Adult Age Differences in Remembering Gain- and Loss-Related Intentions

Sebastian S. Horn and Alexandra M. Freund

University of Zürich

Author Note

Sebastian S. Horn, Department of Psychology, University of Zürich, Switzerland. Alexandra M. Freund, Department of Psychology, University of Zürich, Switzerland and Research Priority Program Dynamics of Healthy Aging.

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Correspondence concerning this article should be addressed to Sebastian S. Horn, University of Zürich, Department of Psychology, Binzmühlestr. 14 Box 11, 8050 Zürich, Switzerland. Email: horn@psychologie.uzh.ch

Abstract

Motivational and emotional changes across adulthood have a profound impact on cognition. In this registered report, we propose an experimental investigation of motivational influence on remembering intentions after a delay (prospective memory; PM) in younger, middle-aged, and older adults, using gain- and loss-framing manipulations. The current study will examine for the first time whether motivational framing in a memory task has different effects on younger and older adults' performance in a controlled laboratory setting. Based on lifespan theories of motivation, we assume that the prevention of losses becomes more relevant with increasing age: We expect that older adults show higher PM performance in a task with loss-related consequences following PM failure than in a task in which successful PM leads to gains. The opposite pattern of performance is expected for younger adults. Thus, age differences in memory performance may be moderated by gain-loss framing that corresponds with people's motivational orientation. Alternative theoretical views about the interplay between cognitive and emotional variables are also discussed.

Keywords: Gains and losses, cognitive aging, motivational and emotional orientation, lifespan psychology, prospective memory.

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A key proposition of lifespan psychology is that human development, at any point in life, involves both gains and losses in various domains, such as cognitive functioning, physical health, and social relationships (Baltes, 1987). However, the relative frequency of gain-related and loss-related events changes across adulthood: Younger adulthood is a period with a broad and growing range of developmental opportunities, in which gains predominate, whereas losses and resource limitations become increasingly pertinent in older adulthood (Baltes, Lindenberger, & Staudinger, 2006). Hence, the overall ratio of gains to losses becomes smaller and less favorable with increasing age. There is also agreement among adults of different ages in their expectations of prevailing gains in younger adulthood and increasing losses in later adulthood (Heckhausen, Dixon, & Baltes, 1989; Mustafic & Freund, 2012). Correspondingly, people's goal orientation appears to shift from a predominant focus on achieving gains in younger adults towards an increased importance of maintenance in middle-aged adults and loss avoidance in older adults (Ebner, Freund, & Baltes, 2006; Freund, 2006; Ogilvie, Rose, & Heppen, 2001; Heckhausen, 1999; Staudinger, Marsiske, & Baltes, 1995).

In the proposed research, we will investigate if and how gain- and loss-related consequences may affect memory for intended actions across adulthood. Based on a motivated-cognition perspective—which holds that motivational orientation guides perception, attention, and higher-order cognitive processes—we assume that age differences in motivational orientation systematically impact memory. In what follows, we first discuss findings about the relative impact of positive and negative consequences on younger and older adults' memory. We then sketch research on adult age differences in memory for intended actions. Finally, we describe the experimental approach that we will use to investigate memory for gain- and loss-related intentions in young, middle-aged, and older adults.

The Relative Impact of Gains and Losses on Remembering

Positive-Negative Asymmetries in Younger Adulthood

A wealth of research on human cognition and emotion suggests that people experience gains or losses as positive or negative changes that have different impact on behavior (e.g., Cacioppo & Berntson, 1994; Kahneman & Tversky, 1984; Rozin & Royzman, 2001). One important finding from this literature is that negative information often affects people more strongly than positive information (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Peeters & Czapinski, 1990). However, a notable exception from this pattern seems to be memory functioning: Based on extensive reviews of the literature, Matlin and Stang (1978) concluded that positive information is remembered better than negative information due to selective rehearsal and compensatory processes in long-term memory. Moreover, negative associations tend to be weaker and less common than positive associations; as memories fade, they decrease less strongly for positive than negative experiences. For these reasons, people remember positive information more easily and quickly than negative information (Taylor, 1991). The majority of the studies on positive-negative asymmetries in memory have been conducted with younger adults (mostly undergraduate students in their early twenties). In the next section, we consider the literature on positive-negative asymmetries in older adulthood.

