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MINIREVIEWS

What emotion dimensions can affect working memory performance in healthy adults? A review

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Abstract

Due to the critical roles of emotion and working memory in our daily activities, a great deal of attention has been given to how emotion influences working memory performance. Although the association between emotion and working memory is relatively well established, whether mood enhances or impairs working memory performance remains controversial. The present review provides a relatively representative overview of the research on the effect of different dimensions of emotion on working memory among healthy adults spanning a 30-year period. The findings show that the valence, arousal and motivational dimensions of emotion could all exert an impact on working memory performance. The impact of emotion on working memory might be modulated by task relevance, emotion type, working memory paradigms and individual differences. The vast majority of the studies regarding the effect of emotion on working memory performance focused on the impact of negatively valenced affect and yielded highly contradictory findings. The impacts of arousal and motivation on working memory have been less explored, and inconsistent findings have also been reported. Possible explanations are discussed. Considerable research on the effect of certain dimensions of emotion on working memory has suffered from a lack of control of other emotional dimensions, and different aspects of working memory have been investigated by various paradigms. Directions for further studies should include the exploration of specific dimensions of emotion on different aspects of working memory, with the other dimensions being well controlled.

Key Words: Working memory; Emotion; Valence; Arousal; Motivation; Review

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Core Tip: An updated review of the literature regarding the association between emotion and working memory among healthy adults is provided. Valence, arousal and motivational dimensions of emotion could all exert an impact on working memory performance among healthy adults. The influence of emotion on working memory might be modulated by task relevance, emotion type, working memory paradigms and individual differences. Due to the highly contradictory findings in the literature regarding whether emotion facilitates or impairs working memory, further investigation of the effect of one dimension of emotion on different aspects of working memory with other dimensions being well controlled is clearly warranted.

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INTRODUCTION

Working memory is the ability to maintain and manipulate information in the mind over short periods[1] and is a core component of higher cognitive function, including learning, problem solving, decision-making, and reasoning[2]. Emotion is critical to human cognition and behavior and could either facilitate or hinder performance[3], which might be due to its relevance for survival. Although a burgeoning body of literature investigating the effect of emotion on working memory has emerged, the association of emotion with working memory and its underlying mechanisms are still poorly understood. The key question in understanding the emotion-cognition link is how emotion may affect working memory. Nevertheless, previous literature exploring this topic has not yet reached a consensus on whether emotion improves or impairs WM performance. This article aimed to provide an up-to-date overview of the effect of emotion on working memory based on different dimensional models of emotion.

Different dimensions of emotion are valued as essential in different models. In this article, we first review two main models of affect regarding the dimensions of emotion: one supports a classic view according to which valence and arousal are two main dimensions of emotion[4], and the other claims that apart from valence and arousal, the motivational dimension is another important aspect of emotion[5]. Then, we review the representative studies investigating the effect of emotion on working memory based on the two models.

One of the most prominent conceptions of emotion is the dimensional view. All emotions could be described by two or three independent dimensions[6]. The most frequently and widely applied model is the circumplex model[4]. The model suggests that all emotions could fall in a circle with valence and arousal as the horizontal and vertical axes, respectively. Valence refers to the evaluation of the pleasantness associated with the emotion and ranges from negative (unpleasant) to positive (pleasant), whereas arousal is defined as the level of emotional activation ranging from deactivated to activated[7]. Valence and arousal are associated with different neural systems[8]. Valence mainly activates the orbitofrontal cortex and is related to the mesolimbic dopamine system, while arousal mainly activates the amygdala and correlates with the mesencephalic reticular activating system[9,10]. Each emotion could be described as a linear combination of both valence and arousal. Happy, for instance, is conceptualized as an affective state that involves the combination of positive valence and moderate arousal in the neural system. The difference among emotional states lies at the extent of the activation of the two fundamental neurophysiological systems[11].

