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Original Research Report

The Effect of Stereotype Threat on Age Differences in Prospective Memory Performance: Differential Effects on Focal Versus Nonfocal Tasks

Sascha Zuber, MS,[1] Andreas Ihle, PhD,[1,2,3] Anaëlle Blum, MS,[1] Olivier Desrichard, PhD[1,2] and Matthias Kliegel, PhD[1,2,3]

[1]Department of Psychology and [2]Center for the Interdisciplinary Study of Gerontology and Vulnerability, University of Geneva, Switzerland. [3]Swiss National Center of Competences in Research LIVES–Overcoming vulnerability: Life Course Perspectives, Lausanne and Geneva, Switzerland.

Address correspondence to: Sascha Zuber, MS, Cognitive Aging Lab, Department of Psychology, University of Geneva, Boulevard du Pont d'Arve 40, 1211 Genève 4, Switzerland. E-mail: Sascha.Zuber@unige.ch

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Abstract

Objectives: The current study examined the effects of stereotype threat on prospective memory (PM) performance in younger versus older adults by using a focal (i.e., low cognitive demands) and a nonfocal (i.e., high cognitive demands) PM task.

Method: Sixty younger and 60 older adults performed an event-based PM task, in which task instructions were experimentally manipulated. Half of the participants received instructions that emphasized the memory component of the task (memory condition; i.e., high stereotype threat for older adults) whereas the other half was instructed that the task evaluated participants' reading-ability (reading condition; i.e., low stereotype threat).

Results: Older adults' PM performance was worse than younger adults' only in the memory condition and these effects were specific for nonfocal PM cues as well as for old-old adults.

Discussion: Conceptually, this indicates that stereotype threat particularly impacts age effects for cognitive processes associated with executive control and that this particularly affects old-old adults. Therefore, the current findings illustrate for the first time that age differences in PM can be influenced by stereotype threat and suggest changes in controlled attention as possible cognitive pathway.

Keywords: Intentional behavior, Motivation, Task-instructions

Prospective memory (PM) designates the ensemble of processes that underlie remembering to perform a planned action after a certain delay (e.g., Brandimonte, Einstein, & McDaniel, 1996; Ellis & Kvavilashvili, 2000; Kliegel, Mackinlay, & Jäger, 2008). Typical everyday-life examples of PM would be ordinary tasks such as remembering to send an e-mail to a colleague by the end of the week or remembering to take a meal out of the oven after a certain time, but also more crucial tasks, such as remembering to take one's medication. PM therefore is highly relevant for everyday functioning and studies examining the development of PM with age have shown that it plays an important role in maintaining the independence and the autonomy of older adults (e.g., Aberle, Rendell, Rose, McDaniel, & Kliegel, 2010; Ihle, Schnitzspahn, Rendell, Luong, & Kliegel, 2012; Schnitzspahn, Ihle, Henry, Rendell, & Kliegel, 2011; Woods, Weinborn, Velnoweth, Rooney, & Bucks, 2012). At the same time, PM performance has been found to decline with increasing age (particularly when assessed in laboratory conditions, see e.g., Aberle et al., 2010; Henry, MacLeod, Phillips, & Crawford, 2004; Ihle, Hering, Mahy, Bisiacchi, & Kliegel, 2013; Rendell & Craik, 2000).

To explain this age-related decline, multiple studies have focused on the *cognitive resources* that may be impaired in older adults (see Kliegel et al., 2016, for an overview). More specifically, it had previously been shown that PM tasks require some degree of *episodic memory* to encode, store, and retrieve the content of the planned action (e.g., Kliegel, Altgassen, Hering, & Rose, 2011; Zuber, Kliegel, & Ihle, 2016), and that certain PM tasks additionally require *executive controlled attention* and *working memory* to detect the appropriate moment to perform the PM task but also to reallocate one's attention from the ongoing activity to the PM task (e.g., Kliegel et al., 2011; Schnitzspahn, Stahl, Zeintl, Kaller, & Kliegel, 2013). As age-related losses have been well documented both for episodic and for working memory (e.g., Craik, 1986; Salthouse, 2009), PM age-deficits have so far largely been associated to the decline of those cognitive resources in older adults (e.g., Zeintl, Kliegel, & Hofer, 2007).