Positive-Negative Asymmetries in Older Adulthood

Age-related differences in many cognitive processes, including learning, recognition, and recall, suggest that younger and older adults evaluate positive and negative information differently (Mather, Knight, & McCaffrey, 2005; Spaniol, Voss, & Grady, 2008; for overviews, see Murphy & Isaacowitz, 2008; Scheibe & Carstensen, 2010). Based on the literature, two different patterns regarding the relative impact of gain- and loss-related consequences could be expected: Following a *loss-prevention view*, older adults' motivational orientation towards the prevention of losses might result in higher sensitivity to negative than positive information when information has to be remembered. This appears to be the case particularly when a motivational component is involved in the task, as is the case when remembering has a decision- or action-relevant function and when there is an opportunity of actually avoiding negative or achieving positive consequences (Depping & Freund, 2013). Alternatively, *socioemotional selectivity theory* suggests that, as future time perspective decreases across adulthood, people become increasingly motivated to optimize their affective well-being. To the extent that goals associated with emotional meaning and well-being become more salient with increasing age, older adults might remember more positive or less negative information than younger adults (e.g., Mather & Carstensen, 2005). Both perspectives have received empirical support (for overviews, see Depping & Freund, 2011; Freund, Mustafic, & Hennecke, 2012; Murphy & Isaacowitz, 2008; Scheibe & Carstensen, 2010) and suggest that changes in motivational orientation during adulthood impact cognition. Given the strong motivational component in prospective memory (see below), it is surprising that there are no studies of age-related differences in remembering intentions that either lead to positive consequences or prevent negative ones. The aim of the current study is to address this issue.

Cognitive Aging and Remembering Intentions

In the present research, we focus on the influence of goal orientation on memory for intended actions (prospective memory; PM). PM always involves the retrieval of an intention as part of a goal-directed, declarative plan (e.g., Cohen & Hicks, 2017; Kliegel, McDaniel, & Einstein, 2008; Smith, 2008). Therefore, motivational orientation likely plays a central role in

PM tasks. Its inherent future orientation could make PM particularly sensitive to motivational influence and to information about looming losses or gains—perhaps more than other memory tasks. However, the role of motivational orientation in PM is unclear. Our central assumption is that changes in motivational orientation across adulthood may explain performance differences in memory for gain- and loss-related intentions. Specifically, the degree to which PM intentions are relevant for people of different ages should reflect their prior motivational orientation. Based on this thesis, we aim to address the following research questions: With increasing age, are intentions associated with prevention of losses better remembered than intentions associated with the promotion of gains? Does goal orientation have similar impact on PM as it has in other tasks with different measures (e.g., self-report measures; Ebner et al., 2006; persistence; Freund, 2006)? How do cognitive processes involved in PM reflect these motivational changes?

The cognitive processes underlying age differences in PM have been extensively investigated (Einstein & McDaniel, 1990; Henry, MacLeod, Phillips, & Crawford, 2004; Maylor, Darby, Logie, Della Sala, & Smith, 2002; Smith & Bayen, 2006; Uttl, 2008; Zimmermann & Meier, 2006). The predominant finding from laboratory studies is that younger adults outperform older adults in time-based PM tasks (remembering to perform an intended action at a specific clock time; e.g., “attend a meeting at 2 p.m.”) and event-based PM tasks (remembering to perform an action when a target event occurs; e.g., “buy bread when you pass the supermarket”). The magnitude of adult age differences in PM depends on task characteristics. Age differences are usually smaller in PM tasks in which salient cues support retrieval and reduce strategic demands of monitoring the environment (Craik, 1986; Kliegel, Jäger, & Phillips, 2008; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997).

