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Effects of age and anxiety on episodic memory: Selectivity and variability

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Selective age-related differences in source memory relative to item memory, and individual differences in memory performance in relation to anxiety were explored with high- and low-anxious subjects screened from normal young and elderly adults. They were read false facts about the locations of well-known and unknown sights in a male or female voice. Intentional and incidental learning instructions were administered for source memory. Selective age-related deficits in source memory were observed under both encoding conditions. Higher level of anxiety was related to lower memory performance only in the old group; this relation was stronger in source recall. The findings suggest that the presence of such selectivity is unrelated to the tradeoff between item encoding and source encoding. Anxiety affects the variability, and mediates the selectivity of age effects on episodic memory.

Key words: Selectivity, variability, source memory, item memory, age, anxiety.

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It is well established that memory functioning deteriorates with advancing age. However, the magnitude of age-related memory deficits varies across different types of memory (for a review, see Light, 1991), and broad individual differences can be observed in the rate and timing of memory aging (see Filipp, 1996; Lindenberger & Baltes, 1994). The two types of variances in memory aging will be referred to here as *selectivity* and *variability* respectively.

Episodic memory involves storage and retrieval of information encountered in a particular temporal-spatial context. Thus, it includes two basic aspects, namely, memory for the content of a past event (i.e., *item memory*) and memory for its context (i.e., *source memory*). Issues concerning selectivity in memory aging have been of increasing interest in relation to investigations of source memory. An open question is whether age-related decrements in source memory are disproportionally greater than age-associated impairments in item memory. Empirical studies designed to test this hypothesis have yielded mixed evidence. Many studies confifirmed the selective age-related deficits in source memory, whereas others revealed parallel deficits in memory for item and source information (see Spencer and Raz, 1995, for a meta-analysis). As far as the encoding instructions for source information are concerned, incidental instructions were administered in most studies (e.g., Erngrund, Mäntylä & Nilsson,1996; Ferguson, Hashtroudi & Johnson, 1992; Hashtroudi, Johnson, Vnek & Ferguson, 1994), whereas others used intentional instructions (e.g., McIntyre & Craik, 1987; Schacter, Kasznial, Kihlstrom & Valdiserri, 1991). Under incidental learning conditions, participants are not instructed to retain memory for the context of content presentation. In contrast, under intentional learning conditions, participants are explicitly informed about the subsequent memory test for contextual information. Intentional and incidental learning conditions demand high and low encoding effort respectively. It is conceivable that more age-related deficits should be expected in more effortful encoding. Therefore, we suppose that the learning instruction for source information might be one potential reason for the above mixed evidence. So it was manipulated to be intentional or incidental in the present study, while the subsequent memory test for item information was always known. One earlier study (Kausler & Puckett, 1981) used the same manipulation during the study phase, with the focus on whether encoding source attribute (sex of voice) was effortful or automatic. Their results indicated that intentional condition enhanced voice recognition, but impaired sentence recall. Furthermore, such a tradeoff effect was significant only in elderly adults. However, this study does not allow a straightforward comparison of the magnitude of age-related differences in source memory with that in item memory, because Kausler and Puckett investigated source memory with a recognition test and item memory with a recall test.

Another primary interest of the present study is about the variability in memory aging. Age-related memory deficits are ubiquitous, but some people are more affected than others by aging. Even among the very old, the existence of mentally fit individuals is indisputable (Lindenberger & Baltes, 1994). Furthermore, in older ages individual differences in cognitive abilities are accentuated (McClean, Johansson, Berg, Perdersen, Ahern, Petrill & Plomin, 1997). Hence, broad individual differences should be taken into consideration for full understanding of the memory aging process. Various individual differences in demographic, intellectual and biological variables have been observed to be correlated with old people's memory performance (Arbuckle, Gold & Andres, 1986; Cherry & LeCompte, 1999; Erngrund, Mäntylä, & Nilsson, 1996; Erngrund, Mäntylä & Rönnlund, 1996). The role that individual differences in anxiety, a central personality trait, may play in old people's memory performance has received scant attention. The position that anxiety has a major impact on memory has been well studied in young adults (see Eysenck, 1992). In addition, greater anxiety has been found to predict lesser satisfaction with social support, lower life satisfaction, poorer health and poorer socioeconomic status later in life, which have been found to be negatively associated with cognitive performance (see Gold & Arbuckle, 1990). So, it is very likely that individual differences in anxiety among old individuals would influence their memory performance, but few researchers have examined this issue, and fewer studies have compared young and old groups in this regard. Two studies by Deptula, Rajkumar, and Pomara (1993) and Ross (1968) suggested the possibility that the elderly could be more vulnerable to the disruptive effects of anxiety on memory than the young. In contrast, results from Bellott (1995), Erber, Abello, and Moninger (1988), Trepanier and Nolin (1997), and West, Crook, and Barron (1992) indicated that individual differences in anxiety did not affect the memory performance of old people. In addition, it should be noted that all memory tasks used in these surveyed studies dealt with item information exclusively. Thus, whether anxiety affects source memory and item memory differently is unknown.