However, in the present paper, we suggest a novel perspective on age-deficits in PM that might contribute additional insights in variables further explaining older adults' PM impairments. Specifically, we propose that *how* the task is *presented* to the participants could constitute a core mechanism that moderates PM age-deficits in the lab. This proposal is inspired by Maylor's (2008) notion that "a significant source of variance across PM studies may lie in the exact wording of the task instructions" (p. 229). For example, Maylor highlighted that participants' performance could vary depending on how much *relative importance* the instructions accredit to the ongoing versus the prospective task, or on how exactly the instructions *framed* the PM task itself. Following up on this idea, in a recent study, Hering, Phillips, & Kliegel (2014) empirically demonstrated that older adults' PM performance was indeed heavily impacted by the *relative importance* that the instructions accredited to the PM task in contrast to the ongoing task: Age effects were only present when the PM task was described as less important than the ongoing task, while no age differences between older and younger adults were observed when the PM task was presented as more important than the ongoing task.

Further examining Maylor's (2008) commentary, for the current study, we aimed at examining whether participants' performance was influenced by the *specific wording* of the task instructions, which might evoke a certain *stereotype* in older participants. The idea that the task description might influence older adults' performance receives support from increasing evidence showing that negative age stereotypes (e.g., being slow, having bad memory) have a detrimental impact not only on older adults' personal well-being (e.g., Coudin & Alexopoulos, 2010), but also on their cognitive performance (see Horton, Baker, Pearce, & Deakin, 2008, for a meta-analysis; see Hummert, 2011, for a review). Importantly, some of the key cognitive processes associated with PM (such as *episodic* and *working memory*, see above) have been shown to be susceptible to stereotype-evoking task instructions. For example, Desrichard and Köpetz (2005) compared an experimental condition in which instructions explicitly emphasized the mnemonic component of the task (by telling participants that they had to perform a task "designed to assess their memory capacity") to a condition with no mention of memory capacities (by telling participants that they were about to perform a task testing "their sense of orientation"). The authors showed that older adults performed worse on an episodic memory task (i.e., memorizing a list of shopping items) only when task-instructions underlined the memory component, but that they performed equally well as younger adults when memory capacities were not mentioned. A similar effect has also been demonstrated for working memory: Mazerolle, Regner, Morisset, Rigalleau, & Huguet (2012), for example, showed that older (compared to younger) adults performed worse on a reading span task only when they were told that both *younger* and *older* adults participated in the study (which activated age-related stereotypes in the older participants; for further studies on age-related stereotypes also see, e.g., Chasteen, Bhattacharyya, Horhota, Tam, & Hasher, 2005; Lamont, Swift, & Abrams, 2015; Rahhal, Hasher, & Colcombe, 2001).

The fact that age-related stereotypes influence retrospective as well as working memory could have important consequences for PM research. As illustrated above, retrospective memory is necessary to maintain and to retrieve the content of the prospective intention and controlled attention/working memory are required to process the ongoing task while simultaneously monitoring for PM cues (see also Kliegel et al., 2011, for an overview as well as Guynn, 2003; Zeintl et al., 2007). Thus, it seems plausible that age-related stereotype threat might represent an additional important factor that could (at least partially) explain older adults' inferior PM performance in the laboratory. If such was the case, this would have significant methodological implications for PM and aging research: If age-related stereotype threat was demonstrated to impair older adults' PM performance, the likelihood of such a threat would have to be minimized in future PM studies to allow valid comparisons of older versus younger adults' PM performance. Despite the potential importance of stereotype threat in PM research, to our knowledge no PM study has explicitly targeted this issue so far.

