

A Retrospect in Study of Relationships Between Anxiety, Depression and Working Memory Capacity

Meihao Guo^{1,a,*}

¹Shenzhen College of International Education, Shenzhen, 518048, China

a. s23727.guo@stu.scie.com.cn

*corresponding author

Abstract: Working Memory Capacity (WMC) is a crucial component in the study of cognitive functions such as learning, problem-solving, and decision-making. Recent research has illuminated the neurobiological foundations of WMC and its connection to academic success, particularly in children. In addition, research into individual differences throughout a person's life has uncovered connections between visual short-term memory, working memory and mathematical proficiency. Depression, marked by emotional distress and neurological degradation, and anxiety, typified by elevated discomfort and physiological arousal, often coincide. It is important to note that these disorders have high comorbidity rates, impacting almost 90% of those with anxiety and 85% of those with depression. Understanding this comorbidity is crucial due to its significant social impact. Existing research demonstrates that depression and anxiety have separate effects on WMC. Therefore, it is essential to grasp the intricacies of depression and anxiety in context of the comorbidity, considering their adverse social impact. Depression compromises working memory, especially in situations involving emotionally-charged data, while anxiety directs cognitive resources away from tasks requiring WMC by causing deficits in attentional control. Comorbidity exacerbates these deficits and appears to be linked with impairments in inhibitory control. Future research must focus on mechanistic insights, exploring the neural basis and therapeutic interventions for this intricate interplay. In conclusion, there is potential for enhancing cognitive function and mental health interventions through comprehending the interplay between WMC, anxiety, and depression. These results underline the necessity of holistic approaches to tackle the cognitive functioning consequences of mental health issues.

Keywords: working memory capacity, depression, anxiety, cognitive psychology

1. Introduction

The notion of working memory, initially introduced by Miller et al in 1960, otherwise known as short-term memory or immediate memory, concerns a cerebral system that enables temporary preservation and alteration of the information required for intricate cognitive activities, developing the principle of short-term memory system [1]. Working memory capacity (WMC) constitutes a fundamental cognitive concept that possesses noteworthy consequences for various cognitive processes such as learning, resolving problems, and making decisions. It is the cognitive system which is responsible for temporarily storing and manipulating information that is essential for intricate cognitive tasks. Often conceptualised as a mental workspace, this construct operates as a limited-capacity system

which is vital for simultaneously maintaining and processing information. According to Baddeley, working memory (WM) retains and alters information from the external environment and plays a role in tasks beyond simple mental calculations, such as language comprehension and reasoning.

In the past decade, research into WMC has achieved notable milestones. Notably, there has been a focused effort to uncover the neural mechanisms underlying WMC. Recent research has investigated the complex relationship between WMC and other cognitive functions. Alloway et al. carried out a study with children which demonstrated a correlation between WMC and academic attainment, especially in subjects that require advanced information processing and retention [2]. Rebecca et al. assessed children's short-term memory, working memory, and executive functioning when they were four years old and attending preschool, and then predicted their academic performance three years later. The findings demonstrated that visual short-term memory and working memory were shown to be specifically associated with mathematical ability [3]. This highlights the practical consequences of understanding and assessing WMC, specifically within educational environments.

Study of WMC has deepened our understanding of its neural foundations, its intricate relationship with other cognitive domains, and its evolution across the lifespan. The paper aims to maintain objectivity by excluding subjective evaluations, and fortunately, recent progress in measurement techniques, such as the n-back task and complex span task, have enabled innovative methodologies to measure and analyse these variables accurately, allowing researchers to further investigate.

Depressive disorder, also called depression, is a mood disorder associated with emotional pain, anger, frustration and loneliness. Major depressive disorder is acknowledged as a neurotoxic and neurodegenerative condition. Its neuroprogressive mechanism encompasses several complex interactions between the nervous, endocrine and immune systems that are harmful to the patient [4]. Research suggests that depression is more likely to arise after experiencing psychosocial stress during the first episode. In contrast, depression tends to become spontaneous after experiencing three or more episodes, rather than being triggered by external events [5]. Such occurrences are often associated with an increased release of cerebrospinal fluid (CSF), a phenomenon that is also observed in cases of anxiety [6].

Anxiety is a multi-dimensional emotional state marked by an increase in feelings of unease, apprehension, and physiological arousal. While it is a common adaptive response, it can manifest as a clinical disorder when it becomes excessive and persistent. For the purposes of this essay, anxiety will be defined as this disorder.

Anxiety has gained substantial research attention owing to its noteworthy impact on individuals' well-being. Significant advancements in research have been made regarding the underlying mechanisms and possible treatments. Craske et al. have investigated the neural circuits involved in anxiety disorders, revealing brain regions linked to fearful reactions [7].

As comprehension of WMC and its associations with depression and anxiety continues to evolve, the grasp of human cognitive abilities will enhance. This essay will examine the research on the relationship between WMC and these two mental health disorders.

