Proceedings of the 4th International Conference on Biological Engineering and Medical Science
DOI: 10.54254/2753-8818/63/20241604

The influence of emotion on memory process

Wenqi Zhang

Cognitive Science, De Anza College, Cupertino, US

zhangwenqi2@student.deanza.edu

Abstract. This paper shows how emotions, from an intuitive point of view, have an essential and profound impact on the cognitive process across a variety of different environments, such as natural, social, and academic settings. Our skills in learning and memorizing are significantly adjusted and influenced by our emotional reactions to challenges arising from education, including exams, homework assignments, and strict deadlines. The present research is deeply concerned with the specific roles that anxiety, happiness, and sadness play in modulating memory processes, particularly within the context of educational technologies like adaptive learning systems and Massive Open Online Courses. These innovative technologies are currently revolutionizing traditional educational methodologies by introducing new emotional dynamics in learners that affect cognitive engagement, motivation, and memory retention differently than conventional face-to-face learning environments. These findings are essential in optimizing the thoughtful design and effective implementation of educational technologies to better support students' affective needs and cognitive development.

Keywords: Emotions, Memory, Anxiety, Educational Technology.

1. Introduction

Emotions significantly influence cognitive processes across various environments, including nature and academic settings. They shape our responses and adaptability to educational challenges such as exams, homework, and deadlines. The influence of emotional states, ranging from frustration and anxiety to boredom, regulates our capacity to learn and remember. This interaction between emotions and memory processes is pivotal, particularly as educational technologies like Intelligent Tutoring Systems (ITS) and Massive Open Online Courses (MOOCs) transform traditional educational methodologies. These technologies introduce new dynamics and potentially diverse emotional experiences for learners, influencing their cognitive engagement and memory retention differently compared to conventional face-to-face learning environments. Emotions are complex responses to internal and external events that significantly alter our cognitive functions, behaviors, and physiological states. In educational settings, they influence students' abilities to process and recall information, thus impacting academic performance significantly.

This review explores the impact of emotions on memory within the context of educational technologies, focusing on three specific emotional states: anxiety, happiness, and sadness. It examines how these emotions influence cognitive engagement and memory retention in environments enhanced by ITS and MOOCs. By synthesizing existing research, this review aims to provide a comprehensive

DOI: 10.54254/2753-8818/63/20241604

understanding that can serve as a reference for future studies and guide the design and implementation of educational technologies to better support the affective needs and cognitive development of students.

2. Basic Processes of Memory

Encoding: The initial step in memory formation is encoding, where incoming information is transformed into a neural code that the brain can use. This process involves attention to and processing the information through visual, auditory, or other sensory pathways, organizing it into meaningful units which are crucial for understanding complex materials. Alan Baddeley discusses various theories and models of working memory, which provide extensive coverage of the encoding process in his seminal work [1].

Storage: After encoding, information is stored within various memory systems of the brain. The duration and stability of these memory types vary, from fleeting sensory memories lasting only a few seconds to more durable forms such as short-term and long-term memory. Schacter, Addis, and Buckner [2] provide insights into how memories are stored and the interactions between memory and imaginative processes, which are fundamental to the prospective functions of the brain.

Retrieval is the process of accessing and bringing previously stored information back into conscious thought. This stage can be spontaneous, as when suddenly remembering a friend's name, or intentional, as during an exam. Tulving and Pearlstone explored the dynamics between availability and accessibility of information in memory, highlighting how different factors may facilitate or hinder the retrieval of information [3].

The increasing number of studies exploring the relationship between emotions and memory has made this a hot topic in recent research.

2.1. Anxiety

To understand how anxiety affects memory processes, we should be aware that anxiety is a very normal and easily occurring emotional state. It is predominantly characterized by the combination of psychological tension and some physiological reactions, such as an increase in heartbeats or sweating. Although in itself, an anxiety reaction is a natural adaptive response to danger, it can evolve into an anxiety disorder if it becomes chronic and unbearable. As one of the most widespread psychological disorders in the world, anxiety disorders come in to afflict hundreds of millions of people. The symptoms range from very mild to full-fledged panic attacks, and in most cases, they significantly impact daily functioning. Apart from its wide influence on everyday life, anxiety has very serious effects on mental functioning—especially memory operations. Anxiety influences the very process of stressing and thus influences encoding memory, namely, the translation of sensory information into an active form that can be stored in the brain. If one feels anxious, attention is withdrawn from task-relevant material toward possible danger or negative consequences. This attentional shift reduces the mental resources that can then be applied for effective information encoding. For instance, Robinson, Oliver J [5], and colleagues discuss how anxiety impacts cognitive functions by triggering physiological reactions that disrupt the encoding of new memories. If a student is too anxious for an upcoming exam, they might not be able to focus on studying very well, resulting in a relatively poorer encoding of study material. Research has shown that anxiety paralyzes activity in the prefrontal cortex, which is a portion of the brain responsible for attention and several other executive functions. As such, people who are anxious tend to encode many new memories poorly.

