By imagining themselves as adults who hold roles that typically occur farther ahead in a normative life course trajectory than their current status, these young adults are led to feel like they are farther from birth (and/or closer to death), thereby priming a limited time horizon.

In contrast, the scenarios meant to induce an expansive time horizon involved participants imagining themselves as a student in several different hypothetical situations (e.g., having lunch with your classmates, arguing with your groupmates about a class project). As these scenarios are merely reflections of the participants' current selves as students, imagining these scenarios may prime concepts that are already accessible to them without altering their time horizon (Tanaka, 2019). Thus, participants in this group served as the control group.

Method

Participants

For Study 2, a sample of 298 undergraduates (M_{age} = 22.3, SD_{age} = 1.76, 72.8% females, 90.9% Chinese) from universities in Singapore were recruited. As mature undergraduates may have life experiences that are different from typical undergraduates, the present study included only undergraduates who are between 18 and 30 years of age. Participants in this study were told that this study is about time-use and mental imagery.

Material and Procedure

Extraversion and Neuroticism. Extraversion and neuroticism were assessed using the BFI (John & Srivastava, 1999), similar to in Study 1. The internal consistency for the extraversion (α = .88) and neuroticism (α = .87) subscale were acceptable.

Meaning in Life. Meaning in life was assessed using a single item that measured the extent to which participants experience a sense of meaning and purpose in their life over the past year. Participants rated their agreement to this item on a 6-point scale (1 = *none of the time*, 6 = *all of the time*).

Optimism. Optimism was assessed using the LOT-R (Scheier et al., 1994), similar to in Study 1. However, instead of a 6-point scale, the LOT-R in Study 2 was administered using a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*). The internal consistency for the scale was acceptable (α = .78).

Activity Goal Focus. Activity goal focus refers to people's tendency to engage in activities that largely involve gaining knowledge (knowledge goal focus) or optimizing emotional states (emotion goal focus). It was assessed with a single self-developed item using a 6-point bipolar scale (1 = *only knowledge-driven*, 6 = *only emotion-driven*). One end of the scale indexes a strong motivation to engage in activities that are driven by knowledge-acquisition goals (i.e., learning new skills and concepts even if it is not necessarily enjoyable) while the other end indexes a strong motivation to engage in activities that are driven by emotion-regulatory goals (i.e., enjoyable but may not necessarily involve learning new things). Although an individual can pursue both types of goals simultaneously, this item is focused on assessing the *relative* importance of each type of goal (i.e., bipolar item with two ends) rather than on modeling the structure of goal focus (i.e., two unipolar items).

Subjective Health. Self-rated health was assessed using a single item (Ware & Sherbourne, 1992) that assesses how participants think about their health status on a 5-point scale (1 = *poor*, 5 = *excellent*). Similar to Study 1, self-rated health was included as a covariate as the perception of poor health could influence perceived time horizon independently of the manipulations.

Actual Time-Use. Time spent engaging in different activities was assessed via a time-use survey. For both a typical weekday and a typical weekend, participants indicated the amount of time they tend to spend on each of 17 activities (refer to Appendix D for the list of activities). After respondents have done so, they answered follow-up questions for each activity that they reported spending time on. The follow-up questions assessed the following four activity-related aspects: *(1)* meaningfulness, *(2)* positive feelings, *(3)* negative feelings, and *(4)* extent of social interaction on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*).

Mental Imagery Task. The mental imagery task served to manipulate time horizon within the participants. Before the mental imagery task, participants underwent a training task to familiarize themselves with generating mental imagery. This training task used instructions adapted from Holmes and colleagues' (2008) lemon exercise. Briefly, participants were instructed to imagine themselves interacting with a lemon in various ways, using their different senses (i.e., touch, sight, smell) to experience imagining a vivid scene.

After the training task, participants were randomly assigned into two groups: a control group (expansive time horizon) and an experimental group (limited time horizon). All participants were instructed to imagine themselves in ten different scenarios. The scenarios differed according to the group they were randomly assigned to. For example, those in the control group imagined themselves in situations in the short-term future – which was meant to maintain an expansive time horizon (e.g., “You are on your way to school, but the traffic seems especially congested today”), while those in the experimental group imagined themselves in situations in the long-term future – which was meant to induce a limited time horizon (e.g., “Today is the annual department staff retreat. As the manager of your department, you were hoping that the retreat would improve staff morale”). After each scenario, participants rated how vividly they could conjure the images from each situation on a 5-point scale (1 = *not at all vivid*, 5 = *extremely vivid*).

Scrambled Sentences Task. The scrambled sentences task was adapted from Demeyer and De Raedt's (2014) study and served as a manipulation check by assessing the availability of specific

cognitions related to time horizon. Each list of words must be unscrambled such that there is one less word than the total number of words provided. Since each list of words can only be unscrambled in one of two ways that still leaves the sentence grammatically correct, respondents' prevailing time horizon can be inferred by examining how they unscramble the sentences. For example, when given the following stimulus: "seems/to/time/infinite/be/limited", participants can either respond with "time seems to be limited" (limited time horizon) or "time seems to be infinite" (expansive time horizon). Participants in the experimental group were expected to unscramble more sentences using words related to a limited time horizon, while participants in the control group were expected to unscramble more sentences using words related to an expansive time horizon.

During the task, participants was also asked to remember a three-digit number. This additional cognitive load was meant to suppress the tendency to provide socially desirable responses as it is possible that planning for the future could be perceived as being more socially desirable compared to living in the present, especially among younger adults. Additionally, a time limit of five minutes was imposed for the entire task, which serves to prevent strategic responding. The scrambled sentence task is an implicit measure of perceived time horizon that may be less susceptible to biases occurring after overt experimental manipulations (Demeyer & De Raedt, 2014), such as social desirability bias and participant bias.

Motivated Time-Use. The same activities listed in the actual time-use measure were repeated for the motivated time-use measure. Instead of indicating the amount of time that they *typically* spend engaging in different activities on a typical weekday and typical weekend, participants indicated the amount of time they would *want to* allocate to different activities on both a weekday and weekend in the next week. The same four follow-up questions (administered in the actual time-use survey) were also administered for each activity that participants reported wanting to spend time (in the motivated time-use survey) but did not partake in (in the actual time-use survey). This was so that all activities relevant to the respondent – either as an activity they tend to engage regularly, or an activity they wish to engage in – could be used in forthcoming analyses.

Results

Power and sensitivity analyses were conducted with G*Power version 3.1.9.6 (Faul et al., 2007). All other analyses were conducted with R version 4.2.0; *ltm* version 1.2-0 (for computing Cronbach alpha values), *Hmisc* version 4.7-0 (for correlational analyses), *geepack* version 1.3.3 (for generalized estimating equations), *lm.beta* version 1.62 (for computation of standardized regression coefficients), and *ggplot2* version 3.3.6 (for generating plots).

A priori power analyses (α = .05, power = .80, one-tailed) was conducted to estimate the required sample size based on Demeyer and De Raedt's (2014) findings in (Study 2), which examined group differences in time horizon after an experimental manipulation. For their study, a medium-large effect size (*d* = 0.64) was found – suggesting that a sample size of 62 is adequate for detecting group differences in time horizon after the manipulation. However, it should be noted that even though this sample size is sufficient for detecting a main effect, more is likely needed for detecting an interaction effect (between PA and time horizon) in H_5.

Descriptive analyses

Descriptive statistics (means, standard deviations) and correlations of all variables were reported in Table 6.

Similar to in Study 1, a bubble plot was generated using mean aggregated scores for meaning, positive affect, and negative affect for each of the 16 activities, excluding sleep (Figure 4). Frequencies and mean aggregated scores for the activities are reported in Table 7. Notably, school-related activities and work appeared to be among the least enjoyable activities for younger adults, with lower PA and higher NA compared to the other activities. On average, however, school-related activities were regarded as being more meaningful than work – possibly due to the relative importance/prevalence of school-related activities in their present life stage.

Main analyses

Hypothesis 5. Before formally testing H_5, I processed the data to remove low-quality responses, examined whether the time horizon manipulation was successful, and computed the dependent variable that will be used in the analysis.

Data Screening. First, I omitted respondents who did not follow the instructions when completing the time-use surveys. This includes respondents who indicated a total number of hours that is not equal to 24. As the allocation of hours within a weekday or weekend would be imbalanced for these participants, their responses were removed (n = 7). The sample remaining after removing these participants was 291.

Next, I computed task scores for the scrambled sentences task, which was performed in multiple steps. Before assigning scores to each sentence, I cleaned up typographical errors. For instance, "prospecct" was corrected to "prospects", and "unlinited" was corrected to "unlimited". Following that, I assigned a score of either +1 (sentence formed with a limited word), −1 (sentence formed with an expansive word), or 0 (invalid sentence) to each unscrambled sentence. A sentence was considered invalid when the participant used: (a) both the limited and expansive word; (b) more or fewer words than those provided; (c) a word that was not provided in the list; or (d) sentences that contained grammatical errors.

Following that, the scores were summed to form a limited time horizon index, which range from −10 to +10, with higher scores representing a more limited time horizon and lower scores representing a more expansive time horizon. Following this, I removed responses from respondents with three or more invalid sentences (n = 87). The sample remaining after removing these participants was 204, split into the control group (n = 98) and the experimental group (n = 106).

Manipulation Check. After having derived the final sample, I performed a manipulation check using an independent samples *t*-test to examine if the limited time horizon index derived from the scrambled sentences tasks varied across conditions. Unfortunately, the analysis showed that the difference between groups was not significant (p = .246) – suggesting that the manipulation to induce a limited time horizon in the experimental group did not work. However, as the scores in both conditions were in the expected direction (i.e., higher scores in the experimental/limited group [mean = −3.59], lower task scores in the control/expansive [mean = −4.23] group), I proceeded with the analysis on an exploratory basis.

For the main analysis, I computed the dependent variable (Time Δ) by subtracting – for each activity – actual time-use from motivated time-use. As the analysis was performed at the activity level, each difference score represents one activity. Positive (negative) scores represent the desire to spend more (less) time on a specific activity. Time Δ controls for actual-time use while isolating motivated time-use, which is more powerful than simply using motivated time-use as the dependent variable. This is because variation in motivated time-use may be influenced by between-person variables (e.g., personality) in addition to the effects of the manipulation.

H_5 posits that when a limited time horizon is made salient, people become more inclined to spend time on more enjoyable activities (Figure 5). To test H_5, I estimated a GEE model with Time Δ regressed on *(1)* activity-related PA, *(2)* condition (0 = control group, 1 = experimental group), *(3)* the interaction between activity-related PA and condition, and *(4)* the following covariates: *(a)* extraversion, *(b)* neuroticism, *(c)* past-year-meaning, *(d)* optimism, and *(e)* subjective health. This analysis was performed twice, once for weekday and once for weekend. The results for both set of analyses revealed that the two-way interaction (activity-related PA × condition) on Time Δ was not significant for both weekday (p = .748) and weekend (p = .923; Table 8). Thus, H_5 was not supported.

