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Emotional working memory capacity in test anxiety

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ABSTRACT

Fifty-three highly test anxious persons and 58 lowly test anxious persons completed a modified reading span task assessing emotional working memory capacity. Participants were required to perform simple tasks with emotionally benign material (remembering lists of letters) over short intervals while simultaneously dealing with emotionally-laden intrusive thoughts and feelings (processing sentences describing dysfunctional test-related thoughts) relative to emotionally-neutral information (sentences describing emotionally-neutral facts about the world). Emotional working memory capacity (the ability to remember the letter lists in the context of test-related sentences), relative to neutral working memory capacity (the ability to remember the letter lists in the context of valence-neutral sentences), was poorer in highly test anxious persons compared with lowly test anxious persons. The finding showed a particular difficulty employing working memory in test-related contexts in highly test anxious participants. Interventions that can improve emotional working memory capacity for test anxiety were discussed.

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1. Introduction

Test anxiety involves excessive fear and worry about situations involving formal evaluation of performance, particularly in academic domains (Brown et al., 2011). The negative correlation between test anxiety and academic performance has been found in many domains (Ackerman & Heggstad, 1997; Hembree, 1988; Seipp, 1991). Recently, Owens, Stevenson, Hadwin, and Norgate (2012) showed that working memory capacity (WMC) mediated the link between worry (the cognitive component of test anxiety) and academic performance. WMC is defined as the limited capacity to actively maintain information in the face of ongoing processing and/or distraction (Conway et al., 2005; Dalgleish et al., 2007; Engle, 2002; Smith & Jonides, 1999) and is an important individual-differences variable accounting for a significant portion of variance in general intellectual ability, reflecting the processing of goal-relevant information in the face of goal-irrelevant distraction, and being related to a variety of processing outcomes (Barrett, Tugade, & Engle, 2004; Conway, Kane, & Engle, 2003; Engle, Tuholski, Laughlin, & Conway, 1999). Results of Owens et al. (2012) suggest that interventions that can improve WMC in individuals with test anxiety may be beneficial. However, previous research demonstrated that there were

no effects of test anxiety on WMC assessed by reading span (RS) tasks (Calvo & Eysenck, 1996; Calvo, Eysenck, Ramos, & Jimenez, 1994; Calvo, Ramos, & Estevez, 1992). Given these results and the correlational approach of Owens et al. (2012), we argue that it is first necessary to re-examine the relationship between test anxiety and WMC before more complex issues can be addressed regarding the exact mechanism(s) for impaired WMC or interventions for test anxiety by improving WMC. Accordingly, using an experimental method, we adapted a modified RS task designed for measuring emotional WMC as well as neutral WMC in individuals with posttraumatic stress disorder (PTSD) (Schweizer & Dalgleish, 2011) by making stimuli specific to test anxiety, and examined the effects of test anxiety on WMC.

1.1. Emotional WMC

WMC is typically measured using RS tasks, interleaving the presentation of to-be-remembered target stimuli, such as words or letters, with the presentation of a demanding, secondary processing task, such as comprehending sentences (Conway et al., 2005). Up until the modified RS task developed by Schweizer and Dalgleish (2011) appeared, traditional RS tasks require short-term retention of emotionally-neutral information while simultaneously processing competing emotionally-neutral information. Clearly, any such 'valence-neutral' index of WMC cannot fully capture the nature of more emotionally-laden executive challenges in day-to-day cognition (Schweizer & Dalgleish, 2011). Unlike traditional RS tasks in which both memory and operation components involve

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emotionally-neutral material, the modified RS task in Schweizer and Dalgleish (2011) introduced emotionally-laden material into the operation component, developing a trauma-related context as well as a valence-neutral context in the RS task to simultaneously measure emotional WMC and neutral WMC for individuals with PTSD. The task required participants to remember lists of neutral words over short intervals while simultaneously processing two types of sentences: one describing emotionally-neutral facts about the world and the other describing dysfunctional trauma-related thoughts. Results showed that emotional WMC performance, indexed as the ability to remember the word lists in the context of trauma sentences, relative to neutral WMC in the context of neutral sentences, was poorer overall in the PTSD group compared with trauma-exposed controls with no PTSD history, suggestive of a particular difficulty employing working memory in emotion-related contexts in those with a history of PTSD (Schweizer & Dalgleish, 2011). These findings indicated that RS tasks could operationalize this processing of conflicting mental demands and that the modified RS task instantiating the emotional context in the task design, as opposed to valence-neutral paradigms, could better capture impaired emotional WMC (Schweizer & Dalgleish, 2011).

