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Test Anxiety and Metamemory:
General Preference for External over Internal Information Storage

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Abstract

Substantial evidence suggests that test anxiety is associated with poor memory performance. The relationship between test anxiety and metamemory, however, has remained largely unexplored. The present study examines test anxiety and metamemory from the perspective of storage selection in extended memory systems. A sample of 56 university students with scores in the upper or lower thirds of the distribution for the Test Anxiety Inventory were presented with sentences describing everyday tasks under conditions where low and high importance was attached to future remembering. For each sentence, participants indicated whether they would choose internal memory storage (neurophysiological memory) or external storage (external memory aids) to remember the information. Results showed that test-anxious participants displayed a general preference for external over internal storage, independent of the importance attached to remembering. Low estimated success of internal storage emerged as a potential reason for this preference. Implications of these findings for research on test anxiety, metamemory, and storage selection in extended memory systems are discussed.

Keywords: test anxiety, memory, memory aids, metacognition

Introduction

Substantial evidence accumulated over the last 25 years suggests that test anxiety is associated with poor memory performance (for reviews, see Eysenck, 1979; Mueller, 1992; Zeidner, 1998). According to cognitive models of anxiety and performance (Eysenck, 1992), test-anxious individuals show impaired performance because part of their working memory is occupied with task-irrelevant thoughts such as worries about performance and thoughts about failure, leading to inferior performance in memory tasks.

Whereas the relationship between test anxiety and memory is well documented (e.g., Hembree, 1988), only very little is known about the relationship between test anxiety and metamemory (Zeidner, 1998). The concept of metamemory was first introduced by Flavell (1971) and later defined as the "individual's knowledge of and awareness of memory, or of anything pertinent to information storage and retrieval" (Flavell & Wellman, 1977, p. 4). Thus, metamemory comprises not only knowledge about one's own memory (such as knowledge about the strengths and weaknesses of one's memory) but also knowledge about ways and means to compensate for potential weaknesses, including knowledge of mnemonically relevant parts of the external world such as external memory aids.

Following Flavell's broad conception of metamemory, Schönflug and Esser (1995) introduced the concept of "extended memory systems." Traditional views on human memory have restricted memory to internal (neurophysiological) memory. According to Schönflug and Esser, however, memory is more than what people can keep in their heads. Instead, human memory is an extended and interrelated system of internal memory combined with various external memory stores. These include not only written records (e.g.,

notes), but also non-verbal cues (e.g., the classic "knot in your handkerchief")¹ and other individuals (e.g., one's secretary).

Within the framework of extended memory systems, one important question concerns storage selection: How do individuals decide whether to use internal memory or external memory to store a new piece of information? According to the theory and research of Schönplflug and Esser (1995; Esser, 1996, 1998; Schönplflug, 1986a, 1986b), three parameters are crucial when evaluating internal and external storage, namely (a) the importance of remembering the information, (b) the estimated likelihood of successful remembering of the information when using internal memory versus external memory aids, and (c) the estimated effort of storing the information internally versus externally. If remembering a piece of information is of great importance, individuals generally prefer external storage over internal storage. Otherwise, individuals estimate the success and effort associated with internal versus external storage and choose the storage method with the higher likelihood of successful remembering or with the lower effort of storing.

The aim of the present study was to explore metamemory in test anxiety by investigating preference for internal versus external storage for sentences under conditions where low and high importance was attached to remembering. Research on test anxiety and memory has demonstrated that test-anxious individuals have poorer (internal) memory than individuals low in test anxiety. Thus, for highly test-anxious individuals, the likelihood of successful remembering when using internal storage should be lower compared to individuals low in test anxiety. Consequently, following Schönplflug and Esser's predictions, test anxiety should be associated with a general preference for external over internal storage of information.

Method

Participants

A sample of 56 (38 female) students was recruited at the Free University of Berlin according to the procedure outlined below. Average age was 27.0 years ($SD = 7.1$). All participants volunteered in exchange for two hours of extra course credit.