However, there are also important “noncognitive” factors that may influence age-related differences in PM, such as emotional and motivational changes. So far, surprisingly little is known about the role of age-related changes in motivational orientation for PM: Why are specific intentions perceived as more relevant and remembered more accurately than others by younger and older adults? Intentions related to personal goals are likely perceived as important and may thus yield good PM performance through beneficial encoding strategies, high accessibility, or facilitated retrieval from memory (e.g., Penningroth & Scott, 2007). So far, several studies have manipulated the importance of PM tasks in younger adults through instructions and found that importance increases PM performance (Kliegel, Martin, McDaniel, & Einstein, 2001; Smith & Hunt, 2014); moreover, a few studies of PM included monetary or non-material incentives (Aberle, Rendell, Rose, McDaniel, & Kliegel, 2010; Brandimonte, Ferrante, Bianco, & Villani, 2010; Cook, Rummel, & Dummel, 2015; Meacham and Singer, 1977; McCauley, McDaniel, Pedroza, Chapman, & Levin, 2009). In line with the assumption that the motivational intensity to reach a goal can be moderated by the magnitude of potential reward (Atkinson, 1957), these studies typically found that incentives increased PM performance (presumably through perceived importance) in younger adults (for an overview, see Walter & Meier, 2014). There is also initial evidence from this research that younger adults' PM performance increases in the presence of both reward and punishment, relative to non-incentivized control conditions (Cook et al., 2015). This work provides an important starting point for our proposed PM research on age differences in motivational orientation. As of yet, there are no attempts to link this line of research with lifespan theories of motivation and extend it to encompass the entire phase of adulthood.

The Current Study

In the current study, we will address the motivation-cognition interplay in the domain of

PM and conceptually bring together separated perspectives from cognitive, aging, and motivation research. The study will focus on gain- and loss-related consequences of remembering and forgetting intended actions. We plan to test central hypotheses about the motivational impact of gains and losses from a theoretical lifespan perspective, suggesting that intentions related with the maintenance/avoidance of losses are relatively better remembered than gain- or growth-related intentions by older adults (whereas a reversed pattern is expected for younger adults).

Aging research about specific valence effects has yielded mixed findings (e.g., varying preferences for positively or negatively valenced stimuli, dependent on the decision context and type of task; e.g., Depping & Freund, 2013; Murphy & Isaacowitz, 2008; see also Grühn, Smith, & Baltes, 2005). Moreover, little is known about the role of adult age differences in motivational orientation in PM. We therefore propose a preregistered study in a controlled laboratory setting to document our main predictions, our planned methods, and analyses in advance. We will use the standard experimental paradigm of event-based PM (Einstein & McDaniel, 1990) to examine the impact of motivational framing manipulations on PM. In the PM paradigm, participants are engaged in an ongoing activity (e.g., a lexical decision task) while they have to additionally remember to perform an intended action (PM task; e.g., press an atypical key) when a specific event occurs (e.g., when the word *tiger* appears). The PM task is embedded in an ongoing activity because PM in everyday life rarely occurs in isolation and successful execution of an intended action typically requires the interruption of other ongoing activities. For example, one may be riding the bike and attending to the traffic, but then has to remember to stop at the supermarket to buy bread on the way home from work.

To investigate how age differences in motivational orientation affect PM, our planned laboratory study will include two key predictor variables that are expected to influence PM: (a) participants' chronological age and (b) the type of consequence (gains following PM hits; or losses following PM misses). That is, participants between 18 and 85 years of age will experience gains and losses, contingent on their event-based PM performance. In a gain-frame condition, participants will be informed that successful PM will lead to gains (accumulation of money or points); by contrast, participants in a loss-frame condition will be instructed that PM failure will lead to losses (deduction of money or points). Thus, we will frame the consequences of PM success or failure in terms of gains or losses, respectively. Similar framing manipulations in the laboratory have been applied in PM research only with younger adults so far (Cook et al., 2015).

Instructional framing has robust impact on people's decision making (Kahneman & Tversky, 1984; Kühberger, 1998) and research has shown that framing can have lasting effects on health-related and financial behavior (McNeil, Pauker, Sox, & Tversky, 1982; for an overview, see Rothman & Salovey, 1997). Moreover, for younger adults, messages framed to be congruent with their motivational orientation have been found to be more effective in inducing desired behaviors than messages incongruent with their motivational orientation: When given loss-framed messages, avoidance-oriented people showed higher compliance than approach-oriented people (and vice versa with gain-framed messages; Mann, Sherman, & Updegraff, 2004; cf. Idson, Liberman, & Higgins, 2000). To the extent that motivational orientation changes across the lifespan from promotion of gains to prevention of losses, loss-framed manipulations may be more effective in older than younger adults, and vice versa with gain framed-manipulations.