1.2. The test anxiety construct

Test anxiety is a situation-specific form of personality anxiety (Spielberger & Vagg, 1995), which refers to the set of phenomenological, physiological, and behavioral responses that accompany concern about possible negative consequences or failure in an evaluative situation (Zeidner, 1998, 2007). Test anxiety has two major components: worry and emotionality (Cassady & Johnson, 2001; Liebert & Morris, 1967; Spielberger & Vagg, 1995), and the cognitive component of test anxiety is regarded as the defining component of test anxiety (Sarason, 1988). At different temporal phases (pre-evaluation, active evaluation, and post-evaluation) of an evaluation, individuals with different experiences of test anxiety are disadvantageously influenced by worry associated with the consequences of failure (Flett & Blankstein, 1994; Pekrun, Goetz, Perry, Kramer, & Hochstadt, 2004; Raffety, Smith, & Ptacek, 1997; Zeidner, 1998). Test anxiety is characterized by intrusive anxiety-related behaviors and cognitions elicited by testing stimuli in academic settings (Szafranski, Barrera, & Norton, 2012). Apart from poor study skills (Sanghvi, 1995), poor test performance (Chapell et al., 2005), and fear of negative evaluation (Brown et al., 2011), test anxiety is characterized by an attentional bias towards threat stimuli (Putwain, Langdale, Woods, & Nicholson, 2011). Self-reported test anxiety correlates negatively with various evaluative outcomes and WMC mediates the effect of worry on academic performance (Owens et al., 2012).

1.3. Aim of the present study

In conclusion, there are good reasons to believe that impaired emotional WMC will be present in highly test anxious (HTA) persons under the test-related context, relative to lowly test anxious (LTA) persons. Moreover, it might be the main reason for the null effects of test anxiety on WMC found in those previous research using traditional RS tasks (Calvo & Eysenck, 1996; Calvo et al., 1992, 1994) that they did not explore emotional WMC in a test-related context. Thus, we aimed to develop and test a RS measure of emotional WMC and neutral WMC for test anxiety. In this work we introduced test-related sentences forming a test-related context to assess emotional WMC as well as valence-neutral sentences forming a valence-neutral condition to assess neutral WMC into a RS task. We predicted that HTA participants should perform worse than LTA participants in the test-related context, relative to the valence-neutral context.

2. Method

2.1. Participants

A total of 111 first-year undergraduates (mean age, 19.77 ± 1.11 years; 61 females) from Southeast University volunteered for this study. All participants (native Chinese speakers) gave written informed consent. The study was approved by the Ethics Committee of Southeast University.

2.2. Measures

2.2.1. Test anxiety

The Short Form of Test Anxiety Inventory (Taylor & Deane, 2002) in Chinese (Short Form of TAI-C) (Dong, Zhou, Gao, Jiao, & Guo, 2011) was used to assess test anxiety. It showed good validity and reliability evidenced by a large sample survey in undergraduate students. HTA participants ($N = 53$; mean age, 19.87 ± 1.04 years; 28 female) were defined as those scoring more than 13 ($M = 15.23, SD = 1.79$), LTA participants ($N = 58$; mean age, 19.67 ± 1.18 years; 30 female) being those scoring less than 8 ($M = 6.60, SD = .59$) in our study. These cut-off points represented approximately the upper and lower 16% of preliminary norms for the Short Form of the TAI-C (one standard deviation above and below the mean) (Dong et al., 2011). They were selected because Merrell (2000) suggested that a criterion of one standard deviation above or below the normative group mean is a reasonable standard for screening with rating scales, and were found to approximate those used to select HTA and LTA participants, respectively, in several other studies (Chapell et al., 2005; Putwain et al., 2011). In order to encourage participants to respond honestly on the self-report measure, they were asked to use an anonymous code (instead of their names) in the selection phase.

2.2.2. State anxiety

The Chinese version of the state scale of the State-Trait Anxiety Inventory (STAI-S; Spielberger & Diaz-Guerrero, 1975) was used to assess state anxiety. Participants were instructed to select a number ranging from 1 (strongly disagree) to 4 (strongly agree) for each item to indicate how they felt while performing the practice task.

2.2.3. Our modified RS task

To measure emotional WMC, we adopted a modified RS task (see Fig. 1). Participants first saw a sentence and read it loudly. Sentences were spread across two conditions. In the test-related condition, sentences, which were derived from the Test Anxiety Scale (Sarason, 1978) and then were modified, were related to dysfunctional beliefs about test and/or responses to it (e.g., "I feel my heart beating very fast during important tests."). In the valence-neutral condition, sentences were related to emotionally-neutral facts about the world (e.g., "Each day the sun rises in the east and sets in the west."). There were 17–18 Chinese characters in each sentence. Sentence presentation order was randomized across participants within the two conditions.

Once participants had read the sentence loudly, they clicked the mouse to advance to the next screen presenting a prompt ("This sentence contains a two-character item which is a pseudoword") and were required to click on "True" or "False". The order of two characters of a nonreversible Chinese two-character word in one quarter of the sentences in each condition was reversed (e.g. "Mei Li" (a two-character word meaning beautiful) was used in a sentence as "Li Mei" (a two-character item which is a pseudoword)). This ensured that participants had to process all of the sentences as opposed to blindly responding "False" to each one. Importantly, the basic meanings of the sentences remained apparent even with a two-character pseudoword. Care was taken that all of the sentences included in the test-related and valence-neutral conditions had been coded by 12 independent first-year undergraduates as "easy" (on a 4 point Likert scale from

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