In addition to this methodological contribution to PM research, extending the study of stereotype threat to the field of PM could furthermore provide important conceptual insights to disentangle the precise mechanisms that lead to the impairing effect of stereotype threat. As Jamieson and Harkins (2007) pointed out: "Although stereotype threat has been studied extensively, researchers have yet to reach a consensus as to what mechanism(s) mediate(s) its effect on performance" (p. 560). In the current study, we suggest that using a PM paradigm may be particularly helpful to analyze which cognitive processes are impacted by stereotype threat within a given task that requires both memory and controlled attention. Specifically, although all PM task rely to a certain degree on episodic memory (in order to remember *what* has to be done), the *Multiprocess Theory*—one of the key models on PM functioning (McDaniel & Einstein, 2000)—suggests that PM tasks can vary in terms of controlled attention that is deployed in order to detect the cue (which indicates *when* the PM action has to be done). As stated by the *Multiprocess Theory*, these variations in deployment of controlled attention are critically linked to the PM task being either *focal* or *nonfocal*. In *focal* tasks, there is a *high* overlap between the processing that is required to perform the ongoing task (e.g., categorizing words) and the processing that is required to detect the PM cue (e.g., detecting words of a particular category, such as "animal"). As a consequence, in focal tasks the detection of the PM cue may be relatively spontaneous and does not require (substantial) cue monitoring, resulting in low recruitment of controlled attentional processes. In *nonfocal* tasks on the other hand, there is a *low* overlap between the processing of the ongoing task (e.g., categorizing words) and processing required for the detection of the PM cue (e.g., detecting words that contain the syllable "tor," see e.g., McDaniel, Shelton, Breneiser, Moynan, & Balota, 2011). Participants therefore are required to strategically monitor for the appearance of the PM cue which results in high recruitment of controlled attentional (for studies examining attentional demands of focal and nonfocal tasks, see e.g., McDaniel & Einstein, 2000; Shelton et al., 2011).

Thus, if stereotype threat proved to impact performance mainly in the focal condition, this would suggest that stereotype threat specifically loads on more spontaneously driven bottom-up associative processes which have been linked to hippocampal brain activity by previous PM studies (see e.g., McDaniel, Umanath, Einstein, & Waldum, 2015 for a recent review). If, on the other hand, stereotype threat particularly affected performance in the nonfocal condition, this would indicate that stereotype threat specifically interferes with more executively controlled processes such as higher level of controlled attention (additionally required in nonfocal tasks to strategically monitor for the nonfocal PM cues while continuing to perform the ongoing task), which is associated to frontal brain activity (e.g., Cona, Scarpazza, Sartori, Moscovitch, & Bisiacchi, 2015; McDaniel & Einstein, 2011; McDaniel et al., 2016; Scolaro, West, & Cohen, 2014).

In summary, our principal goals for the current study were to examine for a first time whether an effect of stereotype threat could be shown for a PM task and whether it would influence the typical age-deficits obtained in most laboratory studies. If this was the case, we furthermore aimed to investigate the cognitive mechanisms involved in such an impairing effect. To this end, we aimed at disentangling the processes of PM that would be influenced by stereotype threat, namely whether lower PM performance could be explained by an impairment of more stimulus-driven associative bottom-up processes which are linked to temporal brain regions (especially hippocampal networks), or whether it would be due to an impact on more high-level controlled top-down processes which are more strongly linked to frontal brain networks.

Based on previous research examining the effect of stereotypes on participants' cognition, we hypothesized that older adults tested in the laboratory would show lower PM performance in the presence of age-related stereotypes and that they would perform worse than younger adults especially/only in the stereotype threat condition with task instructions that explicitly emphasize the mnemonic component of the task. As the PM literature has demonstrated that nonfocal PM tasks require higher levels of controlled attention than focal PM tasks, we furthermore expected to find a stronger impact of the stereotype induction on strategic/attentional processes occurring in nonfocal PM tasks than on the more spontaneous associative processes in focal PM tasks.

Methods

Participants

One hundred and twenty participants took part in the study: 60 younger (M_{age} = 26.25, SD = 4.63, range: 19–36) and 60 older adults (M_{age} = 65.35, SD = 7.41, range: 55–86). There were no gender differences between both samples (40 women in the younger and 45 in the older group, respectively; $\chi^2(1, N = 120) = 0.65$, $p = .422$). For all participants, Mini-Mental State Examination (MMSE) score was at least 27 (M = 28.97; SD = 0.89), thus none of them did show clinical indication of cognitive impairments. There was no significant difference in MMSE score between younger and older adults, $t(118) = 0.615$, $p = .540$.