Hypotheses

Based on the aforementioned considerations, we make the following predictions: Regarding PM performance as the main dependent variable (proportion of accurate responses on PM target events), we expect different effects of gain- and loss-framing on PM as a function of age: We thus hypothesize motivational framing × age interactions in PM performance (H_1). To the extent that older adults are more motivated to avoid losses than to achieve gains, they should be particularly sensitive to negative consequences and to show relatively better PM with loss-related than gain-related consequences. Alternatively, according to socioemotional selectivity theory and the related assumption of a positivity effect in older adulthood, older adults should show a stronger focus on positive than negative consequences, which would result in better PM with gain-related than loss-related consequences.

We further expect adult age differences in PM performance (H_2), based on previous cognitive aging research on PM (e.g., Kliegel et al., 2008; Smith & Bayen, 2006): Older adults in an event-based laboratory PM tasks are expected to show lower PM performance than younger adults; for middle-aged adults, we expect an intermediate pattern of PM performance, lying between younger and older adults. Notably, following a loss-prevention view, this also implies that age differences in PM are smaller for loss-related than gain-related intentions ($H_{3.1}$). Alternatively, following socioemotional selectivity theory and the related assumption of a positivity effect in old age, the age differences should show the reversed pattern, namely smaller age differences in PM for gain-related compared to loss-related intentions ($H_{3.2}$). These key predictions of motivational influence and cognitive aging on PM are schematically depicted in Figure 1. Finally, we expect that PM will be higher in groups with performance-contingent payoffs than in control groups, in which payoffs are not tied to performance, because motivational incentives typically enhance memory performance (H_4).

Regarding ongoing-task performance, we expect age-related slowing (H_5), which has been observed in many investigations of cognitive performance (Verhaeghen & Salthouse, 1997); this includes previous studies that focused on younger and older adults' ongoing-task response time and accuracy in the PM paradigm (e.g., Horn, Bayen, & Smith, 2013). That is, we expect older adults to respond slower in an ongoing task (lexical-decision task) than younger adults.

Method

Design

Our design will include the between-subjects factor *motivational framing*, with three levels (gains; losses; control). Participants will be randomly assigned to one of the three experimental groups with equal probability. Research on human memory in general and on PM in particular has often ignored the population of middle-aged adults. This is a missing pillar in much of the lifespan research on motivated cognition (Freund & Isaacowitz, 2013). Therefore, we will include middle-aged adults in the proposed study. To achieve a sufficiently homogenous age distribution, we plan to sample an equally large number of younger adults (18-35 years of age), middle-aged adults (36-65 years), and older adults (66-85 years) within each experimental group. Participants' chronological age will then be entered in regression analyses as continuous predictor variable (to avoid loss of information through categorizing the age variable), but in case of significant interactions, additional follow-up tests within the three age groups are also possible. No further covariates will be included in the analyses.

Participants and Sample Size

Participants will be native speakers of German with no cognitive impairments (e.g., dementia or stroke) and must be at least 18 years. We will collect data from communitydwelling older, younger, and middle-age adults through a laboratory database and additional recruitment at such locations as gyms or community centers. Participants will receive credit points or a flat fee for participation (CHF 15 per hour) plus a performance-contingent bonus (for more detail see below). If a participant's data cannot be used for analysis (see below for exclusion criteria), their data will be replaced (before hypothesis testing) by collecting data from a further participant to achieve the planned sample size.

