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Everyday experiences of memory problems and control: the adaptive role of selective optimization with compensation in the context of memory decline

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The present study examined the role of long-term working memory decline in the relationship between everyday experiences of memory problems and perceived control, and we also considered whether the use of accommodative strategies [selective optimization with compensation (SOC)] would be adaptive. The study included Boston-area participants (n = 103) from the Midlife in the United States study (MIDUS) who completed two working memory assessments over 10 years and weekly diaries following Time 2. In adjusted multi-level analyses, greater memory decline and lower general perceived control were associated with more everyday memory problems. Low perceived control reported in a weekly diary was associated with more everyday memory problems among those with greater memory decline and low SOC strategy use (Est. = −0.28, SE= 0.13, p = .036). These results suggest that the use of SOC strategies in the context of declining memory may help to buffer the negative effects of low perceived control on everyday memory.

Keywords: working memory; memory decline; everyday memory; control beliefs; SOC

Reports of everyday memory problems are common among adults of all ages (Lachman, 2004; Slavin et al., 2010). These complaints are often found to be related to anxiety, depression, and neuroticism (Mol, Ruiter, Verhey, Dijkstra, & Jolles, 2008; Pearman & Storandt, 2004). In contrast, there is conflicting evidence regarding whether subjective reports of memory problems are indicative of objective memory performance (Jungwirth et al., 2004; Van Bergen, Jelicic, & Merckelbach, 2009). Longitudinal studies have clearly documented declines in objectively measured memory associated with normal and pathological cognitive aging (e.g., Buckner, 2004; Welsh, Butters, Hughes, Mohs, & Heyman, 1991) and that decline in some cognitive domains, including memory, may occur as early as midlife (Singh-Manoux et al., 2012). Yet, it is not known whether longitudinal changes in objective memory are associated with greater reports of memory problems in daily life.

In addition, psychosocial factors, such as feeling a sense of control over one's life, have also been related to better performance on objective tasks of cognitive functioning and memory, in particular (Agrigoroaei & Lachman, 2011; Bielak et al., 2007; Miller & Lachman, 2000), but there is limited evidence as to whether perceived control is tied to the experience of naturally occurring everyday memory problems. Control beliefs are described as the extent to which people believe they have control over the possible outcomes in their life (Lachman, 2006). Furthermore, perceived control also includes

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the extent to which individuals believe that outside or external factors constrain or limit their ability to influence their life and their outcomes. People who feel a stronger sense of control over their life may be more inclined to partake in behaviors or lifestyle choices associated with more positive health outcomes (Lachman, 2006). Conversely, those with a lower perceived sense of control may be more inclined to perceive aging-related changes as the result of entirely inevitable genetic and biological forces. People who have higher control may be more likely to use effective strategies to help their memory performance and therefore exhibit higher memory performance (Lachman & Andreoletti, 2006). Conversely, greater feelings of anxiety and subsequent task interference may be a mechanism by which low perceived control is related to worse memory performance (Lachman & Agrigoroaei, 2012).

Perceived control may also vary from one day to the next or from one week to the next within individuals. Neupert and colleagues examined within-person (WP) fluctuations in perceived control for up to 60 days and found that on days when older adults felt more in control, they performed better on cognitive tasks both that day and on the next day (Neupert & Allaire, 2012). Further research is needed to better understand whether fluctuations in perceived control in daily life are related to naturally occurring everyday memory problems. In addition, research is needed to investigate whether individuals with greater memory decline are more vulnerable to the effects of low perceived control in their daily life. To address these gaps in research, the current study examined whether experiences of low perceived control in daily life were related to everyday memory problems reported in a weekly diary over 12 weeks. We also examined whether individuals with greater memory decline were particularly vulnerable to the negative effects of low perceived control. We used a diary approach to assess everyday memory problems to minimize the effects of recall bias.

Selection, optimization, and compensation

Poor cognitive performance or declines may not always lead to problems in daily cognitive functioning, such as everyday memory problems, in part, due to differences in the effective use of accommodative strategies (Salthouse, 2012). Behaviors and strategies, such as selective optimization with compensation (SOC), may be adaptive within the context of age-related losses (Freund & Baltes, 2007), such as declines in health or memory. *Selection* refers to targeting ones' efforts toward specific goals and activities, *optimization* is described as expending increased efforts and strategies in order to accomplish specific and relevant goals, and *compensation* consists of adaptive behaviors and the use of alternative strategies which can help accomplish a goal by compensating for losses (M. M. Baltes, Lindenberger, & Staudinger, 2006). Selection strategies can be based on personal choice (elective selection), or selection might also be the result of external or internal constraint, such as aging-related changes (loss-based selection). Selection can help individuals with memory decline to set goals and prioritize activities, and optimization and compensation may help people to cope and improve outcomes for those relevant activities. While perceived control may foster selection of adaptive strategies and persistence in difficult activities or challenging tasks, SOC behaviors may help people by focusing their behaviors and improving their performance on the most goal-relevant tasks. SOC strategies are expected to operate together to produce favorable outcomes by providing a framework to select the most important activities, optimize performance in those activities, and find alternative strategies for accomplishing activities within one's daily life which may help the individual to focus on increasing gains (optimizing) and adjusting to age-related losses (compensating) (P. B. Baltes, Staudinger, & Lindenberger, 1999; Freund, 2008; Freund & Baltes, 2002b).