Eysenck (1992) proposed the *processing efficiency theory* to provide theoretical accounts of the effects of anxiety on performance. Consistent with most theorists, who have attempted to interpret the adverse effects of anxiety on performance, Eysenck argued that worry about task performance, preempted some of the resources of working memory system. On the other hand, different from other relevant theories, he claimed that the presence of worry would also lead to allocating extra processing resources to the task to avoid the likely aversive consequences of poor performance, and thus to reduce or eliminate worry. Given that cognitive resources decrease with aging, we hypothesize that the older group do not have enough additional cognitive resources to compensate for the negative effects, while the younger group can allocate additional processing resources to compensate for, at least in part, the adverse effects. In addition, parallel patterns of the effects of anxiety and age on source memory are expected, as both anxiety and aging are related to diminished cognitive resources. That is, if this study can support the view that source memory is more sensitive to aging, then more anxiety-related defificits would be expected in source memory.

The third concern in the present study is an attempt to investigate the selectivity of age effects on episodic memory in relation to individual differences in anxiety. Few studies have examined age differences in source memory in such an individual-difference approach (Erngrund, Mäntylä & Nilsson, 1996; Erngrund, Mäntylä & Rönnlund, 1996). Accordingly, there are fewer studies exploring the potential mediation of individual-difference variables to the disproportionate age-related deficits in source memory relative to item memory. To our knowledge, this is the first study to explore the influences of individual anxiety differences on differential age-related declines in memory for item and source information.

METHOD

Participants

A total of 98 adults (58 young and 40 old) participated in the experiment.

The trait version of State-Trait Anxiety Inventory–Chinese Revision (STAI-CR) (Zheng, Shu, Zhang, Huang, Zhao, Sun, Fu, Li & Xu, 1993) was used to screen participants. Thirty high-anxious and 28 low-anxious young adults and 19 high-anxious and 21 low-anxious elderly adults were selected from the high and low ends of the trait-anxiety scores in a pool of 209 young and 237 old healthy volunteers. The young adults were undergraduates responding to advertisements around campus. The old volunteers were recruited from a research institute-affiliated community. All the participants were paid the equivalent of US$6 for their participation. They were free from perceptual difficulties, or if not, had corrected vision and hearing. A questionnaire was administered to all participants to be able to exclude those with known or suspected neurological or psychiatric conditions that might affect cognition. Demographic characteristics of the participants are given in Table 1.

The young and the elderly adults ranged in age from 18–23 ($M = 20.26$), 60–76 ($M = 64.03$), respectively. They had all completed at least 9 years of schooling. There were no significant differences in education between the young and old groups, $t(96) = 0.92$, $p > 0.05$, and between the high- and low- trait anxious subjects in each age group, $t(56) = 0.85$, $p > 0.05$; $t(38) = 1.23$, $p > 0.05$.

As shown in Table 1, there were significant differences in the scores of trait anxiety between the high-anxious and low-anxious groups for both the young and old adults, $t(56) = 24.45$, $p < 0.001$; $t(38) = 4.46$, $p < 0.001$. Scores of trait anxiety of the young group were also significantly higher than those of the old group, $t(96) = 3.34$, $p < 0.01$.