Other than the model mentioned above, a large body of literature suggests that emotion depends essentially on the activation of the two motivational systems: the appetitive system and the aversive system[12,13]. The former is activated in contexts that facilitate survival, whereas the latter is activated in dangerous and survival-threatening contexts. Although many researchers have pointed out that valence covaries with the activation of the motivational system and arousal equates to motivational intensity, these views have also received much criticism. Some theorists proposed that the two-dimensional model of emotion failed to capture all aspects of

emotion and reflect vital differences among some emotions[14]. For example, anger and fear are both located in the region of the circle with the combination of negative valence and high arousal, while they are still different. Anger is an approach-related emotion and drives individuals to remove barriers to achieving goals. Conversely, fear is an avoidance-related emotion and makes people turn away from a dangerous environment[15]. Thus, anger and fear reflect different motivational tendencies despite having the same levels of valence and arousal, which suggests motivation as another independent dimension of emotion. Later, Gable and Harmon-Jones reviewed previous literature and proposed a motivational dimension model of affect[5]. The model presented that affect low in motivational intensity broadens cognitive processes, while affect high in motivational intensity results in a general narrowing of cognitive scope, which adds to the understanding of the impact of emotion on cognitive performance.

There is emerging evidence that emotion could impact working memory performance. To the best of our knowledge, this is the first review that summarizes the evidence from previous literature on the effect of emotion on working memory among healthy adults, including both behavioral results and neuroimaging findings. Since the existing literature published in this field is vast, this review does not aim to be exhaustive but rather a relatively representative overview of the research on the effects of different dimensions of emotion on working memory.

Research investigating the influence of emotion on working memory could be categorized into two groups: Integral effect and incidental effect[16]. The integral effect examines how affective contents are processed in working memory. Specifically, the affective states are induced by the materials that are processed in the cognitive task. The incidental effect explores how affective states influence working memory performance. In this case, emotional state is induced by subjective emotional experiences that are irrelevant to the working memory task. A distinction between the incidental effect and the integral effect might be necessary in trying to investigate the effect of emotion on working memory. For example, the incidental emotional state of anger could cause approach-related behaviors, while facial anger expression might cause avoidance-related behaviors since it signals threatening information to the observer. A recent study explored whether the emotion-cognition link was influenced by the task relevance of emotion and found that task-irrelevant emotion disrupted cognitive performance, whereas task-relevant emotion facilitated performance[17].

LITERATURE REVIEW SEARCH STRATEGY

Three separate academic search engines were employed to conduct this review: ScienceDirect, Web of Science and Medline. Since this review aims to focus on the literature regarding the effect of emotion on working memory performance, the database search terms for all three search engines included "working memory or n-back or cognition" and "emotion or emotional or mood". A total of 735 references were retrieved. The identified literature was then exported to Endnote X8, and duplicated articles were removed. The authors independently screened the remaining articles according to the titles and abstracts. The full texts were further downloaded if the reviewers thought the articles satisfied the inclusion criteria or were not sure about the suitability of the literature. The evaluation of the articles was conducted independently by the authors based on predefined criteria. Any disagreements were resolved by discussion. Ultimately, 43 studies were selected to be representative in investigating the impacts of emotion on working memory performance among healthy adults spanning a 30-year period. These representative articles are summarized in this review.

REVIEW OF RESEARCH ON THE INCIDENTAL EFFECTS OF VALENCE AND AROUSAL ON WORKING MEMORY

The vast majority of the literature has provided evidence for the effect of emotional states on working memory performance, with findings gaining serious momentum since the early 1990s. In particular, Eysenck and Calvo[18] put forward processing efficiency theory, suggesting that the impact of negative emotion on cognitive functioning might be mediated by the effects on working memory. Anxious people might pay more attention to anxiety responses irrelevant to the ongoing task, such as

negative cognition and self-preoccupation. As a consequence, this would occupy attention and consume limited working memory resources, which would further lead to reduced response accuracy and prolonged response time[18,19]. Eysenck *et al*[18] suggested that verbal and spatial working memory were equally impaired by negative emotion, while subsequent studies provided robust evidence to support that negative emotion impacted the two kinds of working memory unequally. Ikeda *et al*[20] found a significant difference between high- and low-anxiety groups in verbal working memory performance, whereas the discrepancy was not significant in spatial working memory. However, most studies have shown that negative emotion has a greater impact on spatial working memory than verbal working memory. One of these studies investigated the impact of threat-of-shock anxiety on verbal and spatial working memory through verbal and spatial n-back tasks that were well matched on difficulties. Under anxiety-inducing conditions, deficits in spatial working memory were greater than those in verbal working memory[21]. Li *et al*[19] employed the modified delayed-matching-to-sample task to explore the underlying neural mechanism behind the selective effects of negative emotion on spatial and verbal working memory using the event-related potential technique. Reduced central P2 amplitude and frontal late positive component were observed only in spatial working memory, suggesting the selective influence of negative emotion on spatial working memory performance. Additionally, the study postulated that the frontal lobe was a critical brain structure for the emotion–working memory interaction. A functional magnetic resonance imaging (fMRI) study conducted by Qin *et al*[22] similarly revealed that induced acute psychological stress resulted in reduced activity in the dorsolateral prefrontal cortex (PFC) during the verbal working memory task. Several studies explored the association between naturalistic negative mood and PFC activity during the working memory task without any mood induction[23,24]. The level of negative mood was inversely correlated with PFC activity only during the verbal working memory task, and the negative association was independent of personality traits[24]. Sato *et al*[23] expanded the generalizability of these findings by replicating the experiment in a sample with different language backgrounds. From these studies, it is concluded that the PFC plays a critical role in the association between emotion and working memory[25,26].