Because SOC behaviors may help to buffer losses associated with aging and maximize possible gains throughout the lifespan (Freund & Baltes, 2007), the use of SOC strategies may be particularly relevant for older adults who are experiencing declines. The use of SOC strategies may minimize memory problems among those suffering declines because of their focus on relevant goals and effective means to optimize performance or compensate for losses. Studies have examined a potential protective role of SOC strategy use under other adverse conditions, namely chronic health conditions (Hutchinson & Nimrod, 2012) and specifically, osteoarthritis (Gignac, Cott, & Badley, 2002); however, this work has not directly focused on the potential buffering effects for memory problems in the context of long-term memory decline.

Current study

The current study had several specific aims. Our main goals were to examine whether weekly fluctuations in perceived control were associated with everyday memory problems and whether individuals with greater memory declines were particularly vulnerable to the effects of low perceived control. We were interested in examining the research questions within a developmental perspective focusing on memory changes, rather than level of memory performance at one time point. We examined the role of decline in working memory, specifically, due to evidence that deficits in working memory are related to greater likelihood of distraction and mind-wandering, particularly in the context of daily life tasks requiring concentration and effort (Kane et al., 2007; Kane & Engle, 2003). Individuals experiencing decline may be particularly vulnerable to problems in daily life due to a loss of abilities. We then examined the role of an accommodative strategy, SOC, in minimizing the negative effects of memory decline within everyday life. We predicted that the negative effects of low perceived control on everyday memory problems would be minimized among people with greater memory decline who have high SOC strategy use.

Methods

Sample

Data for the present study are from a subsample of the Midlife in the United States study (MIDUS) who also participated in a satellite study in the Boston area, the Boston Longitudinal Study (BOLOS). MIDUS is a longitudinal interdisciplinary study examining behavioral, psychological, social, biological, and neurological aspects of physical and mental health associated with midlife and aging. Time 1 interviews (MIDUS and BOLOS) took place between 1995 and 1996 and Time 2 interviews (MIDUS and BOLOS) occurred approximately 10 years later between 2004 and 2006. For MIDUS, the retention rate from Time 1 (n = 7,100) to Time 2 (n = 4,955) was 75% after adjusting for mortality. The sample has been described in greater detail elsewhere (Lachman & Agrigoroaei, 2010; Radler & Ryff, 2010). Participants were healthy community-residing adults, and they were not screened for dementia as part of either the MIDUS or BOLOS assessments. As part of the BOLOS data collection, working memory assessments (see Agrigoroaei and Lachman (2011)) were conducted at Time 1 (n = 302) and Time 2 (n = 151). For both Time 1 and Time 2, the BOLOS interviews occurred approximately a year after the MIDUS interviews and at Time 2 participants ranged in age from 34 to 83 years old. At Time 2, the BOLOS battery also included a 12-week diary study. Diary study designs typically assess aspects of everyday life (Bolger, Davis, & Rafaeli, 2003). For the current study, participants completed a weekly report of questions pertaining to their everyday experiences at the end of each week for up to 12 consecutive weeks. The diaries included questions related to everyday memory problems, perceived control, and a range of health and well-being measures. At the end of each week, participants completed the paper-and-pencil diary survey at home which they were instructed to mail back to research personnel within 24 hours of completing the diary. The current study includes the 103 participants who completed at least two weeks of diaries and had complete data for Time 1 and Time 2.

Participants in the current study sample (n = 103) were on average, 59 years old (SD = 12.82) at Time 2, and 44% were female (Table 1). A little over half of the sample (53%) completed a Bachelor's degree or further advanced graduate education. Participants reported their health to be on average, 3.85 (SD = 1.03, range: 1–5 with higher scores indicating better health). Independent samples t-test comparison of means was conducted to examine the characteristics of participants who dropped out of BOLOS after Time 1 (n = 181) or who were not included in the current study because of missing data or less than two diaries completed (n = 18) compared to participants included in this study (n = 103). Results show that the dropouts were marginally more likely to be female, (p = .05), of similar age (p = .73) and education level (p = .10), and there were no differences in working memory performance at Time 1 (p = .60).

