



The Review of Anxiety and Working Memory

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Abstract. Anxiety is a serious global problem at present. A moderate level of anxiety can help individuals perform more adaptively, but persistently high levels of anxiety would impair individual physical and mental health. As a result, it is crucial to pay attention to anxiety. There are numerous studies on the association between anxiety and working memory, however, there is no consensus on this issue. The goal of this paper is to provide a summary of the existing findings concerning the interaction between working memory and two kinds of anxiety (test anxiety and social anxiety). The results showed that: 1) anxiety positively or negatively affected working memory; 2) anxiety and working memory interacted and interfered with each other; 3) working memory and anxiety were unrelated. Since the etiology of anxiety symptoms is often unknown, most studies still need to understand the underlying mechanisms of anxiety. These findings are important for further understanding the effect of anxiety on working memory.

Keywords: Test Anxiety · Social Anxiety · Working Memory · Relationship

1 Introduction

Working memory (WM) is an important part of the cognitive process that demands the recall and processing of information in a short period, such as learning, reasoning, and other complicated cognitive tasks. Thus, working memory is often described as a system [1]. Undoubtedly, one of the most prevalent and significant working memory models used to describe working memory in anxiety research is the multiple working memory models [2]. Short-term memory serves a simple function in providing short-term information storage, according to Baddeley's working memory model. It is a complicated system with multiple components that manipulates information storage for increased and sophisticated cognitive value. Moreover, it involves four components: a temporary memory system (episodic buffer) that is assumed to mediate and integrate various sensory data, the central executive, which includes the attentional control system, a visual-spatial WM, and a verbal WM [3]. Although the multicomponent working memory model is widely used, two other working memory models are also common. One emphasizes the importance of attention and long-term memory in supporting WM function by using an embedded-processes model [4]. This model considers working memory as a short-term storage portion with limited capacity, emphasizing the significant dependence of working memory capacity on attentiveness and other central executive functions that utilize stored

information or interact with long-term memory. WM is a section of the engaged long-term memory that is being noticed. Moreover, the link among WM, short-term memory, and long-term memory can be described hierarchically [5]. Another working memory model is an alternative model, which also demonstrates that working memory capacity and cognitive load, are primarily a product of the attention a person receives for the task at hand [6]. This model is similar to the embedded-processes model, but it further emphasizes the function of long-term memory and the value of WM contrasted with short-term memory.

Anxiety is a broad concept that can be used to describe a variety of mood disorders as well as personality features and a fleeting emotional state. It is defined as a state of worry and fear that persists for at least six months and is characterized by physical symptoms such as heart palpitations, sweating, and feeling stressed [7]. Anxiety can be classified into several subtypes, such as social anxiety and test anxiety, depending on the source of the fear. Test anxiety (TA) is a common, worldwide phenomenon that exists in all genders and socioeconomic backgrounds, and can affect academic performance to some extent. TA usually refers to the cognitive, emotional, physical, and behavioral reactions associated with stress and/or fear of the potential negative consequences of performing poorly or failing an exam, it is a complex multidimensional structure [8]. Worry and emotionality are the two key factors that contribute to test anxiety. Worry is composed of negative self-assessment, the expectation of tasks, and worry about performance. Emotionality is composed of cognitive self-concern and physiological arousal [9]. Another component of anxiety is cognitive self-concern, which includes worries and linguistic cognitive activities. Worry and cognitive self-worry, which have nothing to do with task solving, occupy the capacity of the speech circuit when test anxiety is induced. Because of the reduced quantity of information that can be processed in a working memory job, processing information now requires more time, which may result in less accurate task execution [10]. Social anxiety (SA) is a kind of anxiety related to the social environment, which is afraid of receiving negative evaluations from others and interacting with others [7]. Social anxious people are extremely perceptive of other people's opinions and fear criticism [11]. In social settings, they pay close attention to social cues such as other people's facial expressions and gaze patterns [12]. People with social anxiety are also easily distracted by irrelevant stimuli. When people are looking for a target object surrounded by distractors, people those with elevated levels of social anxiety seem to be more likely to pay attention to distractors and are more likely to be distracted by distractors. The reaction time to the object is delayed [13].