In addition to these findings, many studies have focused on the effect of negative emotion on a specific aspect of working memory. A recent study pointed out that the updating capacity of working memory was disrupted after worry induction and that the detrimental effects were irrelevant to individuals' inherent tendency to worry[27]. Xie and Zhang[28] explored whether negative mood affected working memory resolution (quality) and capacity (quantity). The results found that negative mood boosted visual working memory quality, while no significant effect on the quantity was observed, suggesting dissociable qualitative and quantitative aspects of working memory representation. However, contradictory findings were reported. Figueira *et al*[29] investigated the effect of negative emotional states on working memory capacity using contralateral delay activity (CDA) as a neurophysiological index of the representation of the task-relevant items held in working memory. During the unpleasant emotional state, the expected CDA increase that would occur from 2 to 4 to-be-remembered items was disrupted, suggesting that the unpleasant mood is related to reduced working memory capacity. Interestingly, positive trait affect was found to be positively associated with working memory capacity, and this positive correlation was still preserved even during an unpleasant emotional state, suggesting that personality traits might influence the effects of negative emotional states on working memory[30]. Conversely, a recent study found better working memory capacity in the context of depressogenic sentences than in neutral sentences[31]. Although most studies showed a facilitating or disruptive effect of negative emotional states on working memory, a recent study suggested that sad mood induction had no significant effect on the 2-back task[32]. Apart from negative "basic" emotions (*e.g.*, anxiety, fear and anger), recent research has also examined the role of negative social emotions (*e.g.*, shame and guilt) in working memory performance. Cavalera *et al*[33] suggested that negative social emotions were associated with impaired working memory performance.

When looking at the effect of positive emotion on working memory performance, the findings were also inconsistent. On the one hand, positive mood has been presented to have harmful consequences on working memory performance. Martin and Kerns[34] found that positive emotion had detrimental effects on verbal working memory capacity and proposed a possible explanation for the findings. Positive mood could enhance the spread of activation of items in working memory, which would reduce the ability to maintain the particular item in the focus of attention. On the other hand, there is evidence that positive emotional states could enhance working memory

performance. Yang *et al*[35] suggested that positive affect facilitated working memory measured by the operation span task.

Some studies also compared the influence of both positive and negative emotional states on working memory. The valence model proposed that the left PFC was specialized for pleasant affect, while the right PFC was specialized for unpleasant affect. Verbal working memory was processed in the left hemisphere, whereas visuospatial working memory was based on the right hemisphere. Storbeck *et al*[36] reported that positive emotion and verbal working memory were goal-compatible and that negative emotion was goal-compatible with spatial working memory. Under these circumstances, cognitive effort would be minimized.

Osaka *et al*[37] explored the underlying neural activation behind the associations of positive and negative emotion with working memory using fMRI. Participants were required to read sentences to induce negative, neutral and positive emotional states and memorize the target words from the sentences. Different neural circuits were found to be involved in the modulation effects of positive and negative emotion on verbal working memory. Additionally, the findings indicated that negative emotion impeded working memory, while positive emotion enhanced working memory performance. Another study conducted by Storbeck and Maswood[38] showed that positive emotion (*i.e.*, happiness) facilitated both verbal and spatial working memory capacity, while negative emotion (*i.e.*, sadness) had no impact. The researchers reported no difference in the levels of arousal between happiness and sadness. Nevertheless, theoretically, happiness and sadness differed in both valence and arousal according to the circumplex model of affect.