Hypothesis 6. H_6 posits that chronic activity goal focus (measured before the experimental manipulation) moderates the relationship between activity-related PA and activity-related meaning such that PA and meaning are more strongly associated among people with an emotional goal focus

compared to those with a knowledge goal focus (Figure 6). To test H_6, I estimated a GEE model with activity-related meaning regressed on *(1)* activity-related PA, *(2)* activity goal focus, *(3)* the interaction between activity-related PA and activity goal focus, and the following covariates: *(a)* extraversion, *(b)* neuroticism, *(c)* past-year-meaning, *(d)* optimism, and *(e)* subjective health.

Contrary to the hypothesized relations, I found that the two-way interaction (activity-related PA × activity goal focus) on activity-related meaning was non-significant (p = .416, Table 9). Instead, activity-related PA is positively associated with activity-related meaning (b = .55, SE = .07, Wald = 66.53, p < .001) – suggesting that the relationship between PA and meaning does not differ as a function of the type of goals being prioritized in younger adulthood. In other words, younger adults, regardless of whether they prioritize emotional or knowledge goals, tend to regard enjoyable activities as being meaningful to a similar extent. Thus, H_6 was not supported.

Additional analyses

Moderating influences of NA. Following the analyses conducted for Study 1, I tested a three-way interaction (activity-related PA × activity-related NA × activity goal focus) by regressing activity-related meaning on *(1)* activity-related PA, *(2)* activity-related NA, *(3)* activity goal focus, *(4)* all their cross-product terms, and *(5)* the following covariates: extraversion, neuroticism, past-year-meaning, optimism, and subjective health.

The results revealed a significant three-way interaction (activity-related PA × activity-related NA × activity goal focus) on activity-related meaning (b = .61, SE = .01, Wald = 4.08, p = .043; Table 10). To probe the interaction, I conducted simple effects analysis to examine the simple main effects of PA on meaning at different levels of activity goal focus when NA is at high, average, and low levels of NA (Table 11). A simple slopes plot was also generated to visualize the interaction (Figure 7).

For people who prioritize emotional goals, the effects of PA on meaning did not vary much as the level of NA increased (b's = .58 to 61, all ps < .001). In contrast, for people who prioritize knowledge goals, the effects of PA on meaning grew increasingly weaker as the level of NA increased (b's = .56 to .66, all ps < .001). When looking at activities that are high in NA (Figure 7), knowledge-

focused people report significantly higher levels of meaning than emotion-focused people at low (*β* = −.09, *SE* = .03, Wald = 6.72, *p* = .001) to average (*β* = −.06, *SE* = .02, Wald = 5.08, *p* = .024) levels of PA, but not at high levels of PA (*p* = .399). This might suggest that weaker effects of PA for knowledge-focused people could be because they were able to find meaning even in activities that elicit high NA – which could be related to the types of activities that were reported as being relatively higher in NA (e.g., school-related activities and work) – both of which are unpleasant but important for knowledge-acquisition goals.

Moderating influences of social interaction. I considered the extent of social interaction as a possible moderator. To do so, I tested a four-way interaction (activity-related PA × activity-related NA × activity goal focus × social interaction) by regressing activity-related meaning on *(1)* activity-related PA, *(2)* activity-related NA, *(3)* activity goal focus, *(4)* extent of social interaction, *(5)* all their cross-product terms, and *(6)* the following covariates: extraversion, neuroticism, past-year-meaning, optimism, and subjective health.

The results revealed a significant four-way interaction (activity-related PA × activity-related NA × activity goal focus × social interaction) on activity-related meaning (*β* = 1.37[1], *SE* = .01, Wald = 4.41, *p* = .036; Table 12). To probe the interaction, I conducted simple effects analysis to examine the simple main effects of PA on meaning at different levels of activity goal focus when NA is at high, average, and low levels for social and non-social activities (Table 13). A simple slopes plot was also generated to visualize the interaction (Figure 8).

Qualifying results from the three-way interaction, the present findings suggest that unpleasant activities were only more meaningful for knowledge-focused (compared to emotion-focused) people when they contain a social component. Knowledge-focused people were able to

[1] Standardized coefficients higher than 1.00 could be due to multicollinearity from the inclusion of cross-product terms.

find more meaning from unpleasant activities (i.e., low PA, high NA) when they contained high (β = −.21, *SE* = .04, Wald = 25.18, $p < .001$) to average (β = −.10, *SE* = .03, Wald = 10.16, $p = .001$) levels of social interaction compared to emotion-focused people, but not when the activity was low in social interaction ($p = .858$). However, this finding is difficult to interpret as the source of the negative emotional experience is unclear. For example, knowledge-focused people could find meaning from unpleasant activities shared with others (e.g., studying for a stressful test with friends) or from negative social interactions itself (e.g., arguing with a friend). For emotion-focused people, in general, it appears that the extent of social interaction does not alter perceived meaningfulness of activities. Specifically, activities appear to become less meaningful for emotion-focused people when they are accompanied by low PA (across all levels of NA) – suggesting the critical role of PA for emotion-focused people's experience of meaning.

General Discussion

Recap of Study Findings

Overall, three of the four hypotheses in Study 1 were unsupported (H_1, H_2, and H_3) while one hypothesis (H_4) received partial support. Age did not moderate the relationship between enjoyableness (PA) and meaningfulness for activities (H_1). While time horizon moderated the relationship between enjoyableness (PA) and meaningfulness for activities, it was in the opposite direction (H_2). As there was no support for either H_1 or H_2, I did not proceed to test H_3. H_4 was examined in two parts, once with age and once with time horizon. For age, the three-way interaction effect (PA × NA × Age) was not significant. At high levels of NA, however, I found that the effects of PA on meaning for those with a limited time horizon was attenuated, but not for those with an expansive time horizon. Thus, there was partial support for H_4.

Both hypotheses tested in Study 2 were not supported. For H_5, I found that when a limited time horizon was made salient, people did not become more inclined to spend time on enjoyable activities – which may be due to the unsuccessful manipulation of time horizon in the experimental group. For H_6, I found that chronic activity goal focus (i.e., prioritization of either emotion or

knowledge goals) did not moderate the relationship between enjoyableness and meaningfulness for activities. Additional analyses conducted on the data in Study 2, however, found significant moderating effects of NA such that knowledge-focused people were able to find more meaning from unpleasant activities (i.e., low PA, high NA) compared to emotion-focused people. When investigating whether this moderating effect was, in turn, moderated by the extent of social interaction, I found that knowledge-focused people were more likely to find meaning in unpleasant activities if the activity contained a social element. In general, activities appear to be less meaningful for emotion-focused people (compared to knowledge-focused people) when accompanied by low PA.

The present studies were designed to replicate and extend Hicks and colleagues' (2012) findings that PA is more strongly related to meaning for both older adults and those with a limited time horizon. However, when trying to replicate their findings within the context of daily activities, we found that the effect of PA on meaning did not vary across age and time horizon. Two possible reasons were considered for the non-significant findings.

First, the inherent differences between context-free (e.g., meaning in general) and context-specific (e.g., meaning specific to an activity) judgements may have led to different manifestations of the PA-meaning relationship. While context-free judgments may be a crystallized interpretation of one's overall feelings, it may be more susceptible to biases that can occur throughout the retrieval process (e.g., selective retrieval of meaningful, non-mundane aspects of life) compared to if they were considering specific activities. Thus, one possible explanation for discrepancies between Hicks' study and the current study is that context-free PA (as studied by Hicks and colleagues) may be more heavily influenced by selective retrieval and broader beliefs about the self, while the provision of contextual cues in the form of specific activities better anchors one's experiences to reality.

Second, Hicks and colleagues' studies utilized a sample of Western cultures, while the current study recruited participants from Eastern cultures. This distinction may be especially important for Study 1, as a previous studies have found that there are important cultural differences

related to the way that older adults prioritize positive information (Fung et al., 2008). This will be discussed in more detail in the following section.

Joint Effects of PA and NA

Across both studies, we found that it was important to take both PA and NA into account when considering how people find meaning in daily activities. Broadly, the findings reveal that when enjoyable activities were also high in NA, they were perceived as being less meaningful for people with a limited (compared to an expansive) time horizon. Additionally, we also found that when activities were low in PA but high in NA, they were relatively more meaningful for people focused on knowledge (compared to emotion) goals. The implications of these findings suggest that when considering how people find meaning from activities, it may not be enough to think simply about one's goals and priorities, but also about the vulnerabilities and impediments that may obstruct how one derives meaning from daily activities.

First, we consider the possibility that NA may exert interference effects that work against the meaning-enhancing properties of PA. In our unpublished work, we found evidence that certain negative emotions – when experienced at high levels – can interfere with the meaning-enhancing effects of happiness (Keh & Tov, 2021). However, this interference effect was only present when the negative emotion was low to moderate in arousal (i.e., sadness, tiredness) but not when it was high in arousal (i.e., pain, stress) – suggesting that the interference effect may be influenced by not just the valence, but also arousal level (e.g., Storbeck & Clore, 2008). Since the current study did not examine specific emotion terms, it was unclear if lowered meaning perceptions in the presence of high NA could be due to this possibility.

Second, it is possible that the findings could be explained by cultural differences in how older adults demonstrate a positivity effect (Carstensen & DeLiema, 2018; Mather & Carstensen, 2005). For instance, the positivity effect (i.e., preferential attention given towards positive information among older adults) has been found to be present among older adults in Western, but not Eastern cultures (Fung et al., 2008). The presence of a positivity effect for older adults in

Western cultures could suggest that emotional goals for them are manifested in the maximizing of positive affect (e.g., up-regulation of positive emotions). In contrast, it is possible that for people who do not pay preferential attention to positive information (e.g., older adults in Eastern cultures), minimizing negative affect (e.g., down-regulation of negative emotions) may be more important. This could potentially explain why in Study 1, an effect was found when NA was taken into consideration, but not when PA was examined on its own.

Last, we consider how the desire to maximize happiness may paradoxically lead to lowered meaning. Extant research suggests that when people value happiness excessively, it is possible for them to end up being *less* happy (Gruber et al., 2011; Mauss et al., 2011). This may be because one's goals also act as the standards for which current progress is compared against (Carver & Scheier, 1981). Within the context of the current study, it is possible that a person who prioritizes emotional goals excessively (e.g., wants to be extremely happy or want to avoid all negative emotions) may, paradoxically, experience less meaning when they fail to attain the hard-to-reach emotional goals that they have set for themselves. This may be especially true for the sample in Study 2 (i.e., undergraduates) as they are more likely to have to deal with negative emotions arising from school-related activities (e.g., working on an assignment with a deadline, studying for an exam). For people who prioritize emotion goals, these negative emotions can be inherently incompatible with one's goals (e.g., to be happy, to not be stressed), especially if one values happiness excessively. Future research might examine different approaches to fulfilling emotional goals such over-valuing happiness versus prioritizing positivity (Catalino et al., 2014; Hansenne, 2021) and how these relate to meaning across different age groups.

Other Potential Moderators

Although the present studies focus on examining age, time horizon, and activity goal focus as potential moderators of the relationship between PA and meaning (as an application of the SST), it is likely that other moderators, such as socioeconomic status (SES), gender, and personality traits, may influence the relationship between PA and meaning as well.