Materials

Five old and five young individuals were asked to generate as many well-known sights as possible distributed in 30 provinces all over China as the well-known sights pool and those located at their own hometowns as the unknown sights pool. Forty-four well-known and 35 unknown sights were chosen from the pools to compose a 1–7 point scale. Twenty old and 30 young adults were asked to assess degrees of familiarity with these sights and to try to fill out the corresponding provinces where these sights were located. Based on the familiarity assessment together with the answers to locations, 26 well-known sights reported to be of *high* to *extreme high* familiarity (6–7) and 10 unknown sights reported to be of *no* to *mild*

Table 1. *Demographic characteristics of participants*

Item		Young		Old	
		High-anxious	Low-anxious	High-anxious	Low-anxious
Age(years)	*M*	20.23	20.30	64.55	63.50
	SD	1.07	1.17	5.40	3.19
Education(years)	*M*	14.53	14.64	14.42	15.24
	SD	0.51	0.49	2.52	1.61
Sex	Male	10	13	5	14
	Female	20	15	14	7
TA score	*M*	56.77	32.64	43.00	32.00
	SD	4.02	3.49	8.51	7.08

familiarity (1–2) were chosen to construct the experimental materials. All subjects who generated and assessed the materials were comparable to the experimental subjects in age and years of education, but were not involved in the experiment per se.

The study materials comprised six false locations (i.e., provinces) about well-known sights, such as “Xi Lake is in Shangdong Province” (it is located in Zhejiang province), and six false locations about unknown sights, such as “Ma Ta Island is in Jilin Province” (it is in Hubei province). The study items were equally read in male and female voices and were recorded with computer. The test items included 36 questions inquiring the locations of well-known and unknown sights. Twelve of these questions referred to the studied statements (e.g., Xi Lake is in ______.), and subjects were asked to answer according to the studied content. The remaining questions were distractors in the sense that they had not been studied earlier in the experiment. Twenty of these distractor questions were about well-known sights (e.g., Huang Mountain is in ______.). These questions can be answered with general geographic knowledge (Thus, they were also taken as a test of semantic memory). The remaining four distractors were about unknown sights (e.g., XiLin Tai is in ______.). It is impossible for subjects to correctly answer the questions about unknown sights not studied.

Design

The experiment consisted of a 2 (Age: young vs. old) × 2 (Anxiety: high vs. low) × 2 (Learning instruction: intentional vs. incidental) between-subjects design.

Procedure

First, participants completed a state version of STAI-CR (i.e., pre-test state anxiety). Two episodic memory tasks testing both item and source memory followed. Then after participants completed a state version of STAI-CR again (i.e., mid-test state anxiety), they continued with a verbal fluency test. The last task was a word-fragment completion task. For the present research purposes, only the data from the second episodic memory task and other data related to this task will be reported here.

Scores of pre-test and mid-test state anxiety (SA) are displayed in Table 2.

Pre-test SA scores were significantly higher in the young than in the old, t (94) = 2.69, $p < 0.01$. During the experiment, the SA scores of both young and old subjects increased significantly, t (55) = 2.13, $p < 0.05$; t (38) = 4.87, $p < 0.001$. Age differences in the mid-test SA scores disappeared, t (95) = 0.15, $p > 0.05$. Analysis in another way showed that for pre-test SA scores, high-anxious individuals were much higher than low-anxious individuals in both young and old groups, t (54) = 8.82, $p < 0.001$; t (38) = 3.34, $p < 0.01$. Mid-test SA scores were still much higher in the high-anxious than in the low-anxious for both groups, t (56) = 5.48, $p < 0.001$; t (37) = 6.50, $p < 0.001$.

Table 2. *Pre-test and mid-test state anxiety*

Group		State anxiety			
		Pre-test		Mid-test	
		M	*SD*	*M*	*SD*
Young	High-anxious	47.76	7.91	49.23	9.51
	Low-anxious	30.33	6.78	35.82	9.09
Old	High-anxious	37.79	8.82	51.42	10.69
	Low-anxious	29.86	6.06	33.80	5.61

A modified version of fictitious-facts paradigm developed by Schacter, Harbluk and McLachlan (1984) was used. In the present experiment, false statements about the locations of well-known and unknown sights replaced Schacter *et al.*'s made-up facts about well-known and unknown people.

Participants were tested individually using a PC 586 computer. During the study phase, 12 target sentences were presented three times in either a male or a female voice. Half of the subjects were instructed to remember sentence content for a subsequent memory test. No mention was made of the following test for sex of voice (i.e., incidental learning condition). The other half of the subjects were informed that the purpose of the experiment was to examine memory for both sentence content and sex of voice (i.e., intentional learning condition).