Procedure

Test anxiety. Students were recruited for an experiment on "internal and external memory." Students who indicated interest in participating filled out the Test Anxiety Inventory (TAI-G) devised by Hodapp (1991, 1995). The TAI-G is a 30-item self-report measure of the tendency to experience anxiety in test situations (e.g., "I'm worrying about doing right", "I have an uneasy, upset feeling"). With a 4-point answer scale from *Almost never* (1) to *Almost always* (4), TAI-G scores have a potential range of 30-120. The TAI-G has demonstrated high reliability (Cronbach's $\alpha \geq .91$) and validity (Hodapp, 1991, 1995; Musch & Bröder, 1999). From all participants who had indicated interest in the experiment, we selected 27 (20 female) participants with scores in the upper third and 29 (19 female) participants with scores in the lower third of the distribution of TAI-G scores, following preliminary TAI-G norms for university students (V. Hodapp, personal

¹In the US, this would correspond to "string around your finger."

communication, October 14, 1995).²² The mean TAI-G score in the low test-anxiety group was $M = 50.4$ (range = 33-60) and in the high test-anxiety group $M = 84.4$ (range = 68-100).

Storage selection task. All experimental sessions were held individually. To assess storage selection in extended memory systems, we used the storage selection task developed by Esser (1996, 1998). In this task, participants are presented with 60 sentences describing everyday memory tasks such as "You want to go to a birthday party ten days from now", "You want to check the sparking plugs of your car every six months", or "You want to take an espresso machine with you the next time you go on vacation" (for details, see Esser, 1998). For each sentence, participants told the experimenter whether they would choose internal memory (i.e., try to memorize the information) or external memory (e.g., write the information down on an index card). Instructions emphasized that the storage selection task was not a "test situation" in which there were right and wrong answers. Instead, it more closely resembled an "interview situation" in which the experimenter was merely asking about participants' personal preferences.

Importance of remembering. To manipulate the importance of remembering, a hypothetical situation in which remembering was associated with a premium was given as the context for storage selection for half of the sentences (cf. Meacham & Singer, 1977). After presentation of the first 30 sentences, the experimenter told participants that, for the remaining 30 sentences, they should imagine that they were participating in a game show in which they could win 10,000 German marks if they remembered more items than other participants.

Success and effort. After storage selection was completed, all sentences were again presented to the participants. For each sentence, participants estimated the success (likelihood of successful remembering) and effort (effort of storing) for internal storage (internal memory) and for external storage. Success was rated on an 11-point scale from *Sure failure* (0%) to *Sure success* (100%), effort on a 7-point scale from *Low effort* (1) to *High effort* (7).

Results

First, storage selection was examined using a two (test anxiety) \times two (importance) mixed-factorial ANOVA. Both main effects were significant, test anxiety with $F(1, 54) = 4.34$, $p < .05$ and importance with $F(1, 54) = 18.72$, $p < .001$. In line with our expectations, participants with high test anxiety selected a greater percentage of external storage than participants with low test anxiety (high test anxiety: $M = 59.4\%$, $SD = 22.0$; low test anxiety: $M = 47.2\%$, $SD = 21.8$). In line with Schönplflug and Esser's model, participants selected external storage more often when it was important to remember the information than when it was not (high importance: $M = 57.6\%$, $SD = 24.5$; low importance: $M = 48.6\%$, $SD = 23.3$). However, the main effects were qualified by a significant interaction of test anxiety and importance, $F(1, 54) = 4.88$, $p < .05$. To examine the nature of this interaction, post-hoc difference tests were calculated (Table 1). Results indicated that only participants with low test anxiety showed increased externalization when importance increased. In contrast, highly test-anxious participants showed a general preference for external memory aids, independent of the variation in importance.

²²Participants who did not qualify for inclusion had the opportunity to participate in another, similar study in order to fulfill their course requirements.

Next, success and effort were examined separately for internal storage, external storage, and the storage method that participants had chosen (Table 2). Results showed that test anxiety had a significant effect on estimated success associated with internal storage. Highly test-anxious participants estimated internal storage to be less successful than participants with low test anxiety. No other effects of test anxiety reached statistical significance. Moreover, repeating all analyses with gender as an additional between-participants factor had no appreciable impact on the pattern of results obtained. All main and interaction effects of gender were nonsignificant.