Previous meta-analyses indicate that the magnitude of age effects in PM depend on task characteristics (Henry et al., 2004; Kliegel et al., 2008; Uttl, 2008). There is converging agreement from this literature that age differences in demanding laboratory PM tasks (which we plan to implement in the current study) are medium-to-large, with reported effect sizes of $d = .72$ (Kliegel et al., 2008), ds = .77 to 1.13 (Uttl, 2008), and $d = 0.87$ (Henry et al., 2004). Notably, the authors in these meta-analyses also evaluated potential publication biases: Kliegel et al. (p. 206) concluded that there was "no evidence of a potential confound (…) due to publication bias" in the considered studies. Regarding motivational incentive manipulations, previous experiments with younger adults also yielded medium-to-large effect sizes of $d = .80$ (Cook et al., 2015).

Based on our central prediction for the primary criterion variable (i.e., a motivational framing × age interaction in PM performance) we calculated the required total sample size in a multiple regression model (with age, motivational framing, and their interaction, as predictors of PM performance) detect interaction effects of size $r = .25$ (equivalent to an effect size of $d \approx 0.5$ or $f^2 \approx .06$) with a statistical power of .90, given an alpha level of .05. Given these settings, an a-priori power analysis with the software G*Power3 (Faul, Erdfelder, Lang, & Buchner, 2007) indicated a required total sample size of $N = 178$ participants to evaluate single regression coefficients (weights) using two-tailed t tests; moreover, with this sample size, it is possible to detect differences of $d = .50$ in PM performance between both treatment groups and the control group (as reference category) with a power of .90. Aiming at an equal number of younger adults, middle-age adults, and older adults in each of the three experimental groups, we plan to collect data from 180 participants. Notably, our power analysis assumes effects sizes that are ≈ 33% smaller than those reported in previous meta analyses (e.g., Kliegel et al., 2008). A visualization of achieved power as a function of sample size and population effect sizes is in the Supplemental Materials.

Procedures and Materials

Laboratory tasks. The basic procedure of the laboratory task is planned as follows: Participants first work on a short block of practice trials with feedback (30-50 trials) to familiarize themselves with an ongoing lexical-decision task. Overly slow or fast responding (i.e., below 0.2s or above 4s) will be discouraged by providing initial feedback (“too fast” or “too slow” messages). Following this practice phase, participants will first perform a block of a lexical-decision ongoing task alone (*baseline phase*). Participants then receive instructions for a PM task that differs depending on the experimental/motivational group. After a short filler delay (at least 2 min), participants then perform a block of an ongoing task in which PM target events occur (*ongoing + PM phase*). Finally, participants complete cognitive tests and questionnaires and will be asked which key they should press upon encountering a target event (action-recall check).

For the sake of reliability, we aim at a sufficient number of target events and at avoiding floor or ceiling PM performance (Kelemen et al., 2006); that is, we aim at avoiding mean PM performance in a condition below 10% or above 90% accuracy (cf. Uttl, 2008). In line with previous PM research, relevant target events will occur only on a small proportion of all ongoing-task trials (< 5%) to avoid a scenario that is similar to a vigilance test (e.g., Graf & Uttl, 2001). Hence, our ongoing tasks will be of sufficient length to avoid overly repetitive target appearances: We aim at a lower bound of 300 ongoing-task trials, equally interspersed between 12 PM target events. We will use a non-focal PM task in which the PM target events are defined by specific initial letters. Participants will be asked to press an atypical key whenever a presented string on the screen (word or nonword) begins with one of these letters (see the Supporting Information for an illustration). The detection of PM target events in such tasks is relatively demanding because the stimulus features that are relevant for target detection and for successful ongoing-task decisions do not overlap. Therefore, ceiling effects in PM performance are unlikely (e.g., Scullin, McDaniel, Shelton, & Lee, 2010). Moreover, to make the ongoing task sufficiently engaging, a relatively difficult stimulus composition in the lexical-decision task will be used: The task will include low- and very-low frequency words; nonwords will be created by randomly replacing only one vowel in a given word by another vowel. The proportion of correct lexical decisions in such tasks is typically below .90 (Horn & Bayen, 2015).