When considering how people derives meaning from daily activities, it is possible that the availability of material resources may play an integral role. Although the SST posits that the perception of increasingly limited time shifts one's focus from the future (e.g., knowledge-acquisition goals) to the present (e.g., emotional regulation goals), not everyone may have the luxury of pursuing their present goals. For instance, the pursuit of emotionally meaningful goals (e.g., socialization with close others) for people with lower SES may be supplanted by the need to fulfil basic human needs (e.g., to pay for food and rent) – suggesting that even though time is a limited resource for everyone, it may be more limited for certain people. While people with higher SES can allot more time in pursuit of their goals (e.g., by engaging in enjoyable activities, by making time-saving purchases), people with low SES may be more limited by their responsibilities (e.g., may have to work more to pay for food and rent). Thus, SES may be a possible moderator of the relationship between PA and meaning as people with lower SES may not have the time or money to fully pursue activities that they find enjoyable.

Gender may also play a role in determining the way that people derive meaning from enjoyable activities. In old age, preferred leisure and social activities may be subject to gender differences. For instance, men (compared to women) may show an inclination towards more solitary activities (e.g., walking) and activities that are self-organized rather than being regimented by formal organizations (C. Russell, 2007). Thus, gender may also be a possible moderator of the relationship between PA and meaning as men (compared to women) may find meaning from activities depending on the content of these activities and the way they are organized.

Limitations

First, restricting the activities (in Study 1) to the *most* and *least* meaningful activity may result in more extreme scores compared to a more comprehensive list of activities (like in Study 2). The absence of "middle-ground" responses from the participants (e.g., activities that were neither the most nor least meaningful activity) can potentially exaggerate observed differences, as the rated activities were based on responses from those who feel extremely strongly about it. This not only

contributes to an incomplete consideration of an activity's experiential scope (i.e., scores reflect the most extreme of scores) but may also inflate the extent to which seemingly related activities may be different. Among older adults, for instance, informal social activities were rated by the highest number of respondents as the *most* meaningful activity (*n* = 1,108, while formal social activities, the *least* meaningful activity (*n* = 1,540). Accordingly, their experiential scores reflect the extremity of these results – with high meaning, high PA, and low NA scores for informal social activities, and the reverse for formal social activities (see Figure 4). As participants were not able to rate *all* activities on the list, we miss out on responses from people who have more varied experiences in each activity. For instance, the views of people who participated in formal social activities but felt that it was neither the most or least meaningful activity were omitted from the study, and the resultant mean experiential scores could have become weighted towards the opinions of people who felt that formal social activities are extremely non-meaningful. Future studies should take this into consideration and utilize not only a comprehensive list of activities that is relevant and age-appropriate, but also assess the experiential qualities of these activities in a more thorough manner.

Second, the use of survival expectations as an index of time horizon (in Study 1) might have primed mortality in the participants' mind, as the consideration of one's likelihood for surviving past a certain age would inevitably lead to the consideration of the likelihood of *not* surviving past that age. According to terror management theory, mortality salience can activate defense mechanisms, such as clinging on to existing cultural worldviews, that help people assuage their anxiety towards death (Pyszczynski et al., 1999). Through acts of maintaining one's cultural worldviews, such as the maintenance of one's traditional practices (e.g., adhering to cultural norms, or performing rituals, ceremonies) or re-affirmation of one's cultural values (e.g., convincing other people to adopt one's worldviews or denying alternative worldviews), one's universe becomes meaningful through the provision of orderly structures that help people organize their reality (Greenberg et al., 1997). Because these worldviews can provide people with meaning independently of one's prioritized goals (including emotional goals), it is possible that they may, in turn, attenuate the effects of PA on

meaning. Thus, it is possible that the lack of support for H_1 and H_2 may have been because survival expectation is a much stronger prime of mortality salience than as an index of time horizon.

Third, the failed manipulation (in Study 2) prevents us from establishing the causal effects of a perceived time horizon. Although past studies have successfully manipulated a limited time horizon using similar procedures among age-equivalent undergraduates (Demeyer & De Raedt, 2014; Tanaka, 2019), that was not the case here. There are several potential reasons for this. First, the manipulation may have been too subtle or weak to induce detectable differences. However, this was unlikely to be the sole reason as respondents reported an average vividness score of 2.93 (range: 1 to 5) across all ten mental imagery scenarios, which was acceptable. Second, the participants' pre-existing time horizon (i.e., expansive perception of time) may have been too strong to be overridden with a manipulation. For instance, even though the range of scores for the scrambled sentences task score is between -10 (expansive) and 10 (limited), the average mean score for the task across all participants is −3.85 – suggesting that respondents have a rather strong tendency to perceive time as being expansive. Third, it is possible that the cognitive load in the scrambled Sentences Task may have affected the extent to which the effects of the manipulation could be detected. Although it was included to reduce deliberate response biases, it is possible that it may have instead interfered with, and made it more difficult to detect, the effects of the already-subtle manipulation. Fourth, the administration of the study using an online format in an uncontrolled setting may have exacerbated issues with non-compliance, further weakening the strength of the manipulation. For instance, despite being recommended to spend between 30 and 60 seconds for each mental imagery scenario, participants only spent an average of 15.7 seconds to visualize each scenario. Without spending sufficient time trying to imagine themselves in these scenarios, it is unlikely that such a subtle manipulation can reliably induce a limited time horizon.

Fourth, it is possible that even though the experimental manipulation (in Study 2) was meant to prime a limited time horizon, it may have instead served as an unintentional reminder of how expansive their time horizon is. For instance, in the absence of any life-shortening illness, thinking

about all the things that they have not yet experienced (e.g., becoming a parent) may have led to them feeling that they have *more* (rather than *less*) remaining time in life. Although we find that the mean scores for the limited time horizon index across groups were in the right direction, they were non-significant. As young adulthood is often characterized by uncertainty (compared to older adulthood), it is possible that the idea of being close to the end of life is difficult for young adults to fathom. Future studies that involve the manipulation of time horizon in younger adults could consider priming perceived endings that are disentangled from mortality (e.g., geographical relocations, coming to the end of the holidays), instead of manipulating perceived time remaining in life.

Conclusion

A central prediction of the SST has been that as one ages and begin to perceive an increasingly limited time horizon, goals shift from focusing on the acquisition of knowledge towards emotion regulation. Drawing upon the SST, Hicks and colleagues (2012) demonstrated how the relationship between PA and meaning is stronger among older adults and those primed to perceive less remaining time in life. The present studies sought to extend the idea further by considering whether this pattern of results can be replicated when examined within the context of daily activities. Although none of the tested hypotheses received full support, the findings from additional analyses suggest that when trying to understand meaningful experiences using predictions drawn from SST – researchers may need to consider the joint effects of PA and NA, as well as cultural differences.

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Table 1

Descriptive Statistics and Zero-Order Correlations (Study 1)

		n	*M*	*SD*	Range	1	2	3	4	5	6	7	8	9
1	Age	6,613	65.77	5.80	55 – 99.3	–								
2	Survival Expectations	6,200	55.82	26.54	0 – 100	−.08***	–							
3	Meaning	13,090	3.52	1.43	1 – 6	.01	.04***	–	.83***	−.40***				
4	Positive Affect	13,078	3.60	1.39	1 – 6	.01	.07*	.72***	–	−.46***				
5	Negative Affect	13,062	2.23	1.07	1 – 6	−.03***	−.08***	−.28***	−.36***	–				
6	Extraversion	6,207	3.06	0.55	1 – 5	.01	.12***	.07***	.12*	−.07***	–			
7	Neuroticism	6,208	2.79	0.63	1 – 5	−.01	−.14***	−.06***	−.12***	.17***	−.33***	–		
8	Meaning (past-year)	6,613	4.03	1.12	1 – 6	−.04***	.22***	.11***	.23***	−.18***	.25***	−.34***	–	
9	Optimism	6,498	3.88	0.68	1 – 6	.01	.23***	.09***	.17***	−.18***	.22***	−.38***	.43***	–
10	Self-Rated Health	6,605	0.76	0.12	0 – 1	−.10***	.29***	.08***	.19***	−.23***	.21***	−.35***	.52***	.42***

Note. For survival expectations, lower (higher) survival expectations correspond to a limited (expansive) time horizon. Values below diagonal correspond to between-person correlations while values above the diagonal correspond to within-person correlations.

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

Table 2

Meaning and Enjoyableness Scores of Activities (Study 1)

	Activity	Meaning	Positive Affect	Negative Affect	*Selected as…* Most meaningful	Least meaningful
1	Personal care	4.10	4.00	2.07	981	311
2	Chores and errands	3.63	3.56	2.39	699	704
3	Physical activities	4.09	4.12	1.98	779	299
4	Hobbies	3.29	3.49	2.18	320	578
5	Work	3.76	3.66	2,45	1,049	533
6	Taking care of grandchildren	3.81	3.85	2.13	501	396
7	Taking care of adult family members	3.89	3.68	2.43	280	148
8	Socializing with family and friends	4.27	4.28	2.01	1,108	252
9	Formal social activities	2.23	2.65	2.46	48	1,540
10	Religious or spiritual activities	3.34	3.54	2.04	575	770
11	Volunteering	2.74	3.05	2.25	161	855

Table 3

Moderation Analyses (GEE) Predicting Activity-Related Meaning from Activity-Related PA × Activity-Related NA × Age (Study 1)

	Without covariates					*With covariates*				
	b	*SE*	*β*	Wald	*p*	*b*	*SE*	*β*	Wald	*p*
(PA) Positive Affect	0.83***	.17	.81	24.94	< .001	0.86***	.16	.84	27.40	< .001
(NA) Negative Affect	0.37	.24	.27	2.42	.120	0.36	.23	.27	2.42	.120
Age	0.02	.01	.07	3.27	.070	0.02	.01	.06	2,85	.091
PA × NA	−0.02	.08	−.05	0.05	.816	−0.02	.08	−.06	0.08	.782
PA × Age	< −0.01	< .01	−.10	0.39	.535	< −0.01	< .01	−.10	0.40	.528
NA × Age	−0.01	< .01	−.29	2.80	.094	−0.01	< .01	−.29	2.80	.094
PA × NA × Age	< 0.01	< .01	.04	0.03	.854	< 0.01	< .01	.03	0.02	.882
Extraversion						0.01	.02	< .01	0.53	.467
Neuroticism						0.03*	.02	.01	2,62	.105
Meaning (past-year)						−0.05***	.01	−.04	18.12	< .001
Optimism						−0.01	.02	−.01	0.41	.520
Self-Rated Health						−0.27*	.10	−.04	18.33	< .001

Note. Exchangeable correlation structure was specified for the working correlation matrix.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4

Moderation Analyses (GEE) Predicting Activity-Related Meaning from Activity-Related PA × Activity-Related NA × Survival Expectations (Study 1)

	Without covariates					*With covariates*				
	b	*SE*	*β*	Wald	*p*	*b*	*SE*	*β*	Wald	*p*
(PA) Positive Affect	0.76***	.04	.74	376.13	< .001	0.78***	.04	.76	400.86	< .001
(NA) Negative Affect	0.07	.05	.05	1.74	.187	0.05	.05	.04	0.90	.344
(SE) Survival Expectations	< −0.01	< .01	−.01	0.06	.801	< −0.01	< .01	< −.01	< 0.01	.969
PA × NA	−0.04*	.02	−.11	4.37	.037	−0.04*	.02	−.11	4.58	.032
PA × SE	< −0.01	< .01	−.05	0.74	.390	< −0.01	< .01	−.04	0.43	.512
NA × SE	< −0.01	< .01	−.10	3.78	.052	< −0.01	< .01	−.08	2.36	.124
PA × NA × SE	< 0.01*	< .01	.14	5.12	.024	< 0.01*	< .01	.12	3.88	.049
Age (*d1*)	−0.02	.02	−.01	0.83	.364	−0.02	.02	< −.01	0.57	.451
Age (*d2*)	0.01	.03	< .01	0.04	.832	−0.01	.03	< .01	0.04	.837
Age (*d3*)	−0.02	.04	< −.01	0.27	.602	−0.04	.04	< −.01	1.02	.312
Extraversion						0.01	.02	< .01	0.57	.452
Neuroticism						0.03	.02	.01	2.47	.116
Meaning (past-year)						−0.05***	.01	−.05	17.46	< .001
Optimism						−0.01	.02	−.01	0.31	.575
Self-Rated Health						−0.46***	.11	.02	16.82	< .001

Note. For survival expectations, lower (higher) survival expectations correspond to a limited (expansive) time horizon. Exchangeable correlation structure was specified for the working correlation matrix.