In the test phase, 36 questions were randomly presented on the screen. Each participant was asked to answer the questions verbally with the missing locations, and then to identify the corresponding sources with four alternatives by pressing different keys: presented by male voice, presented by female voice, learned in extra-experiment ways (e.g., learned in school, read in newspaper, magazine or book), and a guessing or a not-known alternative. The time constraints were 10s for the item and source recall tests, respectively.

RESULTS

Item recall

The proportions of correctly recalled items are presented in Table 3.

Table 3. *Proportions of correctly recalled items across age, anxiety and learning instruction*

Group		Learning instruction: Intentional *M*	Intentional *SD*	Incidental *M*	Incidental *SD*
Young	High-anxious	0.40	0.34	0.50	0.28
	Low-anxious	0.35	0.28	0.34	0.27
Old	High-anxious	0.11	0.11	0.28	0.14
	Low-anxious	0.21	0.13	0.48	0.12

Table 4. *Overall proportions of correctly recalled sources across age, anxiety and learning instruction*

Group		Learning instruction: Intentional *M*	Intentional *SD*	Incidental *M*	Incidental *SD*
Young	High-anxious	0.71	0.15	0.56	0.29
	Low-anxious	0.63	0.23	0.45	0.21
Old	High-anxious	0.22	0.15	0.18	0.19
	Low-anxious	0.53	0.28	0.48	0.18

Overall, old participants recalled significantly fewer items than did young participants, $F(1, 90) = 6.66$, $MSE = 0.058$, $p < 0.05$. Item recall was higher under the incidental learning condition of source recall than under the intentional learning condition of source recall, $F(1, 90) = 7.11$, $MSE = 0.058$, $p < 0.01$. Moreover, the interaction between these two factors showed borderline levels of significance, $F(1, 90) = 3.42$, $MSE = 0.058$, $p < 0.07$. The interaction was such that the intentional group recalled fewer items than did the incidental group for old participants, $F(1, 95) = 8.59$, $MSE = 0.063$, $p < 0.01$. For young participants, the incidental group recalled slightly more items than did the intentional group, a difference that was not significant, $F(1, 95) = 0.41$, $MSE = 0.063$, $p > 0.05$. Further analysis showed that only under the intentional learning condition, there was a significant age difference, $F(1, 95) = 7.07$, $MSE = 0.064$, $p < 0.01$. The interaction between age and anxiety was also significant, $F(1, 90) = 7.03$, MSE = 0.058, $p < 0.01$. Subsequent analysis revealed that for old participants, the low-anxious group performed better than the high-anxious group at a peripherally significant level, $F(1, 95) = 3.80$, $MSE = 0.065$, $p = 0.05$. In contrast, for the younger participants, the high-anxious group recalled a little more items than the low-anxious group, a difference that was not significant, $F(1, 95) = 2.80$, $MSE = 0.065$, $p > 0.05$. No other significant effects were observed.

Source recall

Table 4 displays the overall proportions of sources recalled correctly.

An ANOVA revealed significant main effects of age, $F(1, 90) = 27.76$, $MSE = 0.047$, $p < 0.001$, and learning instruction, $F(1, 90) = 5.41$, $MSE = 0.047$, $p < 0.05$, indicating younger participants performed better than older participants, and the sources under the intentional learning condition were better remembered than those under the incidental learning condition. But age did not interact significantly with learning instruction, $F(1, 90) = 1.79$, $MSE = 0.047$, $p > 0.05$. The main effect of anxiety was also significant, $F(1, 90) = 5.50$, $MSE = 0.047$, $p < 0.05$. More importantly, the interaction between age and anxiety was significant, $F(1, 90) = 19.88$, $MSE = 0.047$, $p < 0.001$. Subsequent analysis revealed that for the old participants, but not for the young participants, the low-anxious group performed significantly better than the high-anxious group, $F(1, 95) = 13.20$, $MSE = 0.063$, $p < 0.001$. No other significant differences were found.

Table 5. *Proportions of source recall conditionalized on correct fact recall across age, anxiety and learning instruction*

Group		Learning instruction: Intentional *M*	Intentional *SD*	Incidental *M*	Incidental *SD*
Young	High-anxious	0.89	0.17	0.65	0.36
	Low-anxious	0.76	0.24	0.71	0.24
Old	High-anxious	0.50	0.35	0.27	0.33
	Low-anxious	0.67	0.28	0.67	0.20

Table 5 shows proportions of source recall conditionalized on correct fact recall.