Motivational Manipulation. The PM instructions will differ between groups. Participants in a gain-frame group will be informed that they can accumulate money (up to 6 CHF)—contingent on the proportion of PM target events that they respond to correctly (*PM hits*). Participants in a loss-frame condition will be initially endowed with an amount of 6 CHF, from which losses can be deducted; participants in this condition will be informed that they can maintain their full starting amount, but that they would lose up to 6 CHF, contingent on the proportion of PM target events they would miss (*PM misses*). Finally, in a no-frame control group, participants receive standard PM instructions and an additional flat fee that is not contingent on PM performance (the typical situation in many previous PM experiments, in which only a fixed reimbursement was provided). This will allow us to evaluate baseline PM performance and to contrast people's intrinsic motivation to perform the PM task with conditions in which external consequences occur (cf. Brandimonte et al., 2010, for a study with young adults). Figure 2 shows an example of the basic instructions we will use to induce a motivational gain- or loss-framing. This basic procedure has been successfully tested in previous piloting work and a similar approach has also been taken in one study with younger adults (Cook et al., 2015).

Type of Payoff. Younger adults may sometimes care more about money, whereas non-monetary consequences may matter more for older adults (e.g., Freund & Blanchard-Fields, 2014); therefore, providing the same type of consequences for all participants can have different effects across age groups. To better match the subjective value of the same amount of payoff across age, we therefore apply a previously tested procedure in which participants may initially choose which amount (percentage) of the subsequent payoffs they wish to keep for themselves or to donate to a humanitarian organization (Doctors Without Borders; www.doctorswithoutborders.org) after the study. The goal is to best match the subjective importance of the performance-contingent payoffs. One reason for allowing optional choice between donations and direct monetary payments is that some participants (particularly older adults) in past studies expressed that they do not want to be financially reimbursed (see Freund & Blanchard-Fields, 2014). In order to use motivational incentives that are appealing to younger, middle-aged, and older adults, a flexible amount of earnings (i.e., between 0 and 100%) during the study can be optionally donated. Winning or losing a small amount of money (e.g., CHF 1) might not matter much to some study participants, but it may matter as a donation, given that CHF 1 can provide medical treatment of approximately six children suffering from malaria or two portions of additional nutrition for malnourished children. To stress the value of even small amounts gained or lost, participants will be informed about these facts before the study and earnings will be calculated and determine the actual donation later made to the charity.

Additional Variables and Cognitive Tests. We will collect additional variables to further describe and examine adult age differences in the samples. This will also allow us to explore individual differences and potential covariation between motivational, economic, and cognitive variables. The following information will be collected from the participants: basic demographic information (including information about chronological age, gender, ethnicity, wealth and yearly income); short measures of fluid cognitive abilities (digit-symbol substitution) and crystallized abilities (spot-a-word vocabulary test); brief scales of loss aversion (Gächter, Johnson, & Hermann, 2007) and social-value orientation (Murphy, Ackermann, & Handgraaf, 2011); personal goal orientation towards gains and losses (Ebner et al., 2006); baseline positive and negative mood (Watson, Clark, & Tellegen, 1988); a prospective and retrospective memory questionnaire (Smith, Della Sala, Logie, & Maylor, 2000). Moreover, we will include post-task memory questions about the required PM action and about the PM target items to check whether participants understood the instructions. As a manipulation check of the impact of framing instructions and of the perceived relevance of performance-contingent consequences, participants will provide importance ratings regarding (a) the perceived importance to perform the PM task accurately, (b) the personal relevance of performance-contingent consequences (i.e., of gaining or losing points), and (c) the perceived importance to perform the ongoing tasks accurately. Further information about additional variables collected in the study and about cognitive tests is in the Supporting Information.

Ethics and Open Science Policy. The study will not involve any deception. All participants will be reimbursed for their participation (flat fee) and monetary payoffs will be provided after study completion. The data from the study and analysis files will be made openly available through the Zenodo research data repository (https://zenodo.org/) and the Open Science Framework (OSF; https://osf.io/). Data will only be available in anonymized form in which participants' privacy is strictly maintained.

Planned Analysis

Data Exclusion. Data from participants who perform at chance level in the ongoing task will be excluded from analyses (i.e., if ongoing-task accuracy, averaged across trials, is statistically indistinguishable from chance). Moreover, we will exclude participants who never respond to any PM target event and additionally cannot indicate in a post-task instructional check the PM key they were asked to press when encountering a target. These exclusion criteria are common in PM research to ensure that participants are adequately engaged in an ongoing activity and that PM failure is not attributable to forgetting the required action or PM instructions (e.g., Smith & Bayen, 2006). Moreover, single ongoing-task trials with extreme response times will be discarded from data analysis (i.e., trials with response times more or less than 2.5 *SD*s from an individual's mean in a condition or fast guesses shorter than 0.2s).