Materials

PM and ongoing task

We embedded an event-based PM task in a reading-comprehension ongoing task (OT). The OT consisted in reading a text of 1,715 words (part of "Matin brun," written by F. Pavloff) and—in order to place sufficient importance on this task—subsequently answering five comprehension questions about the text. As PM task, participants additionally had to remember to underline the word *"Charlie"* every time it occurred in the text (focal PM task, as detecting the word Charlie was necessary to successfully execute the OT; semantic processing of the content) as well as all words containing a letter with a circumflex accent (e.g., "*être*," "*île*," or "*château*"; nonfocal PM task, as additional processing of orthographical features is required). Studies in the field of visual perception, attention, and psycholinguistics have shown that although jumbling up, omitting, or misspelling certain letters within a word does impact reading speed, it does not influence word comprehension (*transposed letter effect*, e.g., Perea, Jiménez, Martín-Suesta, & Gómez, 2015; Rayner, White, Johnson, & Liversedge, 2006; for an exemplary text, see http://www.mrc-cbu.cam.ac.uk/people/matt.davis/cmabridge/). Thus, detecting the circumflexes was not necessary for successful execution of the OT (i.e., the semantic meaning of the words and the content of the story could be encoded and retained without consciously noticing the circumflexes), and therefore required additional strategic monitoring, which makes the circumflex-detection a nonfocal PM task. In total, there were 22 occurrences of these cues in the text (approximately 1% of all words; the overall PM score represents number of correctly detected cues divided by 22), 12 of which were the word "Charlie" (the focal PM score represents number of correctly detected *focal* cues divided by 12) and 10 of which were circumflexes (the nonfocal PM score represents number of correctly detected *nonfocal* cues divided by 10).

Procedure

Participants were tested individually. They first signed a consent form and filled out a demographic questionnaire. To familiarize participants with the ongoing task paradigm, they then read a short story of 418 words ("Vaudou", written by F. Brown) page after page without turning back, at their own pace. Note that there were no significant differences between the experimental conditions and/or age groups regarding the reading time for the familiarization task: all t tests resulted in p values greater than .66 with Cohen's d effect sizes of .01 or smaller. Then, the participants were asked to write down the answers to four questions regarding the content of the text. In a next step, participants were instructed that they would have to read another text, which would be followed by a new set of text-comprehension questions. In addition, they were told that they would also have to do a second task that was of equal importance (i.e., the PM task). The instructions for the PM task varied across the two experimental conditions. Half of the participants received instructions that emphasized the *memory* aspect of the task: They were first told that the new task was designed to *"assess [participants'] mnemonic capacities"* (i.e., high stereotype threat for older adults) that they had *"to **remember** to underline some words that [they] will encounter"* and that "*the number of correctly underlined words will allow to diagnose whether [their] **memory** is normal*". The other half of participants were assigned to the condition that emphasized *reading skills*: participants were instructed that the task was designed to *"assess [their] reading ability"* (i.e., low stereotype threat for older adults) and that they had "*to **detect** some words that [they] will encounter"* and that *"the number of correctly underlined words will allow to assess if [participant's] **reading** ability is normal.*" Before doing the ongoing and PM task, participants had to fill out different *questionnaires*, which also served as filler task between receiving the PM instructions and actually performing on the PM task (delay phase of approximately 5 min). After completing the questionnaires, participants performed the actual ongoing and PM task, which was followed by the five control comprehension questions. At the end of the experiment, participants completed the MMSE. In total, each testing session lasted about 30 min.

Statistical Analyses

The three main outcome variables (namely *overall*, *focal*, and *nonfocal* PM scores) followed strongly skewed distributions (Kolmogorov–Smirnov and Shapiro–Wilk tests resulting in p values < .001). As a consequence, we applied a reciprocal transformation to the independent variable outcomes before conducting a parametric ANOVA. Applying this transformation had two advantages, namely (a) that reciprocal transformations are stronger than other transformations (such as logarithmic or square root) and therefore better suit strongly skewed data (see e.g., Osborne, 2002; Tukey, 1977), and (b) that compared to other transformed scores reciprocal scores preserve meaning and are therefore easier to interpret (low scores indicating good performance and high scores indicating bad performance). For all PM scores, subsequent parametric analyses are based on the reciprocally transformed scores.

