Daily Stressors and Memory Failures in a Naturalistic Setting: Findings From the VA Normative Aging Study

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Laboratory studies of stress and memory have generally found that people with more stress tend to have poorer cognitive performance. The present investigation examined the relationship between stressors and memory failures in a naturalistic setting via a daily diary study of 333 older adults in the VA Normative Aging Study. Multilevel models indicated that on days when people experienced stressors, particularly interpersonal stressors, they were more likely to report memory failures. These stressors were also associated with an increase in memory failures from one day to the next. The findings may be important for preventing cognitive decline.

**Keywords:** daily stressors, interpersonal stressors, memory failures, Normative Aging Study

A growing body of research suggests that cognitive performance is negatively associated with stress (e.g., Wolf, Schommer, Hellhammer, McEwen, & Kirschbaum, 2001), but the majority of this work uses laboratory-based measures of stress and cognition in a laboratory setting. Although laboratory studies are beneficial for understanding basic processes in a controlled environment, they shed little light on the relationship between naturally occurring stressors and more real-world memory tasks (e.g., remembering to take one's medication) that can be particularly important for the health and well-being of individuals on a daily basis (Hertzog & Hultsch, 2000).

The present investigation used a within-subjects design and sought to determine whether older adults experienced more memory failures on days when they had stressors. In laboratory-based studies, stress is typically associated with poorer cognitive performance (e.g., Lupien & Lepage, 2001; McEwen, 2000; Sapolsky, 1999) and has been implicated as a component that may accelerate age-related cognitive decline (McEwen & Sapolsky, 1995; Sapolsky, 1996). Cortisol responses (a stress hormone) have also been linked with poorer memory performance (Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996; Wright, Kunz-Ebrecht, Iliffe, Foese, & Steptoe, 2005). In addition, men who were exposed to a stressful experience (a public speaking task) were unable to recall as many words compared with men who were not exposed to the stressor (Kuhlmann, Piel, & Wolf, 2005), and exposure to stressful events has been associated with poor recognition of pleasant words (Domes, Heinrichs, Rimeline, Reichwald, & Hautzinger, 2004). People who report higher levels of self-reported stress outside the laboratory also tend to experience poorer memory performance (e.g., Vedhara, Hyde, Gilchrist, Tytherleigh, & Plummer, 2000; VonDras, Powless, Olson, Wheeler, & Snudden, 2005). The present study extends this work by examining naturally occurring stressors and memory failures for 8 consecutive days, allowing us to assess the association between stressors and memory within individuals over time.

In addition to the number of stressors experienced, the type of stressor that one encounters may also be important. For example, stressors stemming from the workplace are particularly important in predicting myocardial infarction in working men (Neilson, Brown, & Marmot, 1989). In addition, interpersonal stressors (e.g.,...
arguments) are associated with increased psychological distress, especially in women (Almeida & Kessler, 1998). More broadly, stressors that entail some sort of danger are associated with anxiety, whereas stressors that entail loss are associated with depression (Finlay-Jones, 1989). Although the link between types of stressors and memory failures has not been examined previously, the differential association of various stressors with physical and psychological well-being suggests that an exploratory analysis of the relationship between stressor type and memory failures is warranted.

The relationship between stressors and memory failures could be due to a variety of mechanisms. For example, neuroticism is associated with increased perceived stress (e.g., Hooker, Monahan, Shifren, & Hutchinson, 1992) and heightened reactions to stressors (e.g., Mroczek & Almeida, 2004). Furthermore, neuroticism has been linked to cognitive performance, such that lower levels of neuroticism are related to better episodic memory performance (e.g., Meier, Perrig-Chiello, & Perrig, 2002). Perrig-Chiello, Perrig, and Staehelin (2000) found that neuroticism was a significant predictor of memory decline for men over the age of 75, and Wilson et al. (2003) found that people high in neuroticism had twice the risk of developing Alzheimer’s disease compared with those low in neuroticism. In addition, major stressful life events could be related to memory failures. For example, post-traumatic stress disorder has been associated with poorer cognitive functioning (e.g., Yehuda et al., 2005). Physical health could also be important, given a link between poorer health status and lower cognitive functioning (e.g., Hultsch, MacDonald, Hunter, Levy-Bencheton, & Strauss, 2000). Therefore, neuroticism, stressful life events, and self-rated physical health were used as covariates in the present study.