Data Quality and Manipulation Checks. First, the analysis of ongoing-task performance will allow us to check whether participants perform the tasks with sufficient accuracy (the power for this check is sufficiently large, > .90, in each group). Second, we will test whether PM performance is significantly above floor (>10% mean accuracy) and below ceiling level (<90% mean accuracy). We will only test our hypotheses and make further conclusions if this check is passed. Third, participant's importance ratings of the PM task, of the ongoing task, and of performance-contingent consequences (i.e., of gaining or losing points) will be used to additionally evaluate the impact of the motivational manipulations. Finally, we include an additional control group in our design in which participants will not experience any external gain- or loss-related consequences (i.e., the standard situation in many previous cognitive PM experiments, in which only a fixed reimbursement was provided). This will allow us to evaluate baseline PM performance and to contrast people's intrinsic motivation to remember PM tasks across adulthood with conditions in which external monetary consequences occur.

Main Data Analyses and Hypothesis Testing. We will statistically test our hypotheses in the following way: Regarding PM performance as dependent criterion variable (proportion of correct PM responses on target events), we will specify a linear multiple regression model with motivational framing (gain; loss; control) as effect-coded predictor and chronological age as mean-centered continuous predictor. The corresponding regression weights can then be evaluated with standard *t*-tests: First, to test hypothesis H_1, the weight of the framing × age interaction in the regression model is examined; in case of a significant framing × age interaction ($p < .05$), we conduct follow-up tests. These follow-up tests are implemented by examining, within the group of younger adults (18-35 years), middle-aged adults (36-65 years), and older adults (66-85 years), respectively, whether gain-framing leads to a relative advantage in PM over loss-framing, or vice versa. Second, hypothesis H_2 is supported if the regression weight of age in the model is significant. Hypothesis H_3 can be tested by examining effects of age separately for gain and loss conditions. Finally, a planned contrast between both treatment groups and the control group (as reference category) can test hypothesis H_4. Regarding ongoing-task performance, we will specify a linear multiple regression model with participants' median response time (aggregated across trials of each person) as dependent criterion variable. Again, motivational framing (gain, loss, control) and age will be entered as categorical and continuous predictors, respectively. If there is age-related slowing in ongoing-task performance (hypothesis H_5), then the effect of age in the regression model must be significant. A separate regression model (including the same predictors) will be specified to evaluate participants' ongoing-task accuracy (mean proportion of correct lexical decisions) as criterion.