Measures

Covariates

We used the following demographic variables as covariates in the current study because of their previously established relationships with both memory problems and control beliefs: age, gender, education, and functional health. General perceived control was also included as a covariate in order to examine the WP fluctuations of control after adjusting for general perceived control. Age at Time 2 was measured continuously, and education was operationalized dichotomously as low (no college degree) versus high (Bachelor's degree or higher). Functional health was measured as part of MIDUS at Time 2 by asking participants to rate whether their health limits them in daily activities (lifting or carrying groceries; bathing or dressing oneself; climbing several flights of stairs; climbing one flight of stairs; bending, kneeling, or stooping; walking more than one mile; walking several blocks; walking one block; engaging in vigorous activity; engaging in moderate activity). Participants rated whether their health limited them in each of 10 activities from (1) a lot to (4) not at all, and scores were averaged across the 10 items. Scores for functional health ranged from 1 to 4 and higher scores indicated better functional health. General perceived control was measured at MIDUS Time 2. Participants completed a 12-item inventory assessing two aspects of beliefs about control, personal mastery, and perceived constraint (Lachman & Weaver, 1998). There were eight items measuring personal mastery (e.g., "I can do just about anything I really set my mind to"), and 4 items measuring perceived constraint (e.g., "What happens in my life is often beyond my control"). For each item, participants rated how much they agreed or disagreed with that item, with scores ranging from (1) strongly agree to (7) strongly disagree. Some items were reverse-scored so that higher scores reflected higher personal mastery or lower perceived constraint. General perceived control was measured as the average of all 12 items, with higher scores indicating higher perceived control.

Table 1. Descriptive characteristics and intercorrelations for all study variables (n = 103 participants).

Variable	M (SD) or %	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
Level 2 (person-level)									
1. Age	59.17 (12.82)	–							
2. Gender (% female)	44	−0.16	–						
3. Education (% Bachelor's)	53	0.05	−0.16	–					
4. Functional health	3.20 (0.86)	−0.36***	−0.13	0.20*	–				
5. General perceived control	5.62 (0.99)	0.11	−0.04	0.17	0.29**	–			
6. Initial working memory[a]	0 (1.00)	−0.09	−0.28**	0.29**	0.30**	0.20*	–		
7. Working memory decline[b]	−0.02 (0.76)	−0.22*	0.11	0.19*	−0.04	−0.19*	−0.33***		
8. SOC	1.41 (0.99)	0.08	0.08	0.06	0.07	0.23*	0.06	0.03	–
Level 1 (diary-level)									
1. WP weekly perceived control	3.59 (1.13)	–							
2. WP everyday memory problems	9.62 (8.71)	−.21***							

Note: *p < .05, **p < .01, ***p < .001. M: mean; SD: standard deviation; SOC: selection, optimization, and compensation strategy use; WP: within-person. [a]Working memory scores were computed by standardizing the mean of z-scores for forward digit span, backward digit span and serial sevens. [b]Working memory decline was measured continuously as a difference score from Time 1 to Time 2, where higher, positive values indicate less decline and lower, negative values indicate greater decline.

Working memory decline

Change was computed using difference scores (Time 2 minus Time 1) over the course of 10 years with a composite measure of working memory measured at both occasions and hereafter labeled memory decline. The working memory factor included tests of forward and backwards digit span and serial sevens (counting backwards by subtracting sevens) measured at both BOLOS Time 1 (forward digit span: m = 7.01, SD = 1.25; backward digit span: m = 5.03, SD = 1.55; serial sevens: m = 13.73, SD= 8.69) and Time 2 (forward digit span: m = 6.80, SD = 1.36; backward digit span: m = 4.81, SD = 1.57; serial sevens: m = 12.83, SD = 8.69). The three measures of working memory were standardized in order to put all tasks on the same metric, as previous work has done (P. B. Baltes, Cornelius, Spiro, Nesselroade, & Willis, 1980; P. B. Baltes & Willis, 1982; Yaffe et al., 2004) and the average of the three tasks was computed at both occasions (Miller & Lachman, 2000). The working memory mean was then re-standardized using z-scores, and difference scores (memory decline over 10 years) were calculated by subtracting the standardized working memory factor for Time 1 from the Time 2 score. In order to preserve changes in cognition, Time 2 working memory scores were standardized using the means and standard deviation scores from Time 1, following previous work (P. B. Baltes & Willis, 1982). On average, participants declined in memory from Time 1 to Time 2 (p = .003). Memory decline was used in the current analyses as a continuous variable, with lower, negative scores indicating greater decline and higher, positive scores indicating less decline. Because participants declined, on average, we refer to this measure as greater versus less decline; however, a relatively small proportion of individuals remained stable or improved in their raw scores over time. Working memory scores for Time 1 (initial memory level) were used as a covariate in adjusted analyses.