Arousal, as a crucial dimension of affect, could also influence cognitive functioning. Emotional arousal disrupted the working memory process that was necessary for feature binding[39]. Findings from Esmaeili *et al*[40] showed that positive emotional arousal improved working memory performance. In this study, positive arousal was induced by a piece of positive film, which made it hard to distinguish the effects of valence and arousal.

Some researchers pointed out that valence and arousal seemed to work together to influence working memory performance. Kuhbandner and Zehetleitner[8] presented valence and arousal that could be dissociated in their impacts on executive function, which might explain heterogeneous findings reported in the previous literature. Findings from a recent study exploring the effects of valence and arousal on working memory based on virtual reality games suggested that higher levels of arousal and positive emotion had positive effects on working memory performance[41]. Several studies have reported individual differences in the impact of emotion on working memory performance. It has already been reported that both negative and positive emotions could enhance working memory capacity in the high-capacity group, whereas they impeded performance in the low-capacity group[42].

Aside from those findings, the effects of emotional distractors on working memory were also investigated. Based on the study by Anticevic *et al*[43], who utilized slow event-related fMRI, negative distractors at lower working memory load levels resulted in lower accuracy and longer response times in younger adults. The opposite findings were observed in the older group, suggesting that negative distractors mitigate older adults' working memory performance[44,45]. For example, the study conducted by Oren *et al*[44] reported that negative distractors in the low load n-back task caused shorter response times among older adults. Further functional connectivity analysis showed that the amygdala, the region for emotional processing, deactivated in older adults, which might explain the mitigating effect of negative distractors in older groups. Nonetheless, Ziaei *et al*[46] reported a contrasting neural connection outcome. Participants were required to complete an emotional working memory task and ignore irrelevant emotional distractors with positive, negative and neutral valence. Functional connectivity analysis revealed that younger participants adopted only one network for encoding both negative and positive distractors, whereas older participants recruited two neural pathways. The findings stressed the key role of amygdala engagement in emotional working memory tasks among older adults, which is inconsistent with Oren's findings regarding the deactivation of the amygdala[44]. Hence, age could impact the influence of emotion on working memory, although the underlying mechanisms are still controversial.

Based on the literature review above, both beneficial and disruptive effects of positive and negative emotional states on working memory performance have been reported. Due to highly contradictory findings in the previous literature, it has been difficult to conclude the effect of emotional states on working memory performance since the integral effect of emotion on working memory might be influenced by many other factors, such as age and personality traits.

REVIEW OF RESEARCH ON THE INTEGRAL EFFECTS OF VALENCE AND AROUSAL ON WORKING MEMORY

Previous literature has suggested that emotional stimuli interfere with working memory. The first study to explore the impact of emotional content on working memory performance suggested that reaction times were longer for fearful faces than for neutral faces during an emotional n-back task[47]. Jin *et al*[48] similarly investigated the impacts of emotional content on working memory and its underlying neural mechanisms. They reported that positive stimuli exerted a facilitating effect on verbal working memory performance by enhancing retention and retrieval processing, while negative stimuli impaired verbal working memory performance because of the responses avoided during retrieval. Later, another study extended these findings by investigating the impact of valence on verbal working memory performance using functional near-infrared spectroscopy (fNIRS) and electroencephalogram (EEG). Behavioral, fNIRS and EEG results showed that the influences of emotional content on working memory performance depended on the task difficulty and valence. Emotional content with a negative valence seemed to take precedence compared with that with a positive valence[49]. Working memory performance was more impaired under the negative valence condition. Recently, Plancher *et al*[50] revealed the impact of processing negative emotional content on attentional maintenance in working memory. Compared with neutral stimuli, negative emotional stimuli were associated with longer processing times and poorer performance, suggesting that emotional content would occupy attention and prevent the maintenance of working memory *via* attentional refreshing. Positive stimuli were proven to facilitate working memory performance after sleep deprivation[51].

However, Levens and Phelps[52] examined the impact of emotional content on the interference resolution of working memory tasks. The findings showed that both valence and arousal interacted with each other to facilitate working memory performance. Additionally, the authors proposed that trials with emotional words were associated with less interference than trials with neutral words. Follow-up investigations in the differential roles of valence and arousal in working memory performance provided further evidence for the interplay between valence and arousal [53]. The processing of valence and arousal was associated with two distinct neural pathways. Valence-related information was processed by a PFC-hippocampus circuit, whereas arousal-related information was related to an amygdala-hippocampus circuit, indicating separate mechanisms for valence and arousal. Valence was associated with competitions between representations of stimuli in a relatively explicit way. Arousal was a relatively automatic impact of emotion on working memory. The findings suggested that emotional stimuli enhanced working memory performance.