The pattern of conditionalized source recall results was the same as in the unconditionalized data: older adults exhibited markedly lower levels of source recall than did the young. The performance was better in intentional learning condition than in incidental learning condition. An ANOVA revealed significant main effects of age, $F(1, 84) = 14.60$, $MSE = 0.073$, $p < 0.001$, learning instruction, $F(1, 84) = 4.69$, $MSE = 0.073$, $p < 0.05$, as well as non-significant interaction between these two factors, $F(1, 84) = 0.06$, $MSE = 0.073$, $p > 0.05$. Significant main effect of anxiety together with an interaction between anxiety and age were also observed, $F(1, 84) = 4.31$, $MSE = 0.073$, $p < 0.05$; $F(1, 84) = 7.00$, $MSE = 0.073$, $p = 0.01$. The interaction reflected that anxiety had adverse effect only on old participants, $F(1, 89) = 6.37$, $MSE = 0.090$, $p < 0.05$, but not on young participants, $F(1, 89) = 0.26$, $MSE = 0.090$, $p > 0.05$.

Selective age differences in source recall

The above results suggest that there were age-related decrements in both item recall and source recall under intentional encoding. As mentioned earlier, a further question was whether source memory was selectively disrupted by aging.

To test this notion, we carried out a hierarchical regression analysis with overall measure of source recall as a regressor. To remove variance due to differences in item recall, the proportion of correctly recalled items was added in the first step, followed by age. The result showed that after item recall was first added, age explained 19.5% of the source recall variance, $F(1, 46) = 12.54$, $p = 0.001$. In addition, the partial correlation between age and source recall was –0.46, after controlling for item recall, $p = 0.001$. On the other hand, the explanation of age to item recall (7.2%) was not significant after source recall was first added, $F(1, 46) = 3.96$, $p > 0.05$, and their partial correlation (−0.28) was also not significant after controlling for source recall, $p > 0.05$. These results indicate that source memory was more sensitive to aging than item memory under the intentional condition.

Under the incidental condition, as the foregoing analysis revealed, although the elderly participants recalled sources significantly less than the young participants, the two groups showed equivalent levels of item recall. Apparently these results also indicate that source memory was disproportionately impaired relative to item recall. Corresponding hierarchical regression and partial correlation analyses confirmed this point.

Selective anxiety-related deficits in source recall

The selective age-related deficits in source recall encouraged us to further explore whether disproportionate anxiety-related impairments can be found in source recall, since the above results indicated that anxiety had adverse effects on both item and source recall of the elderly subjects. With the similar analysis logic, the hierarchical regression analysis with unconditioned source recall as a regressor revealed that anxiety explained 17.0% of the source recall variance after item recall was added first, $F(1, 37) = 7.77$, $p < 0.01$. The partial correlation between anxiety and source recall was −0.42 after controlling for item recall, $p < 0.01$. After controlling for source recall, neither the explanation of anxiety to item recall (7.3%) nor the partial correlation between these two factors ($r = –0.27$) reached significance, ps > 0.05. These results suggest that the deleterious effects of anxiety on source memory were greater than those on item memory.

DISCUSSION

When source became another target and competed with content for attention resources, the high encoding effort required by the intentional learning condition improved source memory per se, but impaired item memory. This impairment was much greater for elderly people than for young people. The notion that older adults typically show greater divided-attention costs than do younger adults (Baron & Mattila, 1989) supports the present results. Age differences in source memory were not accentuated under the intentional encoding condition; this is inconsistent with our prediction. Furthermore, it was also unexpected that the selective age-related deficits in source memory were observed under both intentional and incidental encoding conditions. That is, the tradeoff relation between item encoding and source encoding did not affect the selectivity in memory aging.

The selective age differences in source memory suggest that this is not only an expression of general age-related decrements of episodic memory. Furthermore, the insensitivity of age differences in source memory to the amount of effort required at encoding contrasted with such sensitivity in memory for item information, suggests that source memory and item memory involve, at least in part, qualitative different properties. But, as to which specific features of source memory should be responsible for the qualitative differences, we cannot yet say much. A detailed investigation of this issue is beyond the scope of the present article. As noted, the intentional encoding enlarged the age differences only in item memory, but selective age-related deficits in source memory were still observed in this condition. One explanation is that the age effects on source memory are strong enough to preclude the identification of any significant effect of such enlargement on the selectivity.