Our measure of working memory is not a pure measure of working memory (Conway et al., 2005) per se; our tasks, in particular, the backward digit span task, assesses mainly the storage and transformation processes required for working memory rather than the supervisory or attention control systems also required for working memory (Oberauer, Süß, Schulze, Wilhelm, & Wittmann, 2000). The serial sevens tasks, however, requires more attentional abilities related to working memory, as evidenced by the use of serial sevens as part of the Mini-Mental Status Exam's measurement of attention and ability to perform calculations (Folstein, Folstein, & McHugh, 1975). Therefore, we examined the construct validity of our measure by examining the correlation of the factor score of the three tasks used in the current study with a well-validated measure of working memory, letter number sequencing (LNS; Hill et al., 2010; Tulsky, Saklofske, & Bornstein, 2003; Wechsler, 1997). LNS was administered in our Time 2 battery only (longitudinal data are not available), and at Time 2, LNS (unstandardized total score, range: 0–21, M = 10.48, SD = 2.90) was significantly correlated with the working memory factor (r = 0.63, p = < .001) as well as the three working memory tasks (Forward digit span: r = 0.51, p = < .001; Backward digit span: r = 0.53, p = < .001; Serial sevens: r = 0.52, p = < .001).

Selective optimization with compensation

SOC strategies were measured as part of BOLOS at Time 2 using the Selective Optimization & Compensation Questionnaire (Bajor & Baltes, 2003; Freund & Baltes, 2002b). The questionnaire used in the current study includes 12 items (Elective selection: ES2, ES3, ES10; Loss-based selection: LBS4, LBS7, LBS12; Optimization: O2, O9, O10;

Compensation: C7, C9, C11) from the larger 48-item scale. A composite of the four subscales (Elective selection, Loss-based selection, Optimization, and Compensation) was used to measure SOC strategy use because of theoretical support that the concepts work together rather than separately to produce favorable outcomes (Freund & Baltes, 2002b). Participants were asked to rate themselves as more similar to either "Person A" or "Person B." A score of 0 was given for Person A and 1 for Person B, except for five of the 12 items which were reverse-scored (1 = Person A and 0 = Person B). The scores for the 12 items were summed so that higher scores reflected greater SOC strategy use.

Diary measures

Everyday memory problems. As part of the BOLOS weekly diaries at Time 2, everyday memory problems were assessed with 11 items, 10 of which are from a previous diary study (Whitbourne, Neupert, & Lachman, 2008) and were drawn from a 35-item measure of everyday memory problems (Sunderland, Harris, & Baddeley, 1983). Examples of everyday memory problems include having trouble remembering someone's name, starting to do or say something and then forgetting what it was you wanted to do or say, or forgetting why you went into a room. In the current study, one additional item was added ("On how many days did you have difficulty dividing your attention between two activities, or doing two things at once?"). Similar short-format versions of the 35-item measure have been used previously in diary studies in older adult populations (Neupert, Almeida, Mroczek, & Spiro, 2006; Whitbourne, Neupert, & Lachman, 2005). Participants were asked to report how many days during that week (0–7) they experienced any of the 11 memory problems each week for up to 12 weeks. A sum score for the total number of memory problems each week was computed by totaling the 11 items to create a composite measure of the "total number of everyday memory problems per week" for each weekly diary ranging from 0 to 77.

Weekly perceived control. Also in the BOLOS weekly diaries at Time 2, participants were asked a number of questions regarding their feelings each week for up to 12 weeks, including one item about perceived sense of control. Participants reported the extent to which they felt "in control of my life" that week, with scores ranging from (1) very slightly or not at all to (5) extremely. The single item measure was used in the current analyses as a weekly measure of perceived control; scores ranged from 1–5 with higher scores indicating higher perceived control.

Statistical analyses

Descriptive information and correlations were computed for all study variables. Before conducting main analyses, predictor variables were mean-centered for moderation analyses. Multilevel modeling (MLM) was used to estimate WP variability in the relationship between Level 1 and Level 2 predictor variables and the outcome memory problems using Proc Mixed in SAS Version 9.2. The Level 1 intraindividual diary variables included weekly perceived control and everyday memory problems. The Level 2 variables were age, gender, education, functional health, general perceived control, initial level of working memory, SOC strategy use, and memory decline over 10 years from Time 1 to Time 2. The MLM estimated the WP (intraindividual variability) and between-person (BP; interindividual variability) predictors of everyday memory problems. WP predictors estimated the intraindividual variation (how people vary from one week to the next), and BP predictors estimated the interindividual variability (how people vary from one person to the next) (Curran & Bauer, 2011). WP control was person-mean centered in order to examine the effect of perceived control from one week to the next compared to that person's average perceived control. For example, WP analysis examines whether someone is reporting higher perceived control on a given week than they usually do. Restricted maximum likelihood estimation method was used because it is a more conservative estimation method for small sample sizes than other estimation methods (e.g., maximum likelihood) (Peugh, 2010).