The goal of the present study was to combine the naturalistic daily stressor approach with self-reported everyday memory failures. Because our sample consisted of older adults, we were able to examine this process in people for whom age-related declines in memory (whether real or perceived) might be particularly salient. A microanalytic daily diary design was chosen because it allows for the examination of within-subjects covariation of daily stressors and memory failures over time. In the present study, we hypothesized that more frequent stressors would be associated with more everyday memory failures and we also examined whether certain types of stressors would be associated with more memory failures. We were also interested in lagged effects—that is, whether stressors on one day were associated with an increase in memory failures from one day to the next. Similar to a change score model, lagged effects models are useful for addressing questions of temporal ordering with correlational data.

Method

Sample

Participants for the analyses were drawn from the VA Normative Aging Study (NAS), a longitudinal study of normal aging processes in men that began in the 1960s (see Spiro & Bossé, 2001, for additional information). In 2001, the 1,125 participants (882 men and 243 of their wives/partners) completed a questionnaire that assessed personality, health behaviors, and life event stressors. Starting in August 2002, recruitment began for the 8-day daily diary study regarding stressors, physical symptoms, positive and negative affect, memory failures, pain, and social support (see Neupert, Almeida, Mroczek, & Spiro, in press, for additional information). Between August 2002 and April 2003, we contacted 529 NAS respondents and their wives and invited them to participate. Of these, 374 agreed, and 333 (181 men and 152 women) returned usable surveys. Most participants completed all 8 days of the study, yielding a compliance rate of 99% and resulting in 2,649 days available for analysis. Respondents who completed the diary did not differ significantly from those who refused or from NAS participants in the 2001 survey who were not included in the diary subsample in terms of age (diary \( M = 73.27 \)), self-rated health (diary \( M = 2.58 \)), life event stressors (diary \( M = 3.36 \)) or neuroticism (diary \( M = 2.21 \)).

Procedure

Instructions indicating when to complete the diary (approximately a half hour before going to bed) and when to return the surveys (when all eight were completed) were sent to each participant. For 8 consecutive evenings, participants completed short semistructured questionnaires about their daily experiences (e.g., stressors, physical symptoms, positive and negative affect, memory failures, pain, and social support). At the conclusion of the 8-day period, participants returned the diaries; if they completed 5 or more of the 8 study days, they received $30; if they completed 4 or fewer days, they received $15.

Measures

Daily stressors. Daily stressors were assessed through the Daily Inventory of Stressful Events (DISE; Almeida, Wethington, & Kessler, 2002). Participants answered questions regarding arguments, potential arguments, stressors that occurred at work/volunteer settings and home, network stressors (that occurred to a network of friends and family), health-related events, and other stressors (stressors that may not have fit into the other categories) each day. Several variables were computed from the frequency of stressors. For each person, for each day, we first computed the sum of all stressors reported (\( M = 0.85, SD = 1.10, range = 0 \) to \( 7 \)); we also computed five dichotomous variables indicating whether the different types of stressors (i.e., interpersonal stressors, demands, network stressors, health stressors, and other) occurred.

Everyday memory failures. Everyday memory failures were assessed through a shortened version of a questionnaire developed by Sunderland, Harris, and Baddeley (1983). The original consisted of 35 yes–no questions tapping five distinct aspects of everyday memory failures: “speech,” “reading and writing,” “faces and places,” “actions,” and “learning new things.” Sunderland et al. instructed participants to complete the questionnaire each evening for 7 consecutive days. Correlations between the subjective test (i.e., the 35-item questionnaire) and objective tests (i.e., laboratory-based cognitive tests) were then calculated. More frequent subjectively reported memory failures were associated with poorer immediate (\( r = .50 \)) and delayed (\( r = .46 \)) story recall and were also associated with poorer performance on an objective paired association test (\( r = .46 \)).

To reduce participant burden, we selected one item from each of the five aspects, specifically choosing the ones that were most likely to be endorsed. Questions included “In the past 24 hours: a) Did you go back to check whether you had done something that you meant to do?; b) Did you start to read something (a book or an article in a newspaper or a magazine) without realizing you had already read it before?; c) Did you find that a word was “on the tip of your tongue,” you knew what it was but could not quite find it?; d) Did you have difficulty picking up a new skill, for example, finding it hard to learn a new game or to work some new gadget after you had practiced once or twice?; and e) Did you fail to recognize, by sight, close relatives or friends, or fail to recognize famous people seen on TV or in photographs?”