Neuropsychological and neuroimaging findings suggest that the qualitative differences in memory for item and source information may have underlying brain structures (see Friedman, 2000, for a review). Prefrontal cortex may play a critical role for context memory and only a minor role for content memory. Because prefrontal cortex is especially vulnerable to aging (for a review, see Raz, 2000), memory functions relying on this region are selectively disrupted by aging. The present data also provide some supportive implications for the important role of the frontal lobes in source memory. We collected data concerning elderly adults' performance on a verbal fluency test, in which subjects were asked to verbally generate items within restricted semantic categories, and to write words beginning with a restricted Chinese radical. The naming and writing tasks reflected category fluency and initial letter fluency respectively (Ratcliff, Ganguli, Chandra, Sharma, Belle, Seaberg & Pandav, 1998). Initial letter fluency was found to be particularly sensitive to frontal lobe dysfunction (Cuenod, Bookheimer, Hertz-Pannier, Zeffiro, Theodore & LeBihan, 1995), whereas category fluency appeared to be relatively spared in frontal lesions (Coslett, Bowers, Verfaellie & Heilman, 1991). We found a significant correlation between overall measure of source recall and the writing task measure, $r = 0.337$, $p < 0.05$, but not between the performances in the source recall and the naming tasks, ps > 0.05.

The present results, that the high-anxious subjects performed much more poorly than the low-anxious subjects only in the older group, are in agreement with Deptula *et al.* (1993) and Ross (1968), but against Bellott (1995), Erber *et al.* (1988), Trepanier and Nolin (1997), and West *et al.* (1992). The mixed results may stem from different measures of anxiety as indicated by Cavanaugh and Zuidema-Murphy (1986), as well as differences in sample of subjects, experiment procedures etc. Although research examining the relation between anxiety and memory with both old and young participants is sparse, some relevant studies provide indirect support to the present results. Arbuckle *et al.* (1986) and Amrhein, Bond and Hamilton (1999) reported that neuroticism and less internal locus of control were related to lower memory performance in the older participants, suggesting the possibility that anxiety, which is closely related to neuroticism and less internal locus of control, might also have an adverse effect on older people's memory performance. The results from Cohen, Eisdorfer, Vitaliano, and Bloom (1980), that trait anxiety was negatively associated with reasoning performance in the elderly, but not in younger subjects, suggest the similar view to ours that the elderly may be more vulnerable than the young to the deleterious effects of anxiety on cognitive performance. Such vulnerability exhibited by the elderly confirmed our earlier assumptions on the basis of the processing efficiency theory, that older adults cannot allocate enough additional resources to compensate for the negative effects of anxiety, but younger adults can.

However, as mentioned in the procedure section, the younger and the older participants reported equivalent levels of mid-test state anxiety. Given this observation, the present findings seem to be in conflict with the classical inverted-U rule, which demonstrates that individuals with moderate levels of anxiety perform better than those with either high or low levels of anxiety. To address this issue, we further examined the *increment of state anxiety* by subtracting the pre-test state anxiety from the mid-test state anxiety, and found that the correlation between age and the increment of state anxiety was significant ($r = 0.23$, $p < 0.05$), suggesting that elderly people exhibited greater state anxiety increment than young participants. Therefore, we suppose that it is the increment of state anxiety that plays an important role to explain the age differences in the relation between anxiety and memory.

The results revealed that anxiety had more adverse effects on source memory than on item memory among older adults. Relating the selective anxiety-related differences in source memory to the notion that source memory is more dependent on the function of frontal lobe, we propose that frontal cortex might also play an important role in the relation between anxiety and source memory. This idea is to some extent supported by the recent experimental evidence that anxiety disorders were consequences of frontal lobe dysfunction (Chrostensen & Bilder, 2000).

Finally, consistent with our prediction, the selective anxiety-related impairments in conjunction with the disproportionate age-related deficits in source memory showed similar patterns of the effects of anxiety and age on memory for source. The parallel patterns imply that anxiety might partially mediate the selectivity of memory aging. On a broader note, the results suggest that future studies of selectivity in memory aging may profit from adapting an individual-difference approach.

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