At present, there are many pieces of research on these two types of anxiety (social anxiety and test anxiety) and working memory, but there is no uniform result. Through the literature review of the available research, this paper on anxiety and working memory seeks to confirm that there is a connection between these two. In the present review, the association of anxiety and working memory can be divided into three parts: 1) anxiety occupies a part of memory system resources and affects working memory; 2) anxiety and working memory interact and interfere with each other; 3) anxiety is unrelated to tasks related to working memory.

2 Anxiety Affects Working Memory

2.1 Negative Effects on Working Memory

Most studies on anxiety and working memory had shown that anxiety had a negative effect on working memory. The connection of test anxiety and the working memory system was examined in a cross-sectional study [14]. According to the current research, respondents who scored highly on the Test Anxiety Inventory did not exhibit significantly more anxious feelings during working memory tests than those from the low-level anxiety group. There were numerous strong associations between the three working memory subtasks of the intelligence scale, which were all part of the verbal working memory domain. Furthermore, there were no statistically significant differences WM performance across college students in higher test anxiety and those with moderate test anxiety. In the high anxiety group, gender was found to significantly influence working memory performance, but the specific reason was not clear. In most cases, previous studies had used auditory or oral presentation tasks (digit, word, or letter span, verbal reasoning using syllogisms) to assess the working memory of test-anxious students, but a few studies had also used visual-based tasks (spatial reasoning, geometric analogy).

Test anxiety's impact on articulatory circuit faults inside the working memory system was investigated in a study employing verbal memory tasks to occupy the articulatory ring and spatial memory activities to occupy the visual-spatial notepad [15]. Seventeen participants with high test anxiety and nineteen participants with low test anxiety completed the two tasks in an anxiety-induced condition. Working memory task performance was assessed using response time by counting the number of accurate responses. According to the result in this research, the high-anxiety group took longer on average to respond to the verbal memory test than the low-anxiety group did. However, on recognition accuracy and processing speed for spatial working memory tasks, test anxiety had no impact [15]. There was no discernible difference in performance between the two groups. Furthermore, the t-test in this study's spatial task revealed no differences between the two groups' rates of correct recognition. This suggested that the verbal working memory system's ability to process information is hampered by test anxiety symptoms like worry and cognitive self-concern. It was significant to remember that verbal worries like egos and anxious ideas.

2.2 Positive Effects on Working Memory

There was not much research on how anxiety affects working memory. In one study, the social anxiety levels and visual working memory abilities of 41 college students were correlated by multiple regression analysis [16]. The levels of state-trait anxiety and trait social anxiety were measured by three separate questionnaires for anxiety categories and levels. The accuracy rate and response time of the test array to calculate the working memory capacity. This study discovered a significant correlation between trait social anxiety and visual working memory, indicating that those with high trait social anxiety may also have strong visual working memory. This implies that people with social anxiety may distribute their WM resources widely. This appeared as quite a surprise considering that no existing theory specifically linked social anxiety with visual WM.

The above literature reviews showed that the degree of different types of anxiety can affect different parts of the working memory system. Test anxiety can negatively affect verbal WM. Moreover, the degree of test anxiety had no significant difference in the performance of the visuospatial sketchpad which was the visual-spatial WM. However, the degree of social anxiety can positively affect visual-spatial WM.

3 Anxiety and Working Memory Interact and Interfere with Each Other

Many contemporary hypotheses contended that anxiety-related processes affect working memory and even cognition [17]. It had been proved that anxious individuals focus excessively on their emotional responses, which were irrelevant to the task considering and occupied the individual's attention, exhausting the limited working memory resources and leading to either decreased accuracy or longer response times. Therefore, anxiety may be limiting the attention resources needed by working memory, which might clarify how influences working memory. However, the etiology of anxiety symptoms was not clear at present, and there is no clear evidence that anxiety symptoms were a trait of cognitive impairment. Although there was some proof that anxiety, once it's there, had a detrimental effect on tests of cognitive capacity. Individual variations in cognitive capacity may be a risk factor, according to another hypothesis [18]. According to the notion, persons who were less cognitively advanced were more likely to experience anxiety in reaction to stress. Either idea argued that one of the factors contributing to anxiety may be working memory capability. Unfortunately, the present review did not fully address this issue. Shock threat experiments provided the greatest support for this claim, demonstrating unequivocally how fear induction impaired at least one measure of working memory function [19]. Then, these investigations applied a strategy to anxiety that has been well examined and verified. Finally, they provided self-reports confirming that induction modulated participants' anxiety.