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

Table 5

Simple Effects of Activity-Related PA on Activity-Related Meaning at Different Levels of Survival Expectations when Activity-Related NA is High/Average/Low (Study 1)

Moderator 1	Moderator 2	*b*	*SE*	*β*	Wald	*p*
Survival Expectations	*Negative Affect*					
… at −1 *SD*	… at −1 *SD*	0.74***	.01	.72	2716.09	< .001
	… at mean	0.71***	.01	.69	2661.44	< .001
	… at +1 *SD*	0.69***	.02	.67	968.11	< .001
Survival Expectations	*Negative Affect*					
… at mean	… at −1 *SD*	0.75***	.01	.73	6120.80	< .001
	… at mean	0.74***	.01	.72	7606.77	< .001
	… at +1 *SD*	0.73***	.01	.71	3170.36	< .001
Survival Expectations	*Negative Affect*					
… at +1 *SD*	… at −1 *SD*	0.76***	.01	.73	3387.43	< .001
	… at mean	0.76***	.01	.74	4286.37	< .001
	… at +1 *SD*	0.77***	.02	.75	1905.00	< .001

Note. For survival expectations, lower (higher) survival expectations correspond to a limited (expansive) time horizon. Exchangeable correlation structure was specified for the working correlation matrix.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 6

Descriptive statistics and zero-order correlations (Study 2)

		n	*M*	*SD*	Range	1	2	3	4	5	6	7	8	9
1	Meaning	2,834	3.82	0.94	1 – 5	–	.60***	−.32***	.15***					
2	Positive Affect	2,834	3.79	0.90	1 – 5	.63***	–	−.48***	.04*					
3	Negative Affect	2,834	2.53	1.04	1 – 5	−.29***	−.43***	–	.16***					
4	Social Interaction	2,834	3.03	1.35	1 – 5	.15***	.06***	.18***	–					
5	Activity Goal Focus	298	3.82	1.13	1 – 6	−.03	< .01	.04*	.02	–				
6	Extraversion	298	2.84	0.72	1 – 5	.05**	.04*	< .01	.10***	.03	–			
7	Neuroticism	298	3.19	0.70	1 – 5	< .01	< .01	.12***	−.02	.28***	−.15***	–		
8	Meaning (past-year)	298	3.24	1.01	1 – 5	.09***	.08***	−.03	.06**	−.08***	.22***	−.27***	–	
9	Optimism	298	3.10	0.66	1 – 5	.09***	.08***	−.12***	.03	−.10***	.26***	−.50***	.36***	–
10	Subjective Health	298	3.17	0.91	1 – 5	.06**	.07***	−.16***	< .01	−.08***	.16***	−.35***	.21***	.28***

Note. For activity goal focus, lower (higher) scores correspond to a prioritization of knowledge (emotion) goals. Values below diagonal correspond to between-person correlations while values above the diagonal correspond to within-person correlations.

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

Table 7

Meaning and Enjoyableness Scores of Activities (Study 2)

	Activity	*n*	Meaning	Positive Affect	Negative Affect	Social Interaction
1	Self-maintenance activities	282	3.92	3.80	2.14	1.71
2	Chores and errands	246	3.32	3.17	2.80	2.59
3	Informal caretaking/caregiving duties	46	4.02	3.67	2.59	4.09
4	Caring for and playing with pets	59	4.44	4.53	1.71	2.86
5	School activities	279	3.52	2.93	3.47	3.62
6	Work (and travel to work)	185	2.97	2.95	3.18	3.39
7	Informal social activities	264	4.31	4.21	2.33	4.45
8	Formal social activities	93	3.97	3.95	2.51	4.24
9	Digital communication and social media use	279	3.63	3.83	2.72	3.73
10	Leisure activities	251	4.21	4.22	2.02	2.65
11	Watching TV or movies	231	3.84	4.23	2.11	2.17
12	Playing electronic games	121	3.66	4.12	2.48	3.05
13	Physical activities	203	4.22	4.09	2.38	2.89
14	Private religious or spiritual activities	54	4.22	4.11	2.30	3.13
15	Volunteering	59	4.36	4.25	2.19	4.34
16	Doing nothing	182	3.65	3.84	2.55	1.75

Table 8

Moderation Analyses (GEE) Predicting Time Δ from Activity-Related PA × Condition for Weekday and Weekend (Study 2, H_5)

	Without covariates					*With covariates*				
Weekday	*b*	*SE*	*β*	Wald	*p*	*b*	*SE*	*β*	Wald	*p*
(PA) Positive Affect	0.33***	.06	.20	33.20	< .001	0.36***	.08	.22	19.00	< .001
Condition	0.23	.31	.08	0.56	.455	−0.19	.46	−.06	0.17	.678
PA × Condition	−0.08	.08	−.11	0.97	.325	0.04	.12	−.05	0.10	.748
Extraversion						−0.02	.06	−.01	0.08	.779
Neuroticism						−0.03	.05	−.02	0.44	.507
Meaning (past-year)						0.01	.04	.01	0.03	.857
Optimism						−0.02	.05	−.01	0.16	.686
Subjective Health						−0.01	.03	−.01	0.12	.728
Weekend										
(PA) Positive Affect	0.23	.23	.13	0.98	.321	0.17	.40	.10	0.17	.677
Condition	0.78	1.03	.25	0.58	.446	−0.25	2.90	−.08	0.01	.931
PA × Condition	−0.21	.27	−.27	0.61	.435	0.06	.58	.07	0.01	.923
Extraversion						−0.01	.64	−.01	< 0.01	.982
Neuroticism						−0.02	1.25	−.01	< 0.01	.987
Meaning (past-year)						−0.02	.38	−.01	< 0.01	.954
Optimism						−0.01	.84	< −.01	< 0.01	.992
Subjective Health						−0.02	.59	−.01	0.01	.979

Note. Condition: 0 = control (expansive time horizon), 1 = experimental (limited time horizon). Exchangeable correlation structure was specified for the working correlation matrix.

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

Table 9

Moderation Analyses (GEE) Predicting Activity-Related Meaning from Activity-Related PA × Activity Goal Focus (Study 2, H_6)

	Without covariates					*With covariates*				
	b	*SE*	*β*	Wald	*p*	*b*	*SE*	*β*	Wald	*p*
(PA) Positive Affect	0.58***	.07	.55	65.38	< .001	0.58***	.07	.55	66.53	< .001
(AGF) Activity Goal Focus	−0.09	.08	−.10	1.29	.257	−0.09	.08	−.11	1.40	.237
PA × AGF	0.02	.02	.10	0.76	.384	0.02	.02	.09	0.66	.416
Extraversion						0.03	.03	.02	1.06	.302
Neuroticism						0.07*	.03	.05	4.83	.028
Meaning (past-year)						0.02	.02	.03	1.61	.204
Optimism						0.07*	.04	.05	3.92	.048
Subjective Health						0.02	.02	.01	0.45	.504

Note. For activity goal focus, lower (higher) scores correspond to a prioritization of knowledge (emotion) goals. Exchangeable correlation structure was specified for the working correlation matrix.

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

Table 10

Moderation Analyses (GEE) Predicting Activity-Related Meaning from Activity-Related PA × Activity-Related NA × Activity Goal Focus (Study 2, Additional Analyses)

	Without covariates					*With covariates*				
	b	*SE*	*β*	Wald	*p*	*b*	*SE*	*β*	Wald	*p*
(PA) Positive Affect	0.98***	.17	.94	34.80	< .001	0.98***	.17	.94	32.91	< .001
(NA) Negative Affect	0.59*	.24	.65	6.02	.014	0.58*	.24	.64	5.65	.017
(AGF) Activity Goal Focus	0.37*	.18	.44	4.13	.042	0.37*	.18	.44	3.96	.047
PA × NA	−0.13*	.06	−.55	4.80	.028	−0.13*	.06	−.54	4.39	.036
PA × AGF	−0.08	.04	−.49	3.72	.054	−0.08	.04	−.49	3.61	.058
NA × AGF	−0.14*	.06	−.78	6.05	.014	−0.14*	.06	−.78	5.75	.017
PA × NA × AGF	0.03*	.01	.63	4.42	.035	0.03*	.01	.61	4.08	.043
Extraversion						0.03	.03	.02	1.01	.316
Neuroticism						0.08*	.03	.06	5.54	.019
Meaning (past-year)						0.03	.02	.03	1.93	.165
Optimism						0.07	.04	.05	3.80	.051
Subjective Health						0.01	.02	.01	0.19	.660

Note. For activity goal focus, lower (higher) scores correspond to a prioritization of knowledge (emotion) goals. Exchangeable correlation structure was specified for the working correlation matrix.

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

Table 11

Simple Effects of Activity-Related PA on Activity-Related Meaning at Different Levels of Activity Goal Focus when Activity-Related NA is High/Average/Low (Study 2, Additional Analyses)

Moderator 1	Moderator 2	*b*	*SE*	*β*	Wald	*p*
Activity Goal Focus	*Negative Affect*					
… at −1 *SD*	… at −1 *SD*	0.69***	.04	.66	301.63	< .001
	… at mean	0.63***	.03	.61	446.61	< .001
	… at +1 *SD*	0.58***	.04	.56	195.73	< .001
Activity Goal Focus	*Negative Affect*					
… at mean	… at −1 *SD*	0.64***	.03	.62	376.32	< .001
	… at mean	0.63***	.02	.60	669.50	< .001
	… at +1 *SD*	0.61***	.03	.59	471.57	< .001
Activity Goal Focus	*Negative Affect*					
… at +1 *SD*	… at −1 *SD*	0.60***	.05	.58	155.40	< .001
	… at mean	0.62***	.04	.59	296.53	< .001
	… at +1 *SD*	0.64***	.04	.61	292.16	< .001

Note. For activity goal focus, lower (higher) scores correspond to a prioritization of knowledge (emotion) goals. Exchangeable correlation structure was specified for the working correlation matrix.