Results

PM Performance

Figure 1 illustrates participants' PM performance split by age groups, stereotype condition, whereas Figure 2 depicts PM performance split by age groups, stereotype condition, and task-type. To examine our hypotheses, we conducted a three-way mixed ANOVA with *condition* (*memory* vs *reading*) and *age group* (*younger* vs *older adults*) as between-subject factors and *focality* (*focal* vs *nonfocal* PM) as within-subject factor. Results showed significant main effects of *age group*, $F(1,102) = 5.69$, $p = .02$, $\eta^2 = .05$ indicating lower overall PM performance of older adults, and of *focality*, $F(1,102) = 83.47$, $p < .001$, $\eta^2 = .45$ indicating higher overall PM performance for the focal task, but no significant overall effect of *condition*, $F(1,102) = 2.21$, $p = .14$, $\eta^2 = .02$. There was a significant interaction between *age group* and *focality*, $F(1,102) = 5.30$, $p = .02$, $\eta^2 = .05$, indicating that the age-effect in the nonfocal task was significant ($t(104) = -2.34$, $p = .02$, Cohen's $d = .46$) while the age effect in the focal condition was nonsignificant ($t(104) = -0.11$, $p = .91$, $d = .02$). Moreover, there was no significant interaction between *condition* and *focality*, $F(1,102) = 1.57$, $p = .21$, $\eta^2 = .02$. The three-way interaction of *condition*, *age group* and *focality* was marginally significant $F(1,102) = 2.99$, $p = .09$, $\eta^2 = .03$.

Considering the large age range in the older adults' group, we followed up on the marginally significant interaction, performing a *Multivariate Adaptive Regression*

Splines analysis (MARS). *MARS* is a robust regression approach which examines nonlinearities and interactions between different variables (see Friedman, 1991). More specifically, instead of fitting *one* single linear regression to the data (as a classical ANOVA would), MARS uses *flexible* regression modeling to detect "splines" (= pieces of functions) in the data, which are joined by knot points. Thus, MARS examines whether the data can best be fitted to linear regression (with a particular slope) until a certain knot point, and then be better fitted to another regression (with a different slope). A simple example would be an inverted U-shape distribution: instead of fitting a flat, linear regression (zero slope) to the data, MARS would use two regression-lines that are joined at the peak of the inverted U-curve. This would have a much better model fit and allow more accurate predictions compared to a single, flat regression. Applying this approach to the present data, the MARS analyses revealed a significant three-way interaction of *Focality* × *Condition* × *Age* starting from the age of 71 ($F(1,104) = 5.71$, $p = .019$). In other words, the MARS analyses revealed a knot point at age 71, with no significant three-way interaction before this age, but a significant three-way interaction starting at age 71. This three-way interaction indicated a stereotype effect on the nonfocal but not on the focal PM task and only in the old-old adults (see Figure 3).

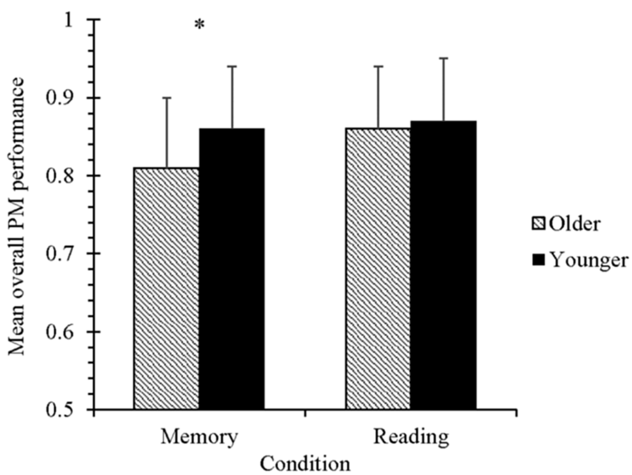

Figure 1. Participants' PM performance (accuracy on PM trials) split by age group and stereotype condition. PM = Prospective memory.