Prior to conducting main analyses, an unconditional model was run to calculate the intraclass correlation coefficient to determine the proportion of WP and BP variability in memory problems. Results of the unconditional model suggest that there was more variation in everyday memory problems between participants than within participants; specifically, 76% of the variability in memory problems was between participants and 24% of the variability was within participants.

To examine the research hypotheses, the following MLM was run to examine whether individuals reported more memory problems on weeks with low perceived control (Equation 1). The same model also examined whether low perceived control was related to more everyday memory problems for people with greater memory decline and low levels of SOC use. Lower order, two-way interactions were included in the model, as well. A three-way interaction (SOC * Control * Memory decline) was included to examine whether perceived control was related to memory problems for people with greater memory decline and low SOC use. Covariates (age, gender, education, functional health, trait sense of control, and initial working memory) are not shown in Equation 1 but were included in the model.

$$\begin{aligned} &\text{Level 1}: \text{MEMORY PROBLEMS}_{ij} = \beta_{0j} + \beta_{1j}\left(\text{WEEKLY CONTROL}_{ij}\right) + e_{ij} \\ &\text{Level 2}: \ \beta_{0j} = \gamma_{00} + \gamma_{01}(\text{SOC}) + \gamma_{02}(\text{MEMORY DECLINE}) \\ &\qquad\qquad\qquad\qquad + \gamma_{03}(\text{SOC} * \text{MEMORY DECLINE})u_{0j} \\ &\qquad\quad\ \ \beta_{1j} = \gamma_{10} + \gamma_{11}(\text{SOC}) + \gamma_{12}(\text{SOC} * \text{MEMORY DECLINE}) + u_{1}j \end{aligned} \tag{1}$$

Because there was a significant drop-off in the reports of memory problems over the course of the 12 weeks of data collection, time was included as a covariate in the analysis as previous work has done (Hahn, Cichy, Small, & Almeida, 2014).

Results

Table 1 displays the sample characteristics, descriptives, and intercorrelations for all study variables. Participants reported, on average, that their trait sense of control was 5.62 (SD= .99, range: 1–7). In weekly diary measures, participants reported, on average, a weekly level of perceived control of 3.59 (SD = 1.13, range: 1–5) and they reported an average of almost 10 memory problems per week (M = 9.62, SD= 8.71). Correlations between Level 2, BP study variables reported in Table 1 show that participants who were older, had lower education, lower general perceived control, and higher initial working memory span at Time 1 were more likely to experience greater memory decline. Correlations between Level 1, WP study variables are also listed in Table 1, and the results show that lower weekly perceived control was correlated with more everyday memory problems ($r = -0.21$, $p < .001$).

Main Effects

Table 2 displays the results of adjusted main analyses examining Level 1 and Level 2 predictors of everyday memory problems. In the adjusted model, the main effect of memory decline was significantly predictive, as expected, of a greater number of memory problems. Lower general perceived control was a significant predictor of a greater number of everyday memory problems, but weekly fluctuations in perceived control were not related to everyday memory problems. SOC strategy use was also not a significant predictor of memory problems as a main effect. Higher age and higher education were significant predictors of a greater number of everyday memory problems.

Moderating effects

The two-way interactions (Memory decline * Control, Memory decline * SOC strategy use, and Control * SOC strategy use) were not significant predictors of memory problems. In support of our hypothesis, the three-way interaction effect of weekly perceived control, SOC strategy use, and memory decline was significant (Table 2) in both the unadjusted and adjusted models. To better understand the interaction effect, we interpreted the effect using the Johnson–Neyman (J–N) technique (Figure 1). The J–N technique depicts the

Table 2. Fixed effects estimates for multilevel models predicting everyday memory problems (n = 103).