To demonstrate that this shortened version could maintain the five domains of the original scale and also capture commonly experienced memory failures, we conducted a pilot study (\( n = 30, 16 \) men and 14
women). The five everyday memory questions were included in a daily diary questionnaire where participants completed the survey every evening for 8 consecutive days. The items were commonly endorsed; on at least one of the study days, 70% of the participants reported going back to check, 37% reported that they started to read something again, 74% reported a tip-of-the-tongue failure, 30% reported having trouble picking up a new skill, and 10% reported failing to recognize someone. In addition, the results indicated some discriminant validity among the five items (i.e., bivariate correlations ranged from .20 to .45), suggesting that the shortened version maintains the original goal of five distinct memory failure types. The diary also included an item assessing everyday memory failures regarding medication. Memory failure variables were constructed in a similar manner as the stressor variables; the frequency of all memory failures for each day was computed ($M = 0.93, SD = 1.08$, range $= 0–6$).

**Covariates**

We controlled for several covariates that were assessed by a survey of all NAS participants in 2001. These included neuroticism (measured by the Eysenck Personality Inventory—Q; EPI-Q; Fodorus, 1974; a short version of the EPI), life event stressors (measured by the Elders Life Stress Inventory; Aldwin, 1991; a 31-item self-administered scale), and a single-item global self-rating of health ($1 = excellent, 5 = poor$).

**Analyses**

To maximize data that were gathered through a daily diary design, we used multilevel modeling (MLM). MLM is frequently used to model intrasubject variability (e.g., Grzywacz, Almeida, Neupert, & Ettner, 2004), that is, people’s variability around their own average. This technique was especially useful because we sought to examine intrasubject variability in stressors and memory failures. The following model was used to examine the within-subjects covariation between stressors and memory failures:

Level 1: $\text{MEMORY FAILURES}_i = \beta_{0i} + \beta_{1i}(\text{STRESSORS}) + r_{it}$

Level 2: $\beta_{0i} = \gamma_{00} + u_{0i}$;

$\beta_{1i} = \gamma_{10} + u_{1i}$.

In Level 1, memory failures for person $i$ on day $t$ are a function of the intercept, $\beta_{0i}$, which is defined as the number of memory failures for person $i$ on stressor-free days (i.e., STRESSORS = 0). $\beta_{1i}$ is the expected change or shift in memory failures associated with the occurrence of stressors. The error term, $r_{it}$, represents a unique effect associated with person $i$ (i.e., individual fluctuation around the mean). In the Level 2 equations, $\gamma_{00}$ is the mean number of memory failures for the sample on stressor-free days (i.e., STRESSORS = 0), and $\gamma_{10}$ is the average change in memory failure between days with and without stressors. The degree to which people vary from the sample mean of memory failures is represented by $u_{0i}$, and the degree to which people vary from the slope is represented by $u_{1i}$.

We conducted a preliminary analysis to ensure that there was sufficient variability between and within subjects to warrant further analyses (e.g., Raudenbush & Bryk, 2002). A fully conditional model (no predictors included in the model) was conducted to obtain estimates of within-subject ($\sigma^2$) and between-subjects ($\tau_{00}$) variability. The estimates were then used to obtain the intraclass correlation coefficient, $\rho_i = \tau_{00} / (\tau_{00} + \sigma^2)$, which was .59, indicating that 59% of the variability in the sum of memory failures was between subjects and 41% was within subjects. In other words, individuals fluctuated around their own averages almost as much as they differed from others; thus, there was sufficient variability in the outcome variable.

**Results**

To address the first hypothesis of the within-subject association between stressor frequency and memory failure frequency on a daily basis, we tested a model controlling for between-subjects differences in neuroticism, life event stressors, and self-reported health with all variables entered simultaneously (see Table 1). The covariates were centered around their grand means, so the grand mean of the sum of the memory failures ($\gamma_{00} = .81$ in the concurrent day model) indicates the number of memory failures on a given day when the covariates were at their mean and when no stressors were experienced (i.e., the sum of stressors was 0). Self-rated health ($\gamma_{0i}$) was not significantly related to daily memory failures, but stressful life events ($\gamma_{10}$), neuroticism ($\gamma_{20}$), and the sum of daily stressors ($\gamma_{1i}$) were positively associated with daily memory failures. On days when people experienced more daily stressors, they reported more memory failures compared with stressor-free days. Specifically, the $\gamma_{1i}$ statistic in Table 1 indicates that each stressor was associated with 0.11 more memory failures in the concurrent day model, so people who experienced one stressor for 9 days could expect to experience one additional memory failure. Note that even after we controlled for the significant effects of stressful life events, the sum of daily stressors was still significantly related to daily memory failures. The percentage of within-subject variance accounted for by the stressor variables was calculated by obtaining the change in within-subject variability estimates ($\sigma^2$) from the fully unconditional (unconstrained) model to the current constrained model and then dividing the result by the unconstrained estimate, $\sigma^2_{\text{uncon}} / (\sigma^2_{\text{uncon}})$. The percentage of between-subjects variance accounted for by the covariates was calculated in a similar fashion with the between-subjects variability estimates, $\tau_{00} / \tau_{00}$.