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

Table 12

Moderation Analyses (GEE) Predicting Activity-Related Meaning from Activity-Related PA × Activity-Related NA × Activity Goal Focus × Social Interaction (Study 2, Additional Analyses)

	Without covariates					*With covariates*				
	b	*SE*	*β*	Wald	*p*	*b*	*SE*	*β*	Wald	*p*
(PA) Positive Affect	0.86***	.30	.83	8.13	< .001	0.87***	.31	.83	8.10	.004
(NA) Negative Affect	−0.05	.42	−.06	0.02	.901	−0.05	.42	−.06	0.02	.901
(AGF) Activity Goal Focus	< −0.01	.30	< −.01	< 0.01	.998	0.01	.30	.01	< 0.01	.984
(SOC) Social Interaction	−0.21	.40	−.31	0.29	.591	−0.19	.40	−.28	0.24	.628
PA × NA	−0.04	.11	−.18	0.17	.684	−0.04	.11	−.17	0.14	.711
PA × AGF	−0.01	.07	−.06	0.02	.889	−0.01	.07	−.07	0.03	.869
NA × AGF	0.04	.10	.22	0.17	.679	0.04	.10	.22	0.16	.685
PA × SOC	0.06	.09	.36	0.39	.535	0.05	.09	.34	0.34	.560
NA × SOC	0.26*	.13	1.44†	4.32	.038	0.26*	.13	1.44†	4.27	.039
AGF × SOC	0.15	.10	1.04†	2.46	.117	0.15	.10	1.02†	2.35	.125
PA × NA × AGF	< 0.01	.03	.02	< 0.01	.966	< 0.01	.03	.01	< 0.01	.983
PA × NA × SOC	−0.05	.03	−1.01†	2.59	.108	−0.05	.03	−1.02†	2.61	.106
PA × AGF × SOC	−0.03	.02	−.95	2.23	.135	−0.03	.02	−.93	2.17	.141
NA × AGF × SOC	−0.08**	.03	−1.91†	7.00	.008	−0.08**	.03	−1.90†	6.93	.009
PA × NA × AGF × SOC	0.01*	.01	1.36†	4.40	.036	0.01*	.01	1.37†	4.41	.036
Extraversion						0.01	.03	< .01	0.06	.803
Neuroticism						0.08**	.03	.06	6.92	.009
Meaning (past-year)						0.02	.02	.02	1.31	.253
Optimism						0.08*	.03	.06	5.26	.022
Subjective Health						0.02	.02	.02	0.55	.458

Note. For activity goal focus, lower (higher) scores correspond to a prioritization of knowledge (emotion) goals. Exchangeable correlation structure was specified for the working correlation matrix.

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

† Standardized coefficients higher than 1.00 could be due to multicollinearity from the inclusion of cross-product terms.

Table 13

Simple Effects of Activity-Related PA on Activity-Related Meaning at Different Levels of Activity Goal Focus when Activity-Related NA is High/Average/Low for Social and Non-Social Activities (Study 2, Additional Analyses)

Moderator 3	Moderator 1	Moderator 2	*b*	*SE*	*β*	Wald	*p*
Social Interaction	*Activity Goal Focus*	*Negative Affect*					
… at +1 *SD*	… at −1 *SD*	… at −1 *SD*	0.58***	.05	.56	122.00	< .001
		… at mean	0.50***	.04	.48	14.082	< .001
		… at +1 *SD*	0.42***	.05	.40	43.88	< .001
	Activity Goal Focus	*Negative Affect*					
	… at mean	… at −1 *SD*	0.52***	.04	.50	148.71	< .001
		… at mean	0.52***	.03	.49	267.38	< .001
		… at +1 *SD*	0.51***	.03	.49	221.06	< .001
	Activity Goal Focus	*Negative Affect*					
	… at +1 *SD*	… at −1 *SD*	0.46***	.06	.44	55.72	< .001
		… at mean	0.53***	.04	.51	144.41	< .001
		… at +1 *SD*	0.60***	.04	.58	239.98	< .001
Social Interaction	*Activity Goal Focus*	*Negative Affect*					
… at mean	… at −1 *SD*	… at −1 *SD*	0.64***	.04	.61	269.26	< .001
		… at mean	0.57***	.03	.55	367.22	< .001
		… at +1 *SD*	0.51***	.04	.49	159.36	< .001
	Activity Goal Focus	*Negative Affect*					
	… at mean	… at −1 *SD*	0.60***	.03	.57	352.88	< .001
		… at mean	0.58***	.02	.56	608.39	< .001
		… at +1 *SD*	0.57***	.03	.54	416.05	< .001
	Activity Goal Focus	*Negative Affect*					
	… at +1 *SD*	… at −1 *SD*	0.55***	.04	.53	148.23	< .001
		… at mean	0.59***	.03	.56	299.80	< .001
		… at +1 *SD*	0.62***	.04	.60	288.99	< .001
Social Interaction	*Activity Goal Focus*	*Negative Affect*					
… at −1 *SD*	… at −1 *SD*	… at −1 *SD*	0.70***	.05	.67	209.94	< .001
		… at mean	0.65***	.04	.62	294.87	< .001

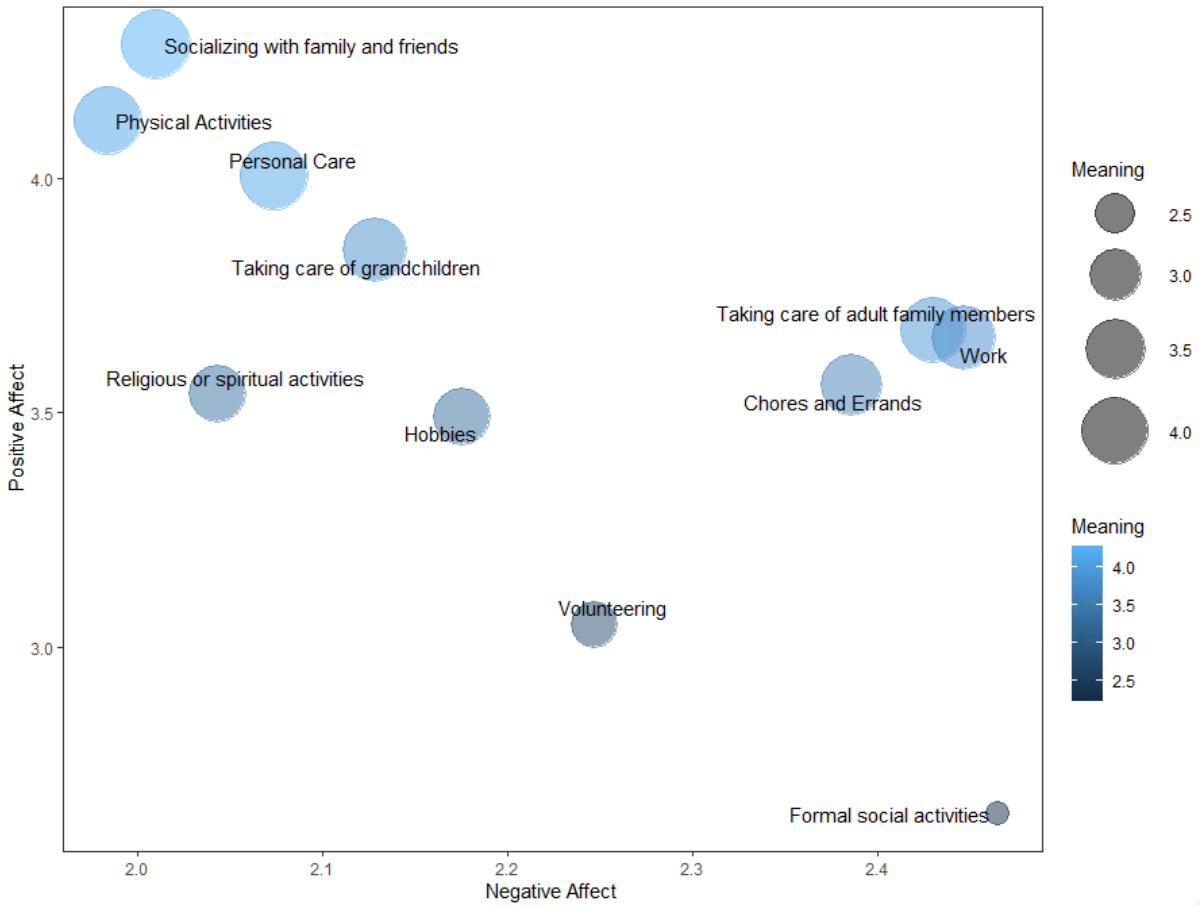
	… at +1 *SD*	0.59***	.05	.57	147.16	< .001
Activity Goal Focus	*Negative Affect*					
… at mean	… at −1 *SD*	0.67***	.04	.64	365.39	< .001
	… at mean	0.65***	.03	.62	496.46	< .001
	… at +1 *SD*	0.62***	.04	.59	281.01	< .001
Activity Goal Focus	*Negative Affect*					
… at +1 *SD*	… at −1 *SD*	0.64***	.05	.62	195.72	< .001
	… at mean	0.64***	.04	.62	250.48	< .001
	… at +1 *SD*	0.65***	.05	.62	148.21	< .001

Note. For activity goal focus, lower (higher) scores correspond to a prioritization of knowledge (emotion) goals. Exchangeable correlation structure was specified for the working correlation matrix.

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

Figure 1

Activities' Meaningfulness and Enjoyableness for Older Adults (Study 1)



Note. This figure displays the extent of positive affect, negative affect, and meaningfulness experienced from each activity category. The extent of meaning is denoted both by the size (i.e., larger points = higher meaning) and shade (i.e., lighter shade = higher meaning) of the point.