Compared with the research on the incidental effect of emotion, the findings with respect to the integral effect of emotion on working memory were less contradictory. It seems that positive emotional stimuli enhance working memory performance. Nonetheless, based on the existing evidence, the literature regarding the integral effect of emotion is relatively less in comparison to the incidental effect of emotion. The integral effects of emotional valence and arousal on working memory remain elusive.

The extensive body of literature has examined the incidental and integral effects of emotion on working memory separately. Only a handful of studies have explored the combined impacts of incidental and integral emotion. Rączy and Orzechowski[54] combined emotional states with emotional materials to investigate the combined effects on working memory. No combined effect of mood states and emotional content of the stimuli was presented. Significantly shorter reaction times for negative emotional contents were found regardless of the mood states. Participants performed more accurately under the induced positive mood state; however, they were less accurate when processing positive stimuli. These findings suggested that combining the effects of emotional states and stimuli could not heighten their individual effects.

REVIEW OF RESEARCH ON THE EFFECT OF MOTIVATIONAL DIMENSIONS ON WORKING MEMORY

The inconsistent findings regarding the influence of emotion on working memory suggest that valence and arousal might not fully explain the effects. Recently, the motivational dimensional model of affect introduced by Gable and Harmon-Jones[5] suggested that the effect of emotion on working memory might be modulated by

motivational intensity. Evidence regarding the effect of the motivational dimension on working memory will be discussed.

In studies assessing the motivational dimension of affect, hemispheric asymmetry-based assertions have also been proposed[55]. Both withdrawal-related emotions and visuospatial working memory are processed in the left hemisphere, whereas both approach-related emotions and verbal working memory are processed in the right hemisphere. Performance would be enhanced if the type of emotion and type of working memory are based on the same hemisphere. Gray[55] provided robust evidence for a double association between verbal-spatial working memory under induced withdrawal-approach emotional states. Specifically, the approach emotional state could facilitate verbal working memory and impair spatial working memory, while withdrawal of the emotional state could enhance spatial working memory and impede verbal working memory. Happiness and fear were induced in the study to represent approach and withdrawal emotions, respectively. However, these two emotions were different in the valence and motivational dimensions. Thus, some research ignored the effect of motivation and interpreted Gray's findings as a valence effect[35,36]. Previous literature has also investigated the influences of motivation on working memory through incentive manipulations with penalties and rewards. The study conducted by Szatkowska *et al*[56] presented the differential impacts of reward and punishment on working memory performance. Specifically, compared with the no-incentive condition, verbal working memory performance was improved in the reward-incentive condition and hindered in the punishment-incentive condition, which is consistent with Gray[55]'s findings. Nonetheless, the reward-penalty technique was also widely used to induce positive-negative emotion in the literature, which also indicated that this method cannot rule out the valence effect.

However, contradictory findings cannot be neglected. Some studies pointed out that performance was impaired if emotions and tasks were processed in the same hemisphere[16,57]. For example, anxiety, as an affective state associated with avoidant tendency, impaired spatial but not verbal working memory performance[57]. Similarly, the study is also questioned since it is hard to tease apart the effects of valence and motivation by induction of anxiety.

To separate the effects of motivation and valence, a recent study included an anger condition to explore whether the influence of induced emotional states on working memory was based on valence or motivational dimensions of affect. As the study claimed, anger was the only negative emotion associated with approach motivation. The findings suggested that the motivational dimension was more effective on working memory performance than the valence dimension[16]. However, until recently, the effect of motivational dimensions of emotion on working memory has still received less attention. Very limited numbers of studies have explored the incidental effect of the motivational dimension on working memory. More in-depth research is needed to yield more insight into the role of the motivational dimension in working memory.

FUTURE DIRECTIONS

Complex behaviors involve both emotion and cognition. It is widely agreed that working memory lays the foundation for higher cognitive function. Exploring the impact of emotion on working memory could be the first step in understanding human behaviors. The review presents new insights into existing knowledge of what emotional dimension would influence working memory performance. All the aforementioned studies add knowledge to the emotion-cognition puzzle by addressing the effect of emotion on working memory from different emotional dimensions. Although there is mounting evidence for the effect of emotion on working memory, some questions remain unanswered (Table 1). Some suggestions for potential next steps were offered.