Discussion

In line with research evidence showing poor memory performance for individuals with high levels of test anxiety, the present study found that participants with high test anxiety expected internal storage of information to be less successful than participants with low levels of test anxiety. Consequently, high-anxiety participants showed a greater preference for external storage over internal storage of information. Moreover, whereas participants with low test anxiety increased externalization of information with increases in importance, high-anxiety participants did not. Instead, they showed a general preference for external over internal storage of information, regardless of the importance attached to remembering.

The present findings have potentially important implications. First, they demonstrate that test anxiety is associated with differences in metamemory. Test-anxious individuals perceive their internal memory as less reliable, as indicated by lower estimates of the successful retrieval of information when stored internally compared with individuals with low levels of test anxiety. Consequently, when it is possible to store information externally, test-anxious individuals should prefer to do so. Second, the present findings demonstrate that personality variables may moderate the role that the parameters of the model developed by Schönplug and Esser (1995; Esser, 1996, 1998) play in the prediction of storage selection in extended memory systems. In general, individuals prefer external storage over internal storage only when it is of great importance to remember. Test-anxious individuals, however, seem to prefer external storage regardless of importance.

However, several limitations of the present study need to be addressed. First, the number of participants was rather low. Moreover, the sample consisted mainly of female participants. This may limit the generalizability of the present findings. Second, the importance manipulation was not counterbalanced. Even though instructions stressed that the storage selection task was not a "test situation", highly test-anxious participants may have felt more nervous at the beginning of the study, rendering them less confident and thus more likely to choose external storage. Finally, future studies may profit from employing designs that capture actual storage selection and actual storage performance. Only with such designs can it be decided whether test-anxious individuals' conceptualization of their memory performance is accurate (cf. Everson, Smolaka, & Tobias, 1994). Moreover, such designs would allow the investigation of an important question: whether external storage (e.g., using notes) is a useful compensatory strategy for test-anxious individuals. So far, research related to this question has produced mixed results. On the one hand, there is research showing that test-anxious children profit from external memory aids. When provided with memory support, they show problem-solving performance at levels comparable to those of low test-anxious children (Sieber, Kameya, & Paulson, 1970). On the other hand, research on note taking has shown that test-anxious individuals take notes

that are less useful than those produced by low test-anxious individuals (Carrier, Higson, Klimoski, & Peterson, 1984). Therefore, test-anxious individuals may prefer external storage as a strategy which enables them to play it safe (Stöber, 1996). However, the actual success of this strategy may be severely limited by the potentially low quality of their external stores.