Figure 2

Conceptual Model for Hypothesis 1

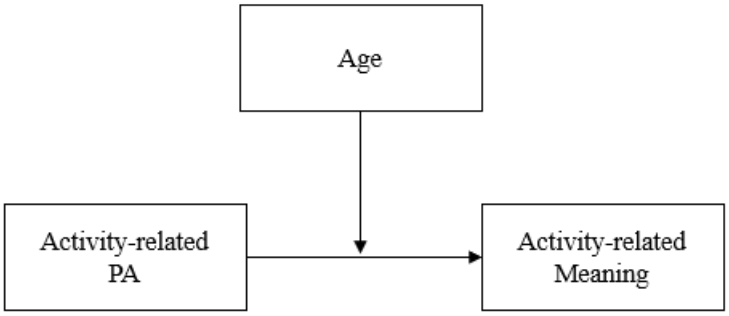
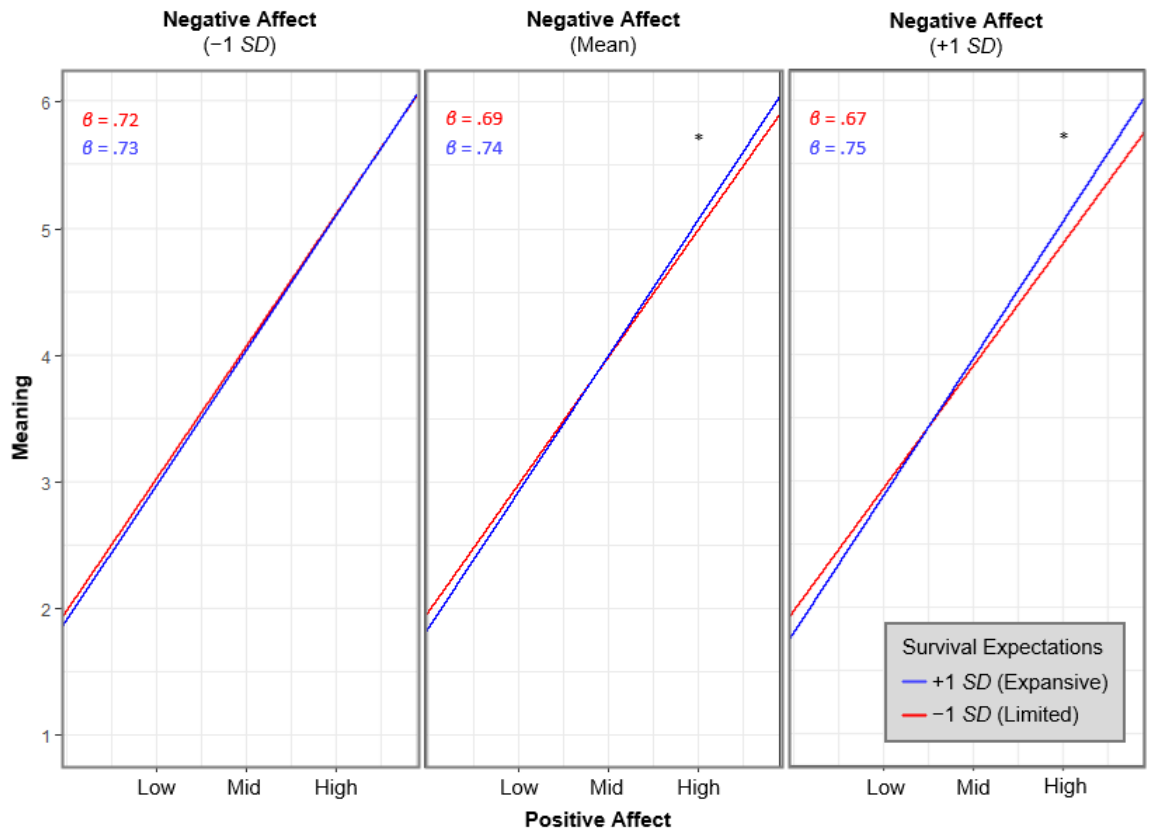


Figure 3

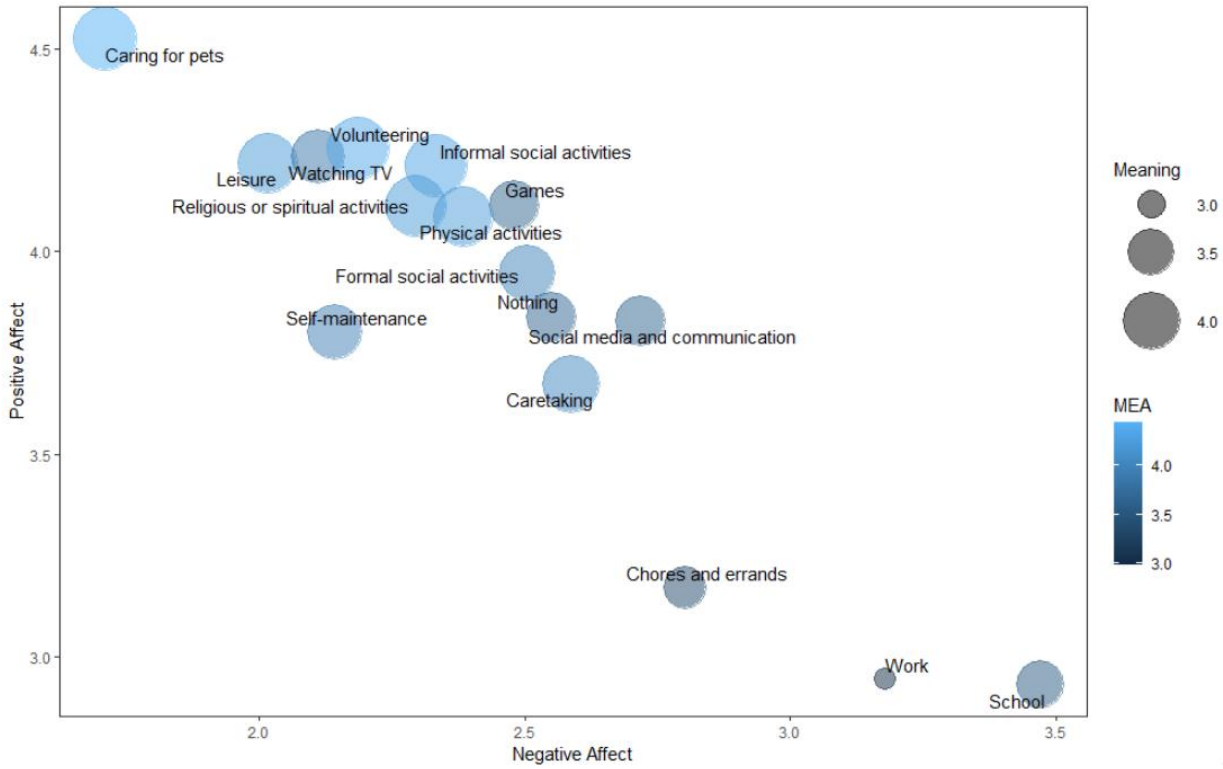
Simple Slopes of Activity-Related PA on Activity-Related Meaning at Different Levels of Survival Expectations when Activity-Related NA is High/Average/Low (Study 1, H_4)



Note. The x-axis is scaled from 1 (left) to 6 (right). The tick marks – low, mid, high – correspond to the point when PA is equal to −1 *SD*, mean, and +1 *SD*. The * character on the plot indexes a statistically significant simple effect of survival expectations at the corresponding level of PA.

Figure 4

Activities' Meaningfulness and Enjoyableness for Younger Adults (Study 2)



Note. This figure displays the extent of positive affect, negative affect, and meaningfulness experienced from each activity category. The extent of meaning is denoted both by the size (i.e., larger points = higher meaning) and shade (i.e., lighter shade = higher meaning) of the point.

Figure 5

Conceptual Model for Hypothesis 5

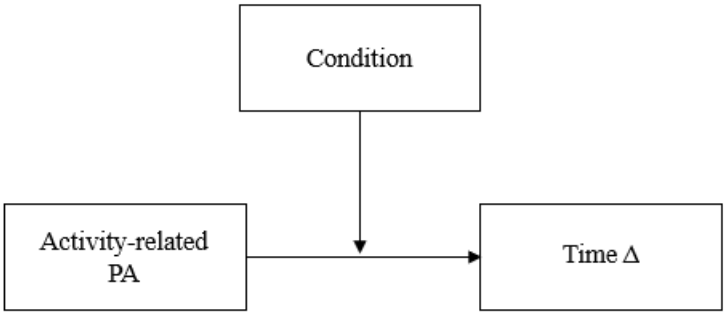


Figure 6

Conceptual Model for Hypothesis 6

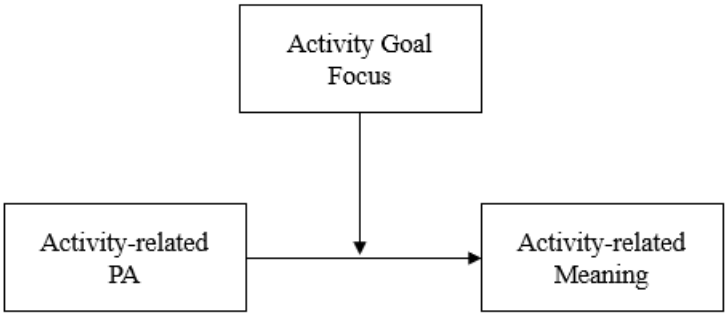
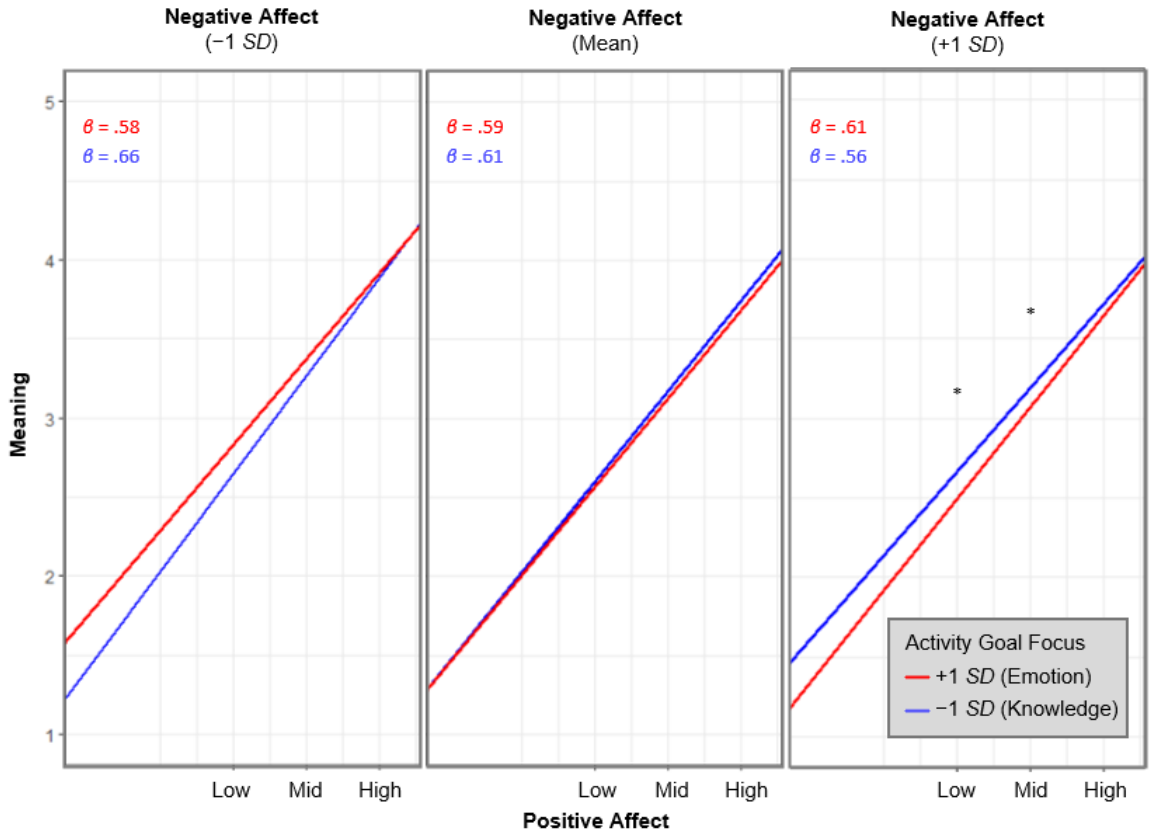