Although the studies reviewed here provided robust evidence that emotion could facilitate or hinder working memory performance, the findings are inconsistent and inconclusive. It is crucial to determine which dimensions of emotion impact working memory performance. The vast majority of the studies regarding the effect of emotion on working memory performance focused on the impact of negatively valenced affect and presented mixed findings. The impacts of arousal and motivation on working memory have been relatively less explored. As discussed, although valence, arousal and motivational dimensions of emotion were all proven to affect working memory performance[16,53], considerable research on the effect of a certain dimension of

Table 1 Unanswered questions about the effect of emotion on working memory

Unanswered questions about the effect of emotion on working memory
What's the effect of a certain dimension of emotion on working memory when controlling other dimensions?
How does complex emotion influence working memory in real life?
How does emotion influence a certain aspect of working memory?
What are the potential personal factors influencing the impact of emotion on working memory?
How do incidental and integral effects interact to influence working memory performance?
How do higher levels of emotion influence working memory?
How does emotion influence working memory among individuals with psychopathologies?

emotion on working memory suffered from a lack of control of other emotional dimensions. This resulted in difficulty in distinguishing the effects of different emotional dimensions, which might account for the contradictory findings. Additionally, no study has considered all three dimensions. It is believed that the effect of emotion on working memory is easier to evaluate at the neural level since neural influence would be detectable even in the absence of a significant effect on behavioral results. Further studies should be specifically planned to explore these issues by exploring the effect of one dimension of emotion under the control of other dimensions and investigating the potential interplay among different emotional dimensions and its underlying neural substrates.

In previous literature, a certain emotion might be studied to explore the association between emotion and working memory. However, induced emotion in the laboratory might contain more than one subjective feeling. For example, it has been questioned by many researchers whether the emotion of "disgust" contains only one subject feeling [58,59]. The induced disgust in many studies might be feelings of disgust mixed with anger[16]. Although both disgust and anger are negative emotions, they are related to different motivational dimensions. Disgust is avoidant-related, while anger is an approach-related state. Hence, it is important to induce emotions effectively and accurately. Furthermore, it is interesting to note that unlike in the laboratory, the co-occurrence of different emotions is common in real life. Studies designed to explore complex emotions should also be conducted to increase generalizability.

One possible reason for the mixed findings reported in the previous literature might be the utilization of different working memory paradigms that address different aspects of working memory (*e.g.*, updating, capacity and maintenance) and vary in sensitivity[60]. It is possible to envisage that different emotions could facilitate certain aspects of working memory and hinder other aspects of working memory. Therefore, further investigations should clearly explain upon which aspects of working memory the studies are focused.

Regarding the role of individual variations in the association between emotion and working memory, another open issue refers to the individual differences in the impact of emotion on working memory performance[3]. The interactions between emotion and working memory could be affected by many factors, such as age and personality [30]. Thus, it is crucial to explore the influential factors that would impact the emotion-working memory link.

In real life, incidental and integral effects are more likely to coexist. For example, if a person is afraid of a snack, he would flee from snacks instead of other neutral materials. Thus, it is important to examine the combined effects. As discussed above, there are limited studies addressing the combined impacts of emotional states and stimuli[16,54]. It would be important to investigate the combined effect on working memory performance.

Another important area of interest concerns the investigation of higher levels of affective phenomena, such as love. The key points lie in how to decode the complex emotions and induce them successfully in the laboratory. Future studies closer to real life have the potential to contribute to better understanding by exploring the effect of higher levels of emotion on working memory.

Finally, in the current review, we only summarized the studies pertaining to the effect of emotion on working memory in healthy adults. However, there are many studies exploring the association between emotion and working memory among individuals with psychopathologies (*e.g.*, major depression, posttraumatic stress disorder, schizophrenia)[61-63]. Future studies could broaden the scope of the review

toward the impact of emotion on working memory in behavioral and neuroimaging research in psychopathology.

CONCLUSION

In summary, the present review analyzed the association between emotion and working memory from the perspective of different dimensions of emotion, mainly focusing on the following research question: what emotion dimensions can affect working memory performance in healthy adults? The present review supports the view that emotion could influence working memory. Based on the current literature, the impact of emotion on working memory might be modulated by task relevance, emotion type, working memory task and personal characteristics.

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