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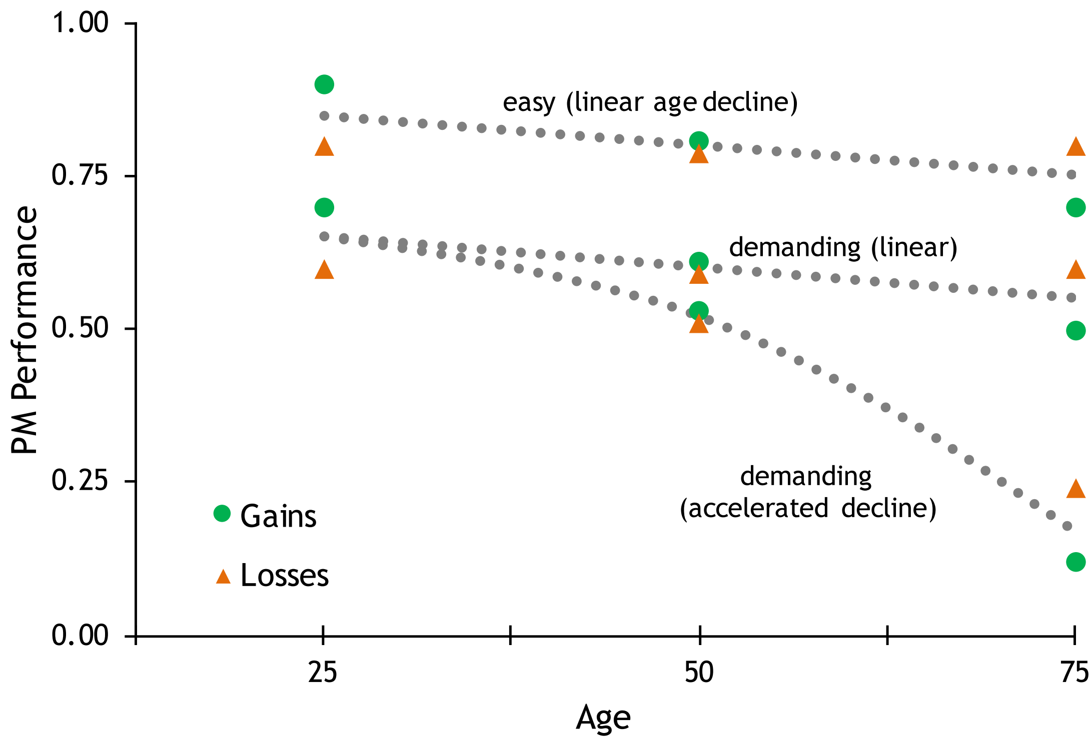

Figure 1. Schematic illustration of PM performance as a function of chronological age for intentions with gain-related (green) and loss-related (orange) consequences from a loss-prevention view. Three hypothetical performance trajectories (grey dashed lines) are shown: Linear age-related decline in cognitively less demanding and more demanding PM tasks (e.g., event-based vs. time-based PM tasks). For tasks with accelerated age-related decline (that have been reported for complex PM tasks in particular), larger age differences in PM performance are conceivable. However, following the predictions of the loss prevention view, a relative advantage for loss-related over gain-related PM in older adulthood is expected. In all scenarios, motivational framing × age interactions are expected.

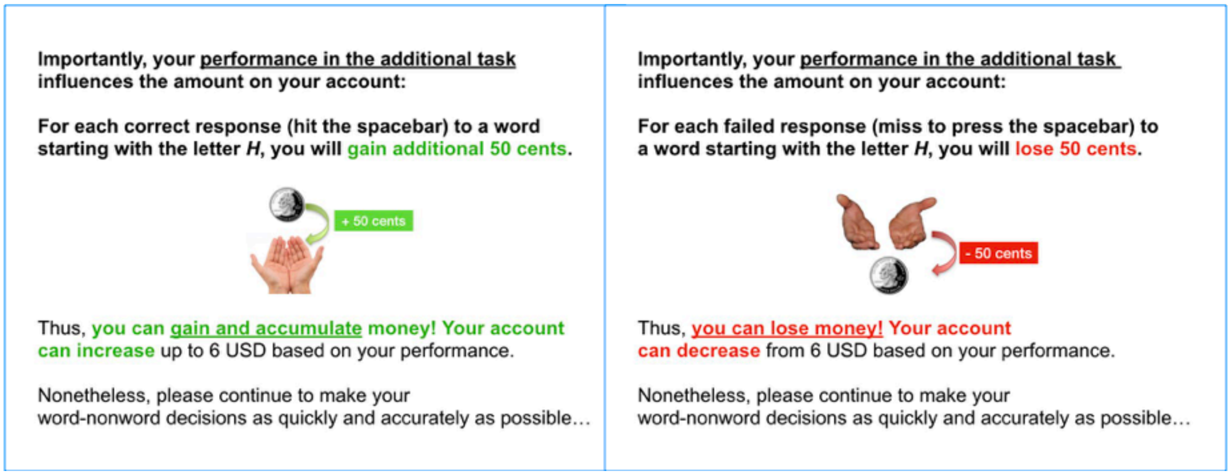

Figure 2. Example instructions for an event-based PM task inducing a gain frame (left) or a loss frame (right). The magnitude of performance-contingent payoffs will be held identical, but the consequences and framing in terms of gaining or losing after remembering or forgetting to respond to target events, respectively, will be manipulated.