Parameter	Est.	*SE*	*p*
Fixed effects			
Intercept	24.21	5.83	<.001
Time	−0.21	0.07	.005
Age	0.20	0.07	.006
Gender	1.57	1.62	.337
Education	5.52	1.78	.003
Functional health	0.70	1.12	.530
General perceived control	−3.70	0.87	<.001
Initial working memory[a]	−0.70	0.95	.466
Working memory decline[b]	−2.45	1.22	.047
SOC strategies	−0.28	0.36	.438
WP perceived control slope	−0.06	0.23	.806
Two-way interaction effects			
WP weekly perceived control slope * Working memory decline	0.13	0.29	.651
WP weekly perceived control slope * SOC	0.03	0.11	.763
Working memory decline * SOC	0.21	0.45	.647
Three-way interaction effect			
WP weekly perceived control slope * Working memory decline * SOC	−0.28	0.13	.036
Covariance parameters			
Intercept variance	63.85	10.60	<.001
Intercept/slope variance	−1.66	0.74	.025
Slope variance	0.34	0.07	<.001
Residual	13.83	0.71	<.001

Note: $*p < .05$, $**p < .01$, $***p < .001$. *SE*: standard error; SOC: selection, optimization, and compensation strategies; WP: within-person. [a]Working memory scores were computed by standardizing the mean of z-scores for forward digit span, backward digit span, and serial sevens. [b]Working memory decline was measured continuously as a difference score from Time 1 to Time 2, where higher values indicate less decline and lower values indicate greater decline.

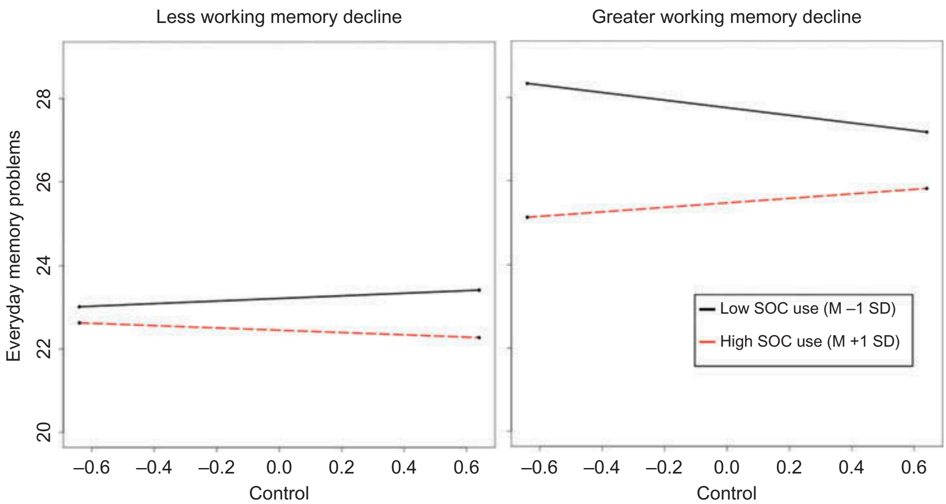

Figure 1. Three-way interaction effect of SOC* control beliefs predicting memory problems as a function of memory decline (n = 103)[a,b].
Note: SD: Standard deviation; SOC: selection, optimization, and compensation strategy use. [a]For the purposes of illustrating interaction effects, Johnson–Neyman technique was used and 1 SD above and below the mean for memory decline and SOC strategy use was computed. However, continuous variables were used in the analysis. [b]Adjusted for age, gender, education, general perceived control, and initial working memory.

moderating effect at all values of the moderator (Bauer & Curran, 2005; Johnson & Neyman, 1936). The results of J–N technique analyses estimated that the regions of significance for the moderator, SOC strategy use, were between the mean-centered values of – 1.57 and 0.59 (Mean-center SOC strategy use: M = 0.00, SD= 2.37), suggesting that the most confidence in the effects of the moderators lies within those given values. The illustrated interaction effect in Figure 1 shows that individuals with greater memory decline reported more everyday memory problems. Figure 1 also illustrates the relationship between weekly perceived control and memory problems as a function of SOC and memory decline. Specifically, the participants with greater memory decline who use *more* SOC strategies were significantly *less* vulnerable to the effects of low weekly perceived control.

Discussion

This study had several key findings. First, those with greater declines in working memory in the previous 10 years reported a significantly greater number of memory problems in everyday life. While the association between objective and subjective measures of memory is not consistently found (Cargin, Collie, Masters, & Maruff, 2008; Jungwirth et al., 2004; Van Bergen et al., 2009), we found that they were in fact related. Second, general perceived control, but not WP fluctuations in weekly perceived control, was predictive of a greater number of memory problems. Third, participants reported greater memory problems on weeks with low perceived control if they had greater declines in memory and used fewer SOC strategies. In contrast, participants with greater memory decline who used more SOC strategies were less vulnerable to the effects of low weekly perceived control. These results suggest that SOC strategies may be an adaptive compensatory strategy that individuals can use to minimize the negative effects of declines in working memory in everyday life.