2. Relation Between Depression and Anxiety

The correlation between depression and anxiety has received substantial attention within the research community, driven by the advancement of precise measurement techniques for both conditions. In 2014, depression was ranked ninth in terms of combined disability and death impact by the World Health Organization, signifying its significant influence on human society. Similarly, anxiety, another challenging mental disorder, has a considerable negative impact on individuals' lives. Interestingly, these two disorders often occur together due to a shared genetic vulnerability to both [5]. Significantly, there is a remarkable overlap between these conditions, with around 90% of individuals suffering

from anxiety disorders also experiencing co-occurring depression. Moreover, it should be noted that 85% of individuals diagnosed with depression also exhibit symptoms consistent with anxiety [5].

This connection between depression and anxiety has prompted substantial research, with the goal of discovering common underlying mechanisms and potential treatments. Tiller's results emphasise the clinical importance of addressing comorbidity and highlight the need to develop interventions that synergistically target both conditions [5].

In addition to the well-established comorbidity of depression and anxiety, current research aims to improve our comprehension of the reliability of assessment instruments employed to gauge these psychological maladies. As measurement methods for depression and anxiety progress, scholars are more capable of exploring the intricate interplay between these conditions.

3. Association Between Anxiety and Depression with Anxiety Respectively

Relationship between depression and WMC

Research into the relationship between depression and WMC by Joormann and Gotlib shed light on impact of depression on cognitive functioning, particularly within the domain of WM. Utilized the classic n-back task to explore the deficits in individuals with depression, the study unveiled that individuals grappling with depression displayed noticeable impairments in their working memory performance when compared to their non-depressed counterparts [8]. This cognitive impairment was particularly pronounced when processing emotionally valenced information. This finding underscores the intricate nature of working memory deficits in depression, revealing that the emotional content of information significantly affects cognitive resources. Consequently, individuals with depression may struggle with tasks requiring the temporary storage and manipulation of emotional material.

3.1. Relationship Between Anxiety and WMC

Anxiety, with its characteristic emotional turbulence and heightened physiological arousal, presents another facet of the cognitive puzzle. Eysenck et al. conducted a study investigating the relationship between anxiety and working memory using the Attentional Control Theory framework [9]. Employing the complex span task, they observed that individuals with high trait anxiety exhibited impaired working memory performance compared to low trait anxiety individuals. Crucially, this impairment was particularly pronounced when the task demanded attentional control. Eysenck et al.'s study illuminates how anxiety's impact on working memory may be driven by deficits in attentional control, where heightened anxiety levels divert cognitive resources away from the task at hand. He suggested that anxiety-induced attentional biases might allocate cognitive resources to threat-related stimuli, resulting in a depletion of resources available for working memory tasks in his later research. He also described how elevated anxiety levels may cause these biases that have an impact on cognitive resources [10]. However, while this study advances our comprehension of the cognitive consequences of comorbid depression and anxiety, it is not without limitations. The cross-sectional design limits the establishment of causal relationships.

4. A Commodity of Anxiety and Depression and Their Relation with Working Memory

While the discrete effects of depression and anxiety on WMC are insightful, it is their intersection in comorbid presentations that unveils a more complex cognitive landscape.

Gudayol-Ferré et al. conducted a comprehensive study to unravel the complexities of comorbid presentations of these mental health disorders [11]. In this study, the research participants, who exhibited varying degrees of comorbidity, were characterized by a range of demographic factors, such as age, gender, and educational background. Additionally, psychological factors including the severity and duration of their depression and anxiety symptoms were carefully assessed to control for

potential confounding variables. Employing a battery of cognitive tasks, including the Digit Span and the Stroop test, the researchers subjected the participants to a rigorous examination of their working memory. The study incorporated a control group of individuals without depression or anxiety, enabling a robust comparison. Data collected from these assessments underwent thorough statistical analysis, revealing intriguing patterns. Comorbid individuals demonstrated significantly more pronounced deficits in working memory when compared to individuals with either depression or anxiety in isolation, pointed to an additive effect of these two disorders on working memory, signifying that their co-occurrence posed a greater challenge to cognitive functioning. Furthermore, the study hinted at a potential mechanism behind these deficits. Gudayol-Ferré et al. proposed that impaired inhibitory control, a cognitive process commonly disrupted by both depression and anxiety, could be a contributing factor to the exacerbated working memory deficits observed in comorbid individuals.

However, while this study advances our comprehension of the cognitive consequences of comorbid depression and anxiety, it is not without limitations. The cross-sectional design limits the establishment of causal relationships. Future research employing longitudinal approaches could offer deeper insights. Moreover, the study predominantly focuses on cognitive aspects, leaving room for further exploration of the neural mechanisms underlying these cognitive deficits. Nevertheless, Gudayol-Ferré et al.'s work provides a substantial foundation for understanding the intricate cognitive landscape of comorbid depression and anxiety and underscores the significance of inhibitory control in working memory deficits within this context [11].