Figure 7

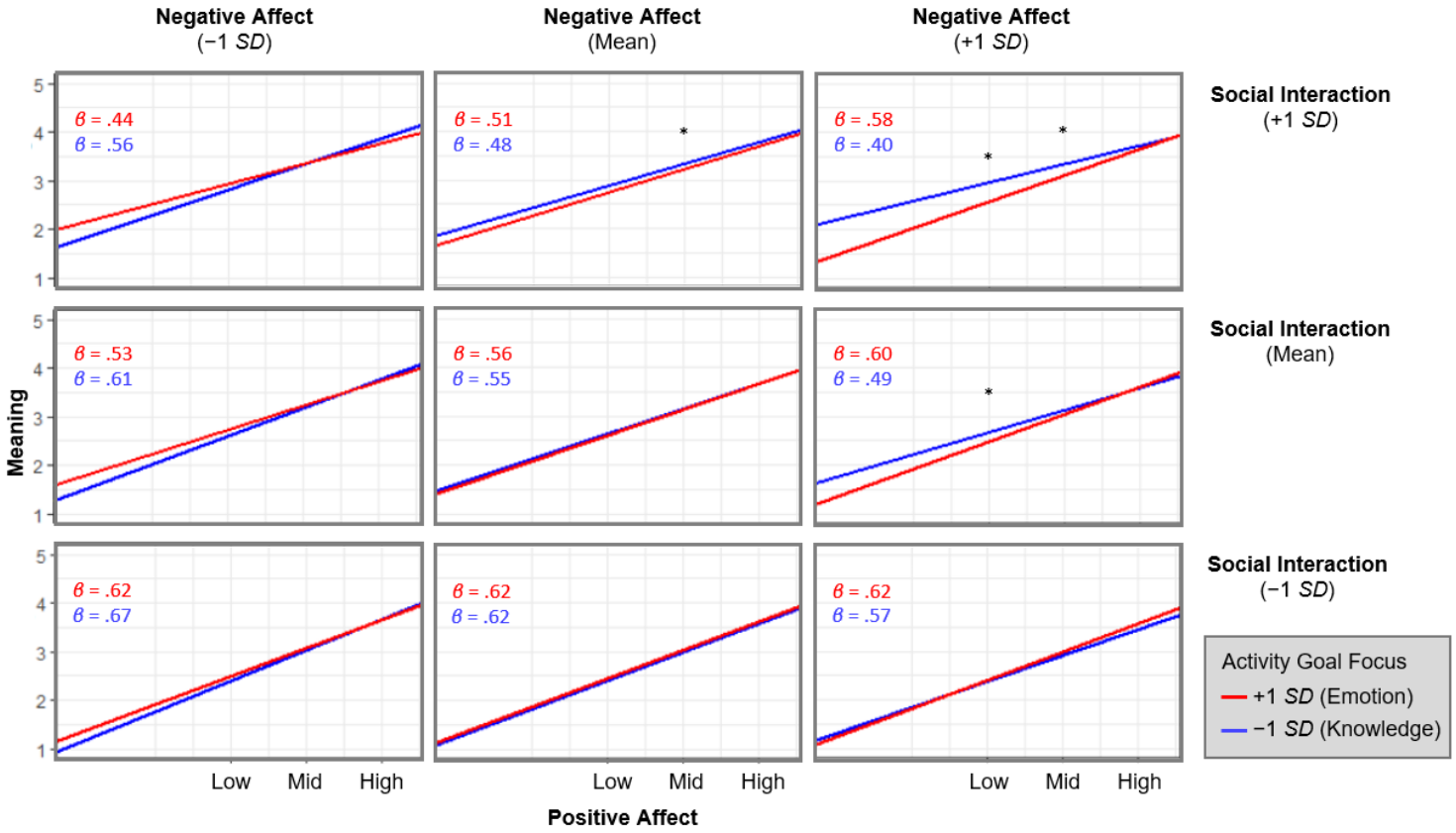
Simple Slopes of Activity-Related PA on Activity-Related Meaning at Different Levels of Activity Goal Focus when Activity-Related NA is High/Average/Low (Study 2, Additional Analyses)



Note. The x-axis is scaled from 1 (far left) to 6 (far right). The tick marks (low, mid, high) correspond to the point when PA is equal to −1 *SD* (2.89), mean (3.79), and +1 *SD* (4.69). The * character on the plot indexes a statistically significant ($p < .05$) simple effect of activity goal focus at the corresponding level of PA.

Figure 8

Simple Slopes of Activity-Related PA on Activity-Related Meaning at Different Levels of Activity Goal Focus when Activity-Related NA is High/Average/Low for Social and Non-Social Activities (Study 2, Additional Analyses)



Note. The x-axis is scaled from 1 (far left) to 6 (far right). The tick marks (low, mid, high) correspond to the point when PA is equal to −1 *SD* (2.89), mean (3.79), and +1 *SD* (4.69). The * character on the plot indexes a statistically significant ($p < .05$) simple effect of activity goal focus at the corresponding level of PA.

Appendix A (Study 1: Measures and Stimuli)

Big Five Inventory (John & Srivastava, 1999)
On a scale of 1 to 5, where 1 indicates strongly disagree and 5 indicates strongly agree, please rate how agreeable you are with the following statements:

1	2	3	4	5
strongly disagree	disagree	neither agree nor disagree	agree	strongly agree

Item stem:
I am someone who…

Extraversion

1. Is talkative
2. Is reserved (R)
3. Is full of energy
4. Generates a lot of enthusiasm
5. Tend to be quiet (R)
6. Has an assertive personality
7. Is sometimes shy, inhibited (R)
8. Is outgoing, sociable

Neuroticism

1. Is depressed, blue
2. Is relaxed, handles stress well (R)
3. Can be tense
4. Worries a lot
5. Is emotionally stable, not easily upset (R)
6. Can be moody
7. Remains calm in tense situations (R)
8. Gets nervous easily

Note. (R) Reversed.

Meaning in Life
During the past month, how often did you experience a sense of meaning and purpose in your life?

1	2	3	4	5	6
none of the time	a little of the time	some of the time	a good bit of the time	most of the time	all of the time

---

Revised Life Orientation Test – Modified from Scheier et al. (1994)
On a scale of 1 to 6, where 1 indicates strongly disagree and 6 indicates strongly agree, please rate how agreeable you are with the following statements:

1	2	3	4	5	6
strongly disagree	disagree	slightly disagree	slightly agree	agree	strongly agree

1. In uncertain times, I usually expect the best.
2. If something can go wrong for me, it will. (R)
3. I'm always optimistic about my future.
4. I hardly ever expect things to go my way. (R)
5. I rarely count on good things happening to me. (R)
6. Overall, I expect more good things to happen to me than bad.

Note. (R) Reversed. The original scale included 4 filler items, which was excluded here. The scale has also been modified to use a 6-point (rather than 5-point rating scale).

Survival Expectations
What is the percent chance that you will live to be **[age]** or more? Remember "0" means there is absolutely no chance and "100" means that you are absolutely certain.

- For participants below 65 years old, **[age]** = 75
- For participants between 65 and 69 years old, **[age]** = 80
- For participants between 70 and 74 years old, **[age]** = 85
- For participants between 75 and 79 years old, **[age]** = 90
- For participants between 80 and 84 years old, **[age]** = 95
- For participants between 85 and 89 years old, **[age]** = 100
- For participants between 90 and 94 years old, **[age]** = 105

Self-Rated Health

Self-rated health was assessed using a composite variable comprised of 3 measures.

a) **Subjective Health**

Would you say your health is:

1	2	3	4	5
poor	fair	good	very good	excellent

b) **Physical Health** (assessed using chronic conditions)

Has a doctor ever told you that you have any of the following conditions? Please check all that apply.

1. Hypertension
2. Diabetes
3. Cancer
4. Heart problems
5. Stroke
6. Arthritis

c) **Mental Health** (assessed using depression indicators)

Below is a list of some ways you may have felt or behaved. Please indicate how often you have felt or behaved this way during the last week by checking the appropriate space.

1	2	3	4	5	6
none of the time	a little of the time	some of the time	a good bit of the time	most of the time	all of the time

1. I felt stressed
2. I felt sad
3. I felt happy (R)
4. I felt lonely
5. I had a fear of the worst happening

Note. (R) Reversed.

Appendix B (Study 1: Activity-Related Feelings)

Part 1: Most meaningful activity

We would like to understand the types of activities that bring people a sense of meaning and purpose in their lives. Below is a list of activities that many older adults may do in their daily life. Please review the list and think about the activities that apply to you. Which of these activities do you find MOST meaningful and important to you personally?

Select one activity:

1. **Personal care**: (e.g., using the washroom, bathing, dressing)
2. **Chores and errands**: (e.g., cooking, washing, cleaning, household repairs, grocery shopping)
3. **Physical activities:** (e.g., exercise, walking, tai chi, playing sports)
4. **Hobbies**: (e.g., playing an instrument, art, crafts, reading books, gardening, mobile/tablet games)
5. **Work**: (e.g., full-/part-time work, self-employment)
6. **Taking care of grandchildren**
7. **Taking care of adult family members**: (i.e., those who need help caring for themselves)
8. **Socializing with family and friends**: (e.g., having meals together, chatting in person or by phone/video chat)
9. **Formal social activities**: (e.g., events organized by community clubs, community centres, etc.)
10. **Religious or spiritual activities**: (e.g., prayer, meditation, preparing offerings)
11. **Volunteering**: (e.g., helping out at community clubs or residents committee, helping neighbors or others in the community)
12. **Other** (please specify) _____

How purposeful and personally meaningful is it for you to engage in this activity?

1	2	3	4	5	6
not at all	very little	somewhat	moderately	very much	extremely

When you engage in this activity, how often do you experience the following feelings?

1. Positive feelings (e.g., happy, relaxed, contented, etc.)
2. Negative feelings (e.g., unhappy, uncomfortable, irritated, etc.)

1	2	3	4	5	6
none of the time	a little of the time	some of the time	a good bit of the time	most of the time	all of the time

---

Part 2: Least meaningful activity

Next, we would like to know which activity you feel is LEAST meaningful or important for you personally. If you feel that all of your daily activities are important, try to select one that is less meaningful compared with the others. <u>This should be an activity that you actually do at least once in a while if not every day</u>.

[See part 1 for follow-up questions.]

Appendix C (Study 2: Measures and Stimuli)

Big Five Inventory (John & Srivastava, 1999)

Same as in Study 1 but includes an additional attention check item.

Meaning in Life

Same as in Study 1 but assesses meaning in the past year (instead of in the past month).