The finding of a relationship between general perceived control and everyday memory problems is consistent with previous research examining the BP relationship of control beliefs in relation to memory tasks assessed in the lab (Lachman & Agrigoroaei, 2012). The present study extends this work by examining memory within the context of everyday life. We did not replicate previous evidence of intraindividual fluctuation of control and objectively measured cognition varying together from day to day (Neupert & Allaire, 2012); however, we examined naturally occurring memory problems rather than objective tasks. It may be that within the context of everyday life, adaptive strategies such as SOC in addition to perceived control may be relevant in determining the occurrence of naturally occurring memory problems.

We did find that certain individuals were more vulnerable to the effects of weekly fluctuations in low perceived control, in particular, individuals with declining memory who have low SOC strategy use. Our finding that SOC strategies serve as a buffer in the context of loss or stress is consistent with previous work. The use of SOC strategies within the context of work-related daily stressors was associated with less fatigue and greater job satisfaction among middle-aged and older adults (Schmitt, Zacher, & Frese, 2012). Because SOC theory posits that the use of SOC strategies may help individuals cope with the losses associated with aging and development (P. B. Baltes, 1997; Freund & Baltes, 2002a), participants with memory decline who do not use SOC strategies may be more vulnerable to fluctuations in perceived control and they may subsequently experience more memory problems in everyday life.

Research and interventions that target adaptive behaviors and beliefs, such as maintaining high perceived control and engaging in SOC strategies may help older adults to adapt to age-related declines in working memory. In the current study, individuals who may benefit most from the use of SOC strategies, that is participants whose memory has declined, may benefit in that SOC serves as a "life management" technique in everyday life and in face of weekly fluctuations in control (Freund & Baltes, 1998). Related work has also identified that adaptive strategies may help to buffer negative outcomes most for those who are most vulnerable to experiencing those negative outcomes. Secondary control strategies, defined as positive reappraisals or "seeing the positive side of a bad situation" (Wrosch & Heckhausen, 1999; Wrosch, Heckhausen, & Lachman, 2000), are related to better subjective well-being more so for middle-aged and older adults who report greater health or financial stress (Wrosch et al., 2000).

We are aware of one cross-sectional study that examined the role of SOC strategies in the relationship between control beliefs and everyday memory (Scheibner & Leathem, 2012). Their study used a retrospective measure of a person's tendencies to be forgetful over the previous six months and they found limited evidence for the role of optimization strategies, and no evidence for selection or compensation strategies, as mechanisms or mediators, in a memory-control relationship (Scheibner & Leathem, 2012). We extended this work by focusing on those experiencing losses in working memory who are thus more likely to benefit from SOC strategy use, and also by measuring naturally occurring everyday memory problems concurrently rather than using a long-term retrospective report. We used a composite measure of SOC for our main analyses because of the theoretical and empirical work suggesting it is the combination that is potentially protective in everyday life (Freund & Baltes, 2002b). We attempted to replicate the (Scheibner & Leathem, 2012) models in two ways. We tested a mediational model using the SOC composite and the individual subscales. Our findings were similar to theirs with no evidence of the SOC composite or the individual subscales as mediators in the perceived control-memory relationship. We also did sensitivity analyses by testing our study's main research questions using each of the SOC subscales individually to better understand whether our finding of SOC as adaptive (i.e., moderator) was influenced by a specific subscale. We found that the results for both optimization and compensation were the same as our study's main findings with the SOC composite. Selection strategies were predictive of fewer memory problems as a main effect and under circumstances of low perceived control. The results of the sensitivity analyses suggest that selection strategies may be helpful for people regardless of the extent of memory decline while strategies of optimization and compensation may be particularly adaptive for people with greater declines in working memory.

The finding of a positive association between education and memory problems is counterintuitive. However, this finding is consistent with a population-based study of over 11,000 Swedish adults (Caracciolo, Gatz, Xu, Pedersen, & Fratiglioni, 2012) which found that people with subjective cognitive impairment (defined as a self-report of change in cognitive functioning in the previous 3 years amidst no dementia or objective cognitive impairment) are more likely to be highly educated and of higher socioeconomic status (SES). The authors suggested that higher education and higher SES participants may report worse cognitive impairment because they may be more aware of health, in general, and specifically, changes in cognition. Two previous studies found greater physiological reactivity to cognitive stressors among individuals of higher SES (Neupert, Miller, & Lachman, 2006) and greater stressor exposure among those with higher fluid cognitive ability (Stawski, Almeida, Lachman, Tun, & Rosnick, 2010). Furthermore, stressor exposure has also been related to increased everyday memory problems (Neupert et al., 2006). Collectively, these studies may suggest that daily stress exposure and reactivity may be a mechanism by which highly educated and higher cognitive functioning individuals experience a greater number of everyday memory problems. Further research is needed to better understand the role of stress in addition to other possible explanations.