There was strong evidence, according to a review, that anxiety symptoms and working memory ability were related. Anxiety was linked to worse overall results on WM tests. What's more, according to a meta-analysis, anxiety moderated the relationship between anxiety and substantive outcomes like academic achievement by reducing working memory capacity [19]. The potency of threat-related connections and the precise tactics employed to disprove those associations both contribute to the maintenance and sustainable development of anxiety disorders. This had led some researchers to hypothesize that restrictive working memory capacity itself might have been a risk key element for afterward developing anxiety [20]. The development of anxiety is assumed to occur as a result of some emotions and thoughts that were challenging to control or suppress. These procedures necessitated working memory capability concurrently. Working memory capacity is correlated to maintenance and/or inhibitory effects on a wide range of difficult cognitive processing. It is essential to various processes that regulate emotions and prevent intrusive thought. When compared to people with strong working memory capacities, people with low working memory capacities had less ability to control their emotions, and intrusive thoughts also happen more frequently ($r = -.024, p < .05$) [21]. These results support the hypothesis that adjusting intrusive memory and cognitive

experience involves cognitive control of working memory capacity. Additionally, there was also a marginal but meaningful association between working memory capacity and anxiety ratings. Second, lower output for various working memory tasks was linked to and interacts with anxiety, both when it was self-reported and experimentally induced.

The level of test anxiety not only interfered with working memory but was also affected by the capacity of working memory. Moreover, only a few papers looked at working memory in social anxiety, and these papers had not established that social anxiety and working memory interact and interfere with each other. Due to the limitations of current technology, the working memory processed most affected by anxiety still has some basic problems. These questions need to be answered in the future with the help of multiple methods of evaluation and good experimental practices.

4 No Association Between Anxiety and Working Memory

Not all research had established the link of working memory and anxiety. Working memory and test anxiety exhibited almost no relationships, according to one study. 3,781 healthy adults between the ages of 18 and 97 completed questionnaires on trait anxiety and depressive symptoms, as well as a battery of cognitive tests [22]. The scores were analyzed to determine whether in a hierarchy of cognitive variables the effects associated with trait anxiety and depressive symptoms occurred [23]. At the top of the cognitive hierarchy, utilizing two separate working memory manipulations, the findings revealed a substantial correlation between trait anxiety and depressive symptoms. However, almost all of the relationships involved effects on other cognitive abilities. After controlling for the effects of cognitive ability and working memory, there was no significant relationship between these two characteristics on measures of the factor of the secondary ability to work memory or cognitive variables, suggesting that the range of structures in working memory was narrower than in other cognitive abilities.

Not only did test anxiety, but also social anxiety did not correlate with working memory. In one study, people with social anxiety compared their memory for socially threatening, positive, and neutral words with a normal control group [24]. In the semantic and perceptual memory tasks involving social threat words, neither the socially anxious participants nor the control group exhibited any memory bias, indicating that social anxiety may not be correlated with working memory.

There had been few studies on the uncorrelation between the working memory and two types of anxiety, and many researchers are skeptical of the findings. Since the task performance of working memory was affected by many other factors besides anxiety, further studies on anxiety and working memory can be conducted by controlling other factors in the future, to confirm the association between anxiety (test anxiety and social anxiety) and working memory.

5 Conclusion

Anxiety is a global health problem that increasingly affects people's daily life. This paper reviews a variety of relationships between anxiety and working memory, but there are methodological limitations (such as the self-assessed anxiety questionnaires) that

make it difficult to unify the relationship between anxiety and working memory. What's more, there are still researchers who believe that working memory and anxiety interfere with each other. In addition, a striking association of visual working memory and social anxiety was found in this analysis that no relevant theory could have anticipated. Working memory and anxiety may not even be related, and it is unclear if the consequences of trait anxiety are evident in the functioning of the working memory system.

Part of the current review of findings may be attributable to measurement and cultural differences issues. Future studies can be conducted by enlarging the sample and using more objective measurement tools. Future research may potentially demonstrate the structural nature of the connection between these two anxiety-related issues and working memory. Moreover, this review did not focus much on trait and state anxiety, which may affect working memory in different ways and could be expanded in future studies.

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