Revised Life Orientation Test (Scheier et al., 1994)

On a scale of 1 to 5, where 1 indicates strongly disagree and 5 indicates strongly agree, please rate how agreeable you are with the following statements:

1	2	3	4	5
strongly disagree	disagree	neither agree nor disagree	agree	strongly agree

1. In uncertain times, I usually expect the best.
2. If something can go wrong for me, it will. (R)
3. I'm always optimistic about my future.
4. I hardly ever expect things to go my way. (R)
5. I rarely count on good things happening to me. (R)
6. Overall, I expect more good things to happen to me than bad.

Note. (R) Reversed. The original scale included 4 filler items, which was excluded here. An additional attentional check item was included.

Activity Goal Focus

In your daily life, do you prefer to engage in activities that are:

(1) knowledge-driven (involve learning new things but are not necessarily enjoyable)
OR
(2) emotion-driven (enjoyable but may not necessarily involve learning new things)

1	2	3	4	5	6
only knowledge-driven	mostly knowledge-driven	slightly knowledge-driven	slightly emotion-driven	mostly emotion-driven	only emotion-driven

Appendix D (Study 2: Time-Use Survey)

Part 1: Time-Use (Actual)

On a typical **weekday** and **weekend** (single day during a weekend), how much time do you spend on the following activities?
Important! The amount of time should add up to 24 hours (for both weekday and weekend).
Note. Responses are provided in increments of 15 minutes.

List of activities:

1. **Sleeping**
2. **Self-maintenance activities**: *Self-maintenance and personal care activities (e.g., using the washroom, bathing, dressing, grooming)*
3. **Chores and errands**: *Household chores (e.g., cooking, washing, cleaning, household repairs) and running errands (e.g., grocery shopping, water the plants)*
4. **Informal caretaking/caregiving duties:** *Taking care of family members (e.g., spouse, parents, siblings, children, relatives) with a health problem, long-term illness, or disability*
5. **Caring for and playing with pets**: *Time spent with household pets (e.g., cleaning, changing housing materials, going on walks, playtime, veterinarian visits, etc.)*
6. **School activities**: *Time spent in lectures and classes, completing assignments, group projects, etc.*
7. **Work (and travel to work)**: *Full-/part-time work, self-employment (include time spent travelling to work)*
8. **Informal social activities**: *Face-to-face contact with family members and close friends*
9. **Formal social activities**: *Participation in activities organized by a formal group (e.g., co-curricular activity groups in school, hobby groups, religious services), exclude volunteering*
10. **Digital communication and social media use**: *Communicating with people digitally using messaging applications (e.g., Telegram, Whatsapp), phone/video calls, and use of social media networking sites/apps (e.g., Instagram, Facebook, Twitter)*
11. **Leisure activities**: *Reading (e.g., books or news, **exclude school-related readings**), hobbies-related activities (e.g., artistic activities, musical activities)*
12. **Watching TV or movies:** *Includes streaming services (e.g., YouTube, Netflix, Disney+, Amazon Prime)*
13. **Playing electronic games**: *Electronic games on PC, mobile, or other consoles (e.g., Playstation, Nintendo Switch)*
14. **Physical activities**: *Light/moderate-intensity physical activities (e.g., stretching, brisk walking, jogging, yoga, hiking) and high-intensity physical activities (e.g., long-distance running, basketball, cycling, swimming, soccer, badminton)*
15. **Private religious or spiritual activities**: *Private religious activities (e.g., prayer, meditation), religious practices (e.g., preparing offerings) etc.*
16. **Volunteering**: *(e.g., food distribution drives, vaccination drives, helping out at old folks' homes, befriending, etc.)*
17. **Doing nothing**: *Time spent not doing anything in particular (e.g., unwinding, daydreaming)*

Part 2: Time-Use (Motivated)

Imagine that you can plan your time usage for a typical **weekday** and **weekend** (single day during a weekend) in the next week. How much time would you like to spend on each of these activities?
Important! The amount of time should add up to 24 hours (for both weekday and weekend).
Note. Responses are provided in increments of 15 minutes.

List of activities:

See Time-Use (Actual).

Part 3: Time-Use (Follow-Up Questions)

On a scale of 1 to 5, where 1 indicates strongly disagree and 5 indicates strongly agree, please rate how agreeable you are with the following statements for this activity: *[Activity]*

1	2	3	4	5
strongly disagree	disagree	neither agree nor disagree	agree	strongly agree

1. This activity is **meaningful** to me.
2. I experience **positive feelings** during this activity.
3. I experience **negative feelings** during this activity.
4. This activity involves interacting with other people.

Appendix E (Study 2: Mental Imagery Task)

Part 1: Mental Imagery Training (adapted from Holmes et al., 2008)

In the following exercise, you will imagine yourself in different scenarios. Mentally picture yourself in these scenarios and think about the experience from a **first-person perspective**. Let's start with a simple one.

To better immerse yourself in these scenarios, you can engage your different senses. For example, you can think about what you can see and hear, what you are feeling, and who the other people are in these scenarios (if applicable).

In this scenario, you will think about interacting with a lemon. To get a more vivid mental imagery, try the following:

1. Engage your different senses: What can you see? What can you hear?
2. Think about what you are *feeling*: Are you hungry? Happy? Or upset?
3. Flesh out the other people in the scenario. It does not matter if you do not know them – think about them *as if* you do.

There is no time restriction for this task, but it is recommended that you take between 60 and 120 seconds to fully immerse yourself in each scenario.

Stimuli:
I would like you now to imagine now that you are standing in your kitchen now.

Look around and glance at the walls, cabinets, countertops, and down at the floor.

Imagine the different appliances that are in this kitchen – the refrigerator, stove, oven, and dishwasher.

Now bring your gaze to the countertop. Notice that there is a wooden cutting board with a bright yellow lemon sitting on top of it. Make your way towards the countertop and stand in front of the cutting board.

Pick up the lemon and wrap your hands around it – notice how the lemon feels in your hand.

Bring the lemon closer to your face – notice how the skin looks.

Put the lemon down on the cutting board. Now pick up the kitchen knife beside the cutting board with your hand.

Holding the lemon steady in your other hand, cut the lemon in half.

Notice how it feels as the knife slices through the lemon.

As the lemon falls apart, think about the zesty smell that fills the air.

Now take one half of the lemon and cut it again, making a quarter-size slice.

Put the knife down and bring the lemon quarter closer to your face.

Now, bite into the lemon.

Part 2: Mental Imagery Scenarios (adapted from Tanaka, 2019)

Now that you have completed the previous scenario, you will move on to imagine a few more scenarios. Unlike the lemon scenario you have just imagined, the next few scenarios are about hypothetical situations that you may encounter in the future.

You may find that some of these scenarios are more difficult to visualize than others, but you should try – as much as you can – to imagine what it would be like to be in these situations. Again, you should think about the experience from a **first-person perspective** (e.g., What can you see and hear? How are you feeling? Who are the other people in the scenario?)

There is no time restriction for this task, but it is recommended that you take between 30 and 60 seconds to fully immerse yourself in each scenario.

Stimuli:
Expansive Time Horizon (Short-Term Future Scenarios)

No.	Valence	Scenario
1	Negative	You are on your way to school, but the traffic seems especially congested today.
2	Positive	Your classmate just gave you a note that reads: "Thank you for being an amazing friend!"
3	Negative	Your professor asked you to share your thoughts on today's assigned reading. However, you have not read it.
4	Positive	You make plans with your classmates to watch a movie and have dinner together after classes today.
5	Negative	You are hungry after a long day of lectures today. However, every store in the food court has extremely long queues.
6	Positive	Your crush is joining you and your classmates for dinner tonight. You think about what you will say later.
7	Negative	You have been unable to get much work done on your school assignments this week as you just recovered from a high fever.
8	Positive	The results for the mid-term examinations were just released. You scored 94% – the highest among your classmates.
9	Negative	You forgot to lock the front door when you left for school today. Your parents are extremely angry.
10	Positive	You got home and found your parents waiting to celebrate your birthday with you. What a joyful occasion!

Limited Time Horizon (Long-Term Future Scenarios)

No.	Valence	Scenario
11	Negative	You are sending your daughter to her first day at university, but the traffic seems especially congested today.
12	Positive	Today is the annual department staff retreat. As the manager of your department, you were hoping that the retreat would improve staff morale.
13	Negative	Today is your 30th wedding anniversary, but you have to stay late in the office. You consider whether to cancel dinner plans with your spouse.

14	Positive	You are going to have dinner with your son and his fiancée tomorrow. It seems like a good opportunity to get to know her more.
15	Negative	After working in the company for more than fifteen years, you have just been retrenched due to rising operating costs.
16	Positive	At a gathering with ex-classmates, everyone seems to be talking about their children or grandchildren. You think about how fast time seems to pass.
17	Negative	You just received a call from staff at your grandson's school informing you that he has gotten into a fight.
18	Positive	Your best friend's son is getting married this weekend. You start shopping for a wedding gift.
19	Negative	Your daughter is hoping to enrol for studies in a university overseas. You have not been able to come to an agreement with your partner about whether she should pursue her studies so far away from home.
20	Positive	You got home and found your family waiting to celebrate your birthday with you. Your grandchildren seemed especially excited. What a joyful occasion!

Part 3: Vividness of Mental Imagery

How vividly were you able to imagine the scenario in your mind?

1	2	3	4	5
not at all vivid	slightly vivid	vivid	very vivid	extremely vivid

Appendix F (Study 2: Scrambled Sentences Task)

Scrambled Sentences Task (adapted from Demeyer & De Raedt, 2014)

In the following section, you will be given a list of scrambled words.

Your task is to form grammatically correct sentences from this list of scrambled words by omitting one word from the list.

Example
You can form two different 6-word sentences from the following list of 7 words:
about / future / think / often / I / seldom / the

Sentence 1: I *often* think about the future. → *"seldom"* omitted
Sentence 2: I *seldom* think about the future. → *"often"* omitted

First, we will start with a practice question to get you familiarized with the task.

When you are ready, click on the → button.

Important!
You will have 5 minutes to form 10 complete sentences. During the task, you will also be given a 3-digit number to remember. This number can only be inputted at the end of the task. Please keep this number in your mind and **do not** write down the number anywhere else.

Word Count	**Unscrambled**	**Scrambled (Stimuli)**
5	My prospects are limited/unlimited.	prospects/limited/are/my/unlimited
6	I experience time as limited/unlimited.	experience/unlimited/time/I/limited/as
6	Few/many prospects are awaiting me.	are/few/awaiting/prospects/many/me
6	Few/many opportunities are awaiting me.	are/many/awaiting/opportunities/few/me
7	My future seems finite/infinite to me.	future/me/finite/to/my/infinite/seems
7	My life ahead is not/very important.	life/important/very/is/my/not/ahead
7	My future is void/full of possibilities.	future/possibilities/void/of/my/full/is
8	Most of my life is behind/before me.	of/is/before/life/most/behind/my/me
8	I expect few/many opportunities in the future.	expect/the/few/in/I/many/opportunities/future
8	It is important to have attainable/many goals.	is/have/many/to/it/attainable/important/goals

Scoring:
Sentences formed with limited (red) words are scored 1, while sentences formed with expansive (green) words are scored -1. Higher scores indicate a more limited time horizon.