Limitations and conclusions

Some limitations in the current study and suggestions for future research should be mentioned. We examined SOC strategy use at Time 2 only; therefore, we cannot determine whether individuals increased in SOC strategy use in response to memory decline. Previous cross-sectional work found a relationship between perceived memory problems and greater memory compensatory strategy use (Garrett, Grady, & Hasher, 2010); however, longitudinal research found that better initial episodic memory was related to increases in memory compensation strategy use over six years (Dixon & de Frias, 2004). These results suggest that strategy use may depend on an individual's perception of memory problems to some extent, but also that people with better objective memory performance are more likely to use strategies. Given the mixed findings with respect to subjective versus objective measurement of cognition and strategy use, future research with a longitudinal measurement of objective cognitive decline, perceived decline, and SOC strategy use is needed to identify whether people increase their use of SOC strategies over time in response to actual or perceived memory declines.

As mentioned earlier, the MIDUS and BOLOS study protocol did not include a screening for dementia. It is possible that individuals with dementia or pre-dementia states such as mild cognitive impairment may be less likely to effectively use SOC strategies. Therefore, the effortful nature of SOC behaviors may not be beneficial for all individuals with memory decline. Future work is needed to examine the use of SOC strategies in adult populations with both normal and pathological changes in cognition.

In addition, our measurement of SOC strategy use was not memory specific; however, we chose to use a well-validated scale rather than developing a measure pertaining to memory beliefs, in part because we are not aware of a memory-specific SOC measure. Previous work has conceptualized SOC strategy use as a "life management" tool by which specific outcomes may be realized because of effective life management through selection, optimization, and compensation (Freund & Baltes, 2002b). Specific health outcomes or measures of functioning in daily life, such as everyday memory problems, may be possible "indicators of successful life management."

In the current study, we used a one-item measure of weekly perceived control, rather than a multiple-item measure specific to the memory domain. This was because of the nature of the study design over 12 weeks in which a brief measure was preferred to reduce participant burden, as has been done previously in other diary studies (Pond et al., 2012). Also, the domain-general measure of perceived control allowed us to examine a range of possible outcomes in the study overall. In previous work, we suggested that domain-specific measures may be needed in some cases to identify relationships (Lachman, 1986). However, finding a relationship with a domain-general measure of control beliefs may be that much more "compelling" as compared to domain-specific control beliefs. We controlled for time in our analyses as previous work has done (Hahn et al., 2014) because over the 12 weeks of diaries there was a significant decline in self-reported memory problems. While short-term repeated measurement in diary studies may reduce recall bias (Bolger et al., 2003), the potential participant burden may result in a drop-off in reports over 12 weeks.

Finally, our measure of cognitive change focused on tasks of working memory, rather than other cognitive domains or other aspects of memory, such as episodic memory, that may also be relevant for daily life and in particular, the experience of everyday memory problems. Daily tasks, such as remembering where you put something or remembering the name of a person you just met, must rely on an effective working memory given that they involve remembering while doing other things. For example, individuals with greater deficits in working memory may be more likely to be distracted (Kane & Engle, 2003), and therefore be more likely to forget the name of a person they met if they meet multiple people at once or are engaging in conversation while learning individual's names.

Memory complaints are common and potentially anxiety provoking among individuals of all ages, and especially individuals whose memory is declining. Modifiable factors, such as perceived control and the use of SOC strategies, may benefit individuals whose memory has declined by helping them feel confident and competent in their daily activities, select beneficial accommodative strategies, focus on relevant tasks, and engage in adaptive behaviors that are commensurate with their abilities. Previous work (Imhof, Wallhagen, Mahrer-Imhof, & Monsch, 2006) identifying that forgetfulness and complaints about memory are tied to worse quality of life, as well as increased risk of distress and anxiety (Mol et al., 2008) provide an impetus for continued research to identify potential risk factors for greater memory complaints in everyday life. Because environmental and developmental factors may result in weekly variations in perceived control, the use of SOC strategies may be particularly adaptive in that it helps people to compensate for short-term intraindividual variations in their perceived control as well as long-term age-related changes in working memory. The current study's findings suggest that perceived control is relevant in everyday life, and that the use of certain adaptive developmental strategies, such as SOC, may help to buffer the negative effects of declines in working memory in everyday life. The study is relatively novel in that it incorporates an advantageous design for studying aging processes by including both short-term WP change as well as longitudinal, intraindividual decline over 10 years (Hektner, 2012). With this type of design, the current study has taken a first step toward illustrating the dynamic processes of interindividual differences in SOC strategy use, long-term intraindividual decline in working memory, as well as short-term intraindividual fluctuations in perceived control as they relate to everyday memory problems, a highly prevalent experience throughout adulthood.

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