References

- Carrier, C., Higson, V., Klimoski, V., & Peterson, E. (1984). The effects of facilitative and debilitating achievement anxiety on note-taking. *Journal of Educational Research, 77*, 133-138.
- Esser, K. B. (1996). What can I do to remember? Outlines of a general model for preparing future retrieval. In W. Battmann & S. Dutke (Eds.), *Processes of the molar regulation of behavior* (pp. 73-88). Lengerich, Germany: Pabst Science Publishers.
- Esser, K. B. (1998). *Ein Modell zur Verknüpfung des persönlichen Gedächtnisses mit externen Informationsspeichern* [A model connecting personal memory with external information stores] [On-line]. Doctoral dissertation, Free University of Berlin, Germany. URL: http://www.dissertation.de/html/body_esser.htm.
- Everson, H. T., Smoldaka, I., & Tobias, S. (1994). Exploring the relationship of test anxiety and metacognition on reading test performance: A cognitive analysis. *Anxiety, Stress, and Coping, 7*, 85-96.
- Eysenck, M. W. (1979). Anxiety, learning, and memory: A reconceptualization. *Journal of Research in Personality, 13*, 363-385.
- Eysenck, M. W. (1992). *Anxiety: The cognitive perspective*. Hove, UK: Erlbaum.
- Flavell, J. H. (1971). First discussant's comments: What is memory development the development of? *Human Development, 14*, 272-278.
- Flavell, J. H., & Wellman, H. M. (1977). Metamemory. In R. V. Kail, Jr. & J. W. Hagen (Eds.), *Perspective on the development of memory and cognition* (pp. 3-34). Hillsdale, NJ: Erlbaum.
- Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. *Review of Educational Research, 58*, 47-77.
- Hodapp, V. (1991). Das Prüfungsängstlichkeitsinventar TAI-G: Eine erweiterte und modifizierte Version mit vier Komponenten [The test anxiety inventory TAI-G: An extended and modified version with four components]. *Zeitschrift für Pädagogische Psychologie, 5*, 121-130.
- Hodapp, V. (1995). The TAI-G: A multidimensional approach to the assessment of test anxiety. In C. Schwarzer & M. Zeidner (Eds.), *Stress, anxiety, and coping in academic settings* (pp. 95-130). Tübingen, Germany: Francke.
- Meacham, J. A., & Singer, J. (1977). Incentive effects in prospective remembering. *Journal of Psychology, 97*, 191-197.
- Mueller, J. H. (1992). Anxiety and performance. In A. P. Smith & D. M. Jones (Eds.), *Handbook of human performance* (Vol. 3, pp. 127-160). London: Academic Press.
- Musch, J., & Bröder, A. (1999). Psychometrische Eigenschaften und Validität des multidimensionalen Prüfungsängstlichkeitsinventars TAI-G [Psychometric properties and validity of the multidimensional test-anxiety inventory TAI-G]. *Zeitschrift für Pädagogische Psychologie, 13*, 100-105.
- Schönplflug, W. (1986a). External information storage: An issue for the psychology of memory and cognitive capabilities. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities* (Vol. 1, pp. 369-375). Amsterdam, Netherlands: Elsevier.
- Schönplflug, W. (1986b). The trade-off between internal and external information storage. *Journal of Memory and Language, 25*, 657-675.
- Schönplflug, W., & Esser, K. B. (1995). Memory and its "Graeculi": Metamemory and control in extended memory systems. In C. A. Weaver III, S. Mannes, & C. R. Fletcher (Eds.), *Discourse comprehension: Essays in honor of Walter Kintsch* (pp. 245-255). Hillsdale, NJ: Erlbaum.
- Sieber, J. E., Kameya, L. I., & Paulson, F. L. (1970). Effect of memory support on the problem-solving ability of test-anxious children. *Journal of Educational Psychology, 61*, 159-168.

Stöber, J. (1996). Anxiety and the regulation of complex problem situations: Playing it safe? In W. Battmann & S. Dutke (Eds.), *Processes of the molar regulation of behavior* (pp. 105-

118). Lengerich, Germany: Pabst Science Publishers.

Zeidner, M. (1998). *Test anxiety: The state of the art*. New York: Plenum.

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Table 1

Percentage of External Storage of Information: Interaction Effect of Test Anxiety and Importance.

External storage (%)	Test anxiety			
	Low (<i>n</i> = 29)		High (<i>n</i> = 27)	
	Low importance	High importance	Low importance	High importance
<i>M</i>	40.6 _{a,b,c}	53.9 _a	57.8 _b	61.6 _c
(<i>SD</i>)	(21.8)	(25.3)	(22.1)	(23.4)

Note. Means sharing the same subscript differ significantly at $p < .05$.

Table 2

Success and Effort: Main Effects of Test Anxiety for Internal Storage, External Storage, and Storage of Choice.

Storage		Test anxiety				<i>F</i> (1, 54)
		Low (<i>n</i> = 29)		High (<i>n</i> = 27)		
		<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)	
Internal	Success	63.1	(12.6)	55.4	(12.0)	5.52*
	Effort	4.03	(0.69)	4.32	(0.67)	2.52
External	Success	72.8	(23.3)	71.5	(19.7)	< 1
	Effort	3.11	(0.91)	3.23	(0.70)	< 1
Choice	Success	76.6	(13.4)	74.8	(12.2)	< 1
	Effort	3.01	(0.66)	3.17	(0.67)	< 1

Note. Choice = the (internal or external) store which participants had chosen for information storage. Success = estimated likelihood of successful remembering, 11-point scale from *Sure failure* (0%) to *Sure success* (100%). Effort = estimated effort for storing, 7-point scale from *Low effort* (1) to *High effort* (7).

**p* < .05.