We conducted a lagged analysis in which memory failures on day $t$ predicted memory failures on day $t + 1$. This model is equivalent to a change score model in terms of the Level 1 variables (Rau-

<table>
<thead>
<tr>
<th>Fixed effects</th>
<th>Concurrent day</th>
<th>Lagged model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of memory failures, $\beta_0$</td>
<td>0.81*** .05</td>
<td>0.59*** .04</td>
</tr>
<tr>
<td>Stressful life events, $\gamma_{0i}$</td>
<td>0.05*** .01</td>
<td>0.04*** .01</td>
</tr>
<tr>
<td>Neuroticism, $\gamma_{20}$</td>
<td>0.06* .02</td>
<td>0.04* .02</td>
</tr>
<tr>
<td>Self-rated health, $\gamma_{0i}$</td>
<td>0.07 .05</td>
<td>0.04 .04</td>
</tr>
<tr>
<td>Change related to stressors, $\beta_1$</td>
<td>0.11*** .02</td>
<td>0.08*** .02</td>
</tr>
<tr>
<td>Previous day memory failures, $\beta_2$</td>
<td>0.81*** .05</td>
<td>0.59*** .04</td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>.05</td>
<td>.04</td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>.04*</td>
<td>.02</td>
</tr>
<tr>
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<td>.04</td>
</tr>
<tr>
<td>Intercept, $\gamma_{20}$</td>
<td>.02</td>
<td>.04</td>
</tr>
</tbody>
</table>

* $p < .05$. *** $p < .001$. 

Note. $n = 333$ participants; 2,649 days.
The lagged model in Table 1 is identical to the concurrent day model with the addition of previous day memory failures as a predictor. As indicated by the $\gamma_0$ statistic, daily stressors were associated with an increase in memory failures from one day to the next, and this model explained 17% of the within-subject variability in memory failures and 67% of the between-subjects variability.

We examined the second hypothesis of the role of specific stressor domains on memory failure frequency by modeling memory failures as a function of daily interpersonal stressors, demands (in work or home domains), network stressors, health-related events, and other stressors. Findings from the concurrent day and lagged models are shown in Table 2. Interpersonal stressors were positively associated with memory failure frequency on the concurrent day and an increase in memory failures from one day to the next. The concurrent day model accounted for 9% of the within-subject variability and 20% of the between-subjects variability, whereas the lagged model accounted for 17% of the within-subject variability and 69% of the between-subjects variability in memory failures.

Discussion

The associations between concurrent day stressors and memory failures, as well as stressors and change in memory failures from one day to the next, remained even after controlling for the effects of neuroticism, life event stressors, and health. Life event stressors were also related to the number of memory failures, such that people who reported more life event stressors also reported more memory failures. The general trend in the association between stressors (life events and daily events) and memory failures supports the findings of many laboratory-based studies (e.g., Vedhara et al., 2000) and extends previous work to a more naturalistic setting. Although life event stressors and daily stressors are different types of events (Wheaton, 1999), they are both important when one is examining everyday memory failures. This finding not only shows the association between stressful life events and memory but also underscores the deleterious effects of seemingly minor stressors that most people experience frequently on a daily basis. Therefore, even if someone does not experience any major life event stressors, day-to-day stressors can still negatively affect memory. Although the association between daily stressors and memory failures remained when controlling for neuroticism, it is important to note that people who reported more neuroticism also reported more memory failures. Based on previous work indicating that neuroticism is associated with increased perceived stress (Hooker et al., 1992) and heightened reactivity to stressors (Mroczek & Almeida, 2004), it is possible that neuroticism could be an important mechanism in this process.