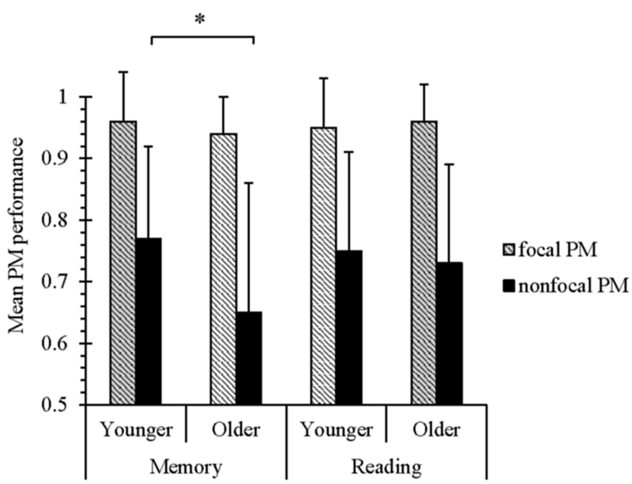

Figure 2. Participants' PM performance (accuracy on PM trials) split by age group, stereotype condition and PM task-type. PM = Prospective memory.

Discussion

The present study set out to examine for a first time whether an effect of stereotype threat could be shown for a PM task and whether it would influence the typical age-deficits obtained in most laboratory studies.

The current findings largely confirmed our main predictions with one important qualification. Results demonstrated that older adults tested in the laboratory showed lower PM performance in the presence (vs in the absence) of induced age-related stereotypes, and that they performed worse than younger adults only when task instructions emphasized the mnemonic component of the PM task. In contrast, in the absence of stereotype threat, older adults performed equally well as younger adults (even in a nonfocal task, see below; which is usually only observed in more naturalistic conditions, e.g., Henry et al., 2004; Schnitzspahn, et al., 2011). Moreover, results also revealed that in the nonfocal task, older adults performed significantly worse than younger adults only in the memory condition, but that both age groups demonstrated similar PM capacities in the reading condition. In the focal task on the other hand, performance did not differ regarding age group or instruction condition. Importantly, all those effects were revealed only for the older participants in our old age group as suggested by the MARS as well as the follow-up analyses.

What do these findings signify? First, the present study for the first time extends the effects of stereotype threat

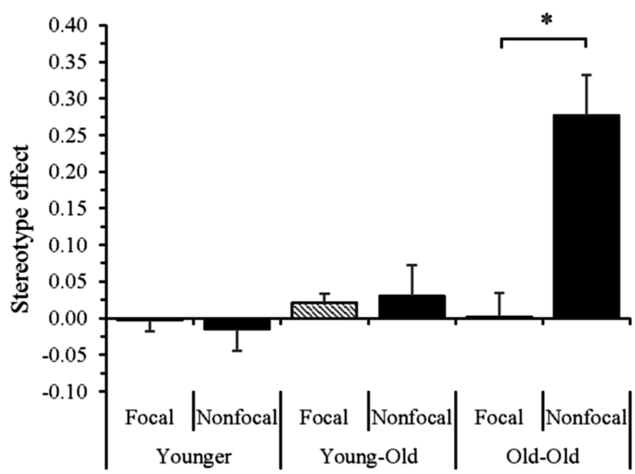

Figure 3. Stereotype effect ("Average accuracy on PM trials in reading condition" – "Average accuracy on PM trials in memory condition) split by age group and PM task-type. PM = Prospective memory.

to the PM literature. Second, findings confirmed our conceptual prediction based on the Multiprocess theory (e.g., McDaniel & Einstein, 2000) that stereotype threat indeed has a stronger impact on controlled cognitive processes deployed in nonfocal PM tasks. By applying a PM paradigm with tasks that differed regarding their demand on attentional resources (but that were similar regarding their demand on mnemonic ressources), the present study therefore allowed to corroborate the previously suggested idea that stereotype threat particularly impairs executively guided attentional resources (Schmader & Johns, 2003) associated to frontal brain activity rather than mnemonic processes.