In comparison to the research conducted by LeMoult and Gotlib, Gudayol-Ferré et al.'s study takes a broader perspective by investigating a wider range of cognitive tasks and considering potential mechanisms underlying working memory deficits [12]. However, LeMoult and Gotlib delve deeper into the cognitive vulnerabilities arising from comorbid depression and anxiety, providing a more comprehensive understanding of how these two disorders intersect to impact cognitive functioning.

Another study has uncovered insights into the idea of neuroprogression in depression, proposing that the neurobiological transformations linked to depression can intensify cognitive deficiencies, including impairments to working memory [7].

Furthermore, neurotransmitter system interactions and brain regions implicated in anxiety and depression may contribute to working memory function disruption, which provide evidence from the side of brain structure of human [12]. Otherwise, evidence has demonstrated that depression and anxiety are linked to negative biases in attention, and the functioning of attention is modulated by anxiety. On the other hand, it has been pointed out that attention can be considered as a resource for storage and processing, while WM contributes to controlling perceptual attention [2]. Meanwhile, studies in the cognitive field have explored anxiety and depression and provided insights that a connection between the two well-known disorders and attention exists [5,6]. Thus, a relationship between the three has been identified via attention bias.

Understanding the link between anxiety, depression, and WMC has crucial clinical implications. Oberauer has stressed the necessity of creating interventions that target both anxiety and depression to alleviate their joint influence on cognitive functions, including working memory [13]. Cognitive therapies, exemplified by cognitive-behavioural therapy, are usually adopted to confront both anxiety and depression and may have a positive effect on working memory performance.

To enhance the understanding of the tripartite relationship between depression, anxiety, and working memory, further analysis is required. Thus, additional efforts should be directed towards investigating this issue.

5. Discussion

The preceding analysis has offered valuable insights into the complex interplay between anxiety, depression, and WMC. By exploring their associations and shared mechanisms, we gain a deeper comprehension of the cognitive obstacles caused by these mental health disorders. The integration of diverse research findings provides a thorough outlook on the interrelations between these factors, whilst also indicating certain restrictions and prospects for future research.

5.1. Research Results and Implications

The research landscape highlights the intricate connections between anxiety, depression, and WMC. The co-occurrence of anxiety and depression results in considerable cognitive susceptibility. LeMoult and Gotlib's research takes a cognitive stance towards depression and proposes that cognitive biases play a role in prolonging depressive symptoms. Meanwhile, Eysenck highlights the connection between anxiety and attentional bias, which affects cognitive resources and, therefore, working memory capacity (WMC). Furthermore, research carried out by Moran and Oberauer sheds light on the links between anxiety, depression, and decreased WMC.

Interestingly, the combined effects of anxiety and depression on WMC appear to exceed the deficits noted when either disorder is present alone. The concept of neuroprogression in depression is introduced by Ruiz et al. in their study. The research highlights that neurobiological changes associated with depression can worsen cognitive deficits, including those affecting WMC. These findings emphasize the need to address both conditions to lessen their cumulative impact on cognitive functions, as Oberauer emphasizes.

5.2. Limitations and Future Directions

While significant progress has been achieved, it is important to recognize certain limitations and possibilities for future investigations. The existing literature primarily examines anxiety, depression, and WMC as distinct constructs, often with a focus on one or two-way interactions. Future research should investigate more comprehensive models that recognise the intricate three-way relationship between anxiety, depression, and WMC. Additionally, current research may have a clinical bias, potentially restricting the generalisability of results to the wider population.

In addition, most studies focus on correlations and associations, leaving scope for further mechanistic understanding. Future research could incorporate experimental designs and neuroimaging techniques to reveal the underlying neural processes that connect anxiety, depression, and WMC. Investigating how treatments targeting anxiety and depression affect WMC and vice versa could offer valuable insights into potential therapeutic interventions.

6. Conclusion

To summarise, the complex relationship between anxiety, depression, and WMC has far-reaching implications for comprehending cognitive functioning in individuals affected by these conditions. Studies have highlighted cognitive vulnerabilities that arise due to their coexistence and the combined effects of these conditions on WMC. As our understanding of these interactions improves, intervention strategies that tackle both conditions simultaneously gain clarity.

The analysis highlights the necessity of a comprehensive approach towards comprehending anxiety, depression, and WMC. They should not be seen as separate entities but rather as parts of a larger cognitive framework. By adopting a more holistic perspective, researchers could divulge the complex mechanisms that are responsible for cognitive deficits and devise interventions that holistically address both mental health conditions and their influence on cognitive processes.

In conclusion, the changing research landscape surrounding anxiety, depression and WMC provides a promising area for investigation. As we explore the intricacies of these connections, our comprehension of human cognition and the potential for innovative treatments expands, providing optimism for improved mental health and cognitive performance for those impacted by these disorders.

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