When participants experienced interpersonal stressors, they experienced more memory failures on that same day, as well as an increase in memory failures from one day to the next. It is possible that interpersonal stressors are especially distracting for older adults, who tend to be solution-oriented when faced with an interpersonal conflict (Bergstrom & Nussbaum, 1996) and therefore place more effort and attention on finding a solution. It is also possible that interpersonal stressors are related to memory failures through cognitive interference, as stressful social situations have been linked with more intrusive cognitions (Sarason, Pierce, & Sarason, 1996). Because effort and attention are directed toward the interpersonal conflict, less attention may be available for tasks requiring memory.

The present findings regarding the associations between interpersonal stressors and memory failures are in line with previous assertions that interpersonal stressors can be particularly detrimen-

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### Table 2

<table>
<thead>
<tr>
<th>Fixed effects</th>
<th>Concurrent day</th>
<th>Lagged model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>SE</td>
</tr>
<tr>
<td>Number of memory failures, $\beta_0$</td>
<td>0.84***</td>
<td>0.05</td>
</tr>
<tr>
<td>Stressful life events, $\gamma_{01}$</td>
<td>0.05***</td>
<td>0.01</td>
</tr>
<tr>
<td>Neuroticism, $\gamma_{02}$</td>
<td>0.07**</td>
<td>0.02</td>
</tr>
<tr>
<td>Self-rated health, $\gamma_{03}$</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Change related to interpersonal stressors, $\beta_1$</td>
<td>0.19***</td>
<td>0.04</td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td>Change related to demands (in work or home), $\beta_2$</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Intercept, $\gamma_{20}$</td>
<td>0.01</td>
<td>0.06</td>
</tr>
<tr>
<td>Change related to network stressors, $\beta_3$</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Intercept, $\gamma_{30}$</td>
<td>0.16***</td>
<td>0.03</td>
</tr>
<tr>
<td>Change related to other stressors, $\beta_4$</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Intercept, $\gamma_{40}$</td>
<td>0.01</td>
<td>0.06</td>
</tr>
<tr>
<td>Previous day memory failures, $\beta_6$</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Intercept, $\gamma_{60}$</td>
<td>0.16***</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*Note. n = 333 participants; 2,649 days.*

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

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nal to individuals’ psychological (Rook, 1984) and physical functioning (Kiecolt-Glaser, 1999). This study extends those findings by highlighting the importance that these stressors can have on a person’s memory. Indeed, one reason for this finding may have physiological underpinnings. Kiecolt-Glaser, Malarkey, Cacioppo, and Glaser (1994) found that close personal relationships that are chronically abrasive and stressful may provoke persistent physiological alterations. Although one might expect older adults to terminate relationships that have negative interactions based on socioemotional selectivity theory (Carstensen, Isaacowitz, & Charles, 1999), this is not always possible because support and strain are often derived from the same relationships (Walen & Lachman, 2000). Thus, it is important to understand the sources and ramifications of negative interactions because they may provide a chronic source of stress (Lachman, 2003). Even though the findings from the present study are not surprising in light of previous research, it should be noted that this was the first time daily interpersonal stressors have been linked with everyday memory failures.

Although this study provided an important and unique perspective on the interconnections between naturalistic stressors and everyday memory failures, it is important to recognize its limitations. The design of the present study did not allow for causal claims regarding the relationship between stressors and memory failures. In the lagged analyses we attempted to examine the potential temporal association between stressors and memory failures, but experiments in controlled settings that assess memory failures, induce various levels of stressors, and then measure memory failures again would be more beneficial for ruling out a potential reverse ordering (e.g., that memory failures could cause a daily stressor). Even with these limitations, it is important to emphasize that the naturalistic setting of the current investigation allowed for the examination of stressors and memory failures as they occurred in the everyday lives of older adults and thus allowed for more ecologically valid findings than those that have been obtained in laboratory settings.

Conclusions and Future Directions

The daily diary design provides a novel approach for simultaneously examining naturalistic stressors and memory failures and can be extended in a number of ways. Future studies could explicitly examine the potential link between underlying physiological processes and naturally occurring stressors and memory failures. Similarly, future research could also incorporate laboratory-based cognitive tests (e.g., processing speed, working memory) to examine the relationships between stressors, stress hormones, subjective memory failures, and objective cognitive tests. Perhaps the most important finding from the present study involves the association found between daily stressors and everyday memory failures in a naturalistic setting. The implication that stressful events (both daily stressors and life event stressors) are related to memory functioning in older adults can be particularly important in finding preventative methods to mitigate age-related cognitive decline.

References


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