Finally, the present findings add a novel nuance to the stereotype literature by showing that old-olds seem to be more especially affected by age-related stereotypes. Although most of the previous research also studied relatively wide age-ranges (starting at age 55 and going up to the mid 90's; e.g., Hess, Hinson, & Statham, 2004; Hummert, Garstka, O'Brien, Greenwald, & Mellott, 2002; Schafer & Shippee, 2010), to our knowledge there is little explicit discussion in the literature regarding the target-age for stereotype induction. However, as the present findings indicate, participants' exact age might play a crucial role for stereotype threat. Previous studies have shown some differences of age-identity between young-olds and old-olds (e.g., Hummert et al., 2002; Levy, 2003, Schafer & Shippee, 2010). Thus, it seems plausible that in our sample young-olds and old-olds differed on how they related to age-stereotypes and therefore were more/less strongly influenced by our stereotype induction. This idea is corroborated by our data, which revealed that an interaction between age and stereotype only occurred after a certain age. More specifically, the present findings showed that the executively guided attentional processes necessary to perform nonfocal PM tasks were the most strongly impaired by stereotype-threat in old-old adults.

Taken together, the present results illustrate that under particular conditions older adults are capable to perform as well as their younger peers both in focal as well as in the more demanding nonfocal tasks, but also that older adults' attentional resources (deployed for nonfocal tasks) can significantly be deteriorated by conditions that elicit stereotypes. With effect sizes ranging from $d = .30$ to $d = .71$, our data are in the range of the previous literature which generally found medium sized effects of age-related stereotype threat. In a recent review and meta-analysis Lamont and colleagues (2015) compared over 30 studies that investigated the impact of age-based stereotypes on older adults' performance (with over 80 effect sizes including close to 4,000 participants, $M_{age} = 69.5$). Overall, their analysis revealed "a significant small-to-medium effect of age-based stereotype-threat ($d = .28$)" (p.180).

On a conceptual level, expanding these findings to the field of PM suggests an interesting perspective on a current debate in research on age-related PM performance: namely that age-related stereotypes may form an additional factor contributing to the overall pattern of the *Age Prospective Memory Paradox*. The *Age PM Paradox* (Rendell & Craik, 2000) refers to the finding that older adults generally perform worse on PM tasks than younger adults when being tested in the *laboratory*, but that they perform better than their younger counterparts when PM is assessed in *everyday life* (e.g., Aberle et al., 2010; Henry et al., 2004; Ihle et al., 2013). Our study provides a novel, more process-related explanation to older adults' deficits in the laboratory (which have so far primarily been attributed the *decline of cognitive resources*, see Kliegel et al., 2016, for an overview; or to *task-inherent characteristics*, such as the relative importance of the PM versus the ongoing task, e.g., Hering et al., 2014; Smith & Bayen, 2004; or the salience/distinctiveness and the emotional valence of the PM cue, e.g., Ballhausen, Rendell, Henry, Joeffry, & Kliegel, 2015; Cohen, Dixon, Lindsay, & Masson, 2003).

From a methodological point of view, our results indicate that for reliable comparisons of PM capacities in older and younger adults, future studies should carefully select their task instructions. A cautious selection of PM instructions seems of particular importance, as previous studies have shown that the simple mention of something having *"to be remembered"* can be sufficient to impair older adults' performance (e.g., Rahhal et al., 2001). Likewise, it has been demonstrated that age-related stereotype threat can affect older adults' cognitive performance even when the mnemonic aspects of the task are not explicitly emphasized in the instructions, but for example simply by informing older adults about the presence of younger participants (Mazerolle et al., 2012). Thus, methodologically important, as both (unintentional) emphasis of the mnemonic demands of the task and information regarding the participation of younger adults may potentially be inherent in many PM experiments, certain effects of stereotype threat can be assumed and should therefore be controlled for in the future. We therefore furthermore suggest that future studies should report more precisely how participants were instructed, so that information on the exact experimental conditions (regarding stereotype threat along with other potential biases) is more easily accessible to the reader.

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Conflict of Interest

None reported.

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