Other than poor memory encoding, anxiety negatively affects the retrieval of memories, which refers to the reproduction of stored information. A common experience that happens in everyday life during very highly anxious situations is "mental blocking", whereby a person knows some information but just can't remember it at that particular moment. This becomes most obvious, perhaps, during some high-pressure scenarios—exams or public speaking. Even though the memory may be correctly stored, it is not retrieved due to anxiety. This interference is believed to be caused by the activation of the amygdala, which deals with the emotional processing that can override the hippocampus, the part responsible for the recall of memory. Research like that of Kenya, Amilliah, and Charles Vuyiya provides evidence of

DOI: 10.54254/2753-8818/63/20241604

how anxiety disorders can lead to significant disruptions in daily functioning due to these memory retrieval issues. Accordingly, even previously learned information may not be recalled by individuals who have a high level of anxiety. Experimental studies, such as those conducted by Tyng, Chai M., et al., use double-blind layouts to empirically assess the effects of anxiety on memory. Researchers prepared a trial involving a double-blind layout to study empirically the effects of anxiety on memory. The participants involved were assigned randomly to the high-anxiety condition group or the low-anxiety condition group. The high-anxiety condition could be stressing the participants by scenarios such as impending speech, whereas low anxiety would involve a relaxed environment. Anxiety was measured using validated psychometric measures, such as the State-Trait Anxiety Inventory. The performance in memory tasks was assessed using standardized tests of word list learning, whereby under both conditions, subjects were asked to learn and recall lists of words. The results came out significant with regard to memory performance between the two groups involving high anxiety and low anxiety. In the high anxiety condition, participants manifested lower accuracy of memory and slower recalling speed as compared to the participants under the low anxiety condition. From a statistical point of observation, high anxiety has a direct impact on the distribution of attention and leads to reduced efficiency during information encoding and retrieval. These findings are consistent with decades of research literature that show anxiety diverts attention to threat-related stimuli at the expense of general cognitive processing and task-related focuses. Conclusively, we can derive from the above study that anxiety has deep influences on memory processes, more specifically, during encoding and retrieval. Anxiety and the accompanying attentional focus on potential threats can give rise to emotional interference, which in most cases seriously hinders a person's attempts at encoding or retrieving information. Experimental evidence supports these claims, as high anxiety conditions lead to poorer performance in memory compared to conditions with low anxiety levels. Knowing how anxiety impacts memory can let one know the mechanisms and inform strategies to mitigate its impact, particularly in a high-pressure environment such as an academic setting. In this way, future studies could assess whether or not anxiety reduction would improve cognitive functioning and mental health more generally.

2.2. Happiness

Happiness is a positive emotional state that strengthens the whole mental health of an individual by improving memory encoding and enhancing the persistence of emotional memories. According to Tyng et al. [6] Positive emotions act through the neurotransmitter dopamine in the brain. It would not be wrong to say that, really speaking, dopamine is pretty closely linked with reward and feelings of pleasure. Research shows that happiness enhances the release of dopamine, facilitating the efficiency of memory encoding. A neuropsychological theory of positive affect and its influence on cognition [7]. It is more likely that after being happy, persons' brain neural circuits will most probably translate information into long-term memory. In addition, dopamine can improve neuron-to-neuron transmission and actively participate in the consolidation of newly acquired information. Happiness not only influences how effective it is to encode memories but also enhances the memory related to good experiences. Positive emotions may enhance the concentration of the brain on the information and involvement, which would lead to better memory performance. For instance, individuals are more likely to focus, deeply understand, and remember learned materials when they are in a happy mood compared to when they are not controlling the entry of information into long-term memory [8]. Such emotional memories increase the impact of elevation not only with respect to experiment whereby happiness-induced emotion induction techniques followed by memory tests were to take place. Participants were then divided randomly into two groups: one group was to undergo the induction of happiness, and the other would serve as the control group. Happiness induction can be done through Video Compact Discs(VCD)that contain either funny videos, happy music, or the mere recollection of past experiences that are gleeful in nature. Such procedures were intended not to manipulate participants' moods but to at least make them feel a specific kind of feeling, a happy one. After the happy induction phase, all the participants completed a standardized memory test. The participant was required to memorize a list of words with time constraints and, later on, recall this word list after some time. From the experimental results, it was shown that the

DOI: 10.54254/2753-8818/63/20241604

group enticed by happiness performed best in the memory test compared to the control group. Specifically, concerning the recall of emotionally related materials, the group with happiness was better. This implies that happiness improves not only an individual's overall memory encoding ability but, most crucially, the persistence of emotional memory. A closer inspection of the outcomes reveals exactly how happiness can influence memory. In the happiness state, it was found that test participants maintained extended enduring accuracy and speed in memory retrieval. Besides listening, data analysis also indicated that memory encoding efficiency was enhanced through an increase in attention, focus, and depth in processing information. Participants in the happiness group retrieved the information in a short time and remembered it more fully, replete with detail, compared to the control group. This is consistent with earlier neuroscience studies that reported a positive emotional state leading to the high release of dopamine, and this tends to firm up neural interconnections, thus resulting in enhanced memory capacity [2]. There is a significant relationship between happiness and the encoding and retrieval of memory. Happiness increases encoding memory efficiency due to the elevated release of dopamine in the brain, more so in memory that is reflected emotionally. Experimental studies have proved that subjects who are induced to be happy express stronger memories, expressed by faster recall speed. This result suggests that enhancing positive emotional states is critical not only for individual mental health but also for improved cognitive functions such as memory capacity. Further research in the future is needed on how happiness contributes to different memory types and how positive effects can be leveraged within the class or work environments, enhancing the ability to perform potential memory performance.

2.3. Sadness

Sadness has a stronger effect on cognitive processes, especially on memory. In contrast to stimulatory and enhancing emotions on cognitive functions, sadness depletes a number of cognitive resources, thereby probably leading to negative distortions in memory details. This emotional state can influence authenticity and the completeness of memory retrieval during personal recall. People with sadness tend to allocate a significant amount of their mental resources to focusing on negative information. This bias might lead them to excessively focus on adverse factors, while their attention to positive or non-emotional information is relatively less. When discussing the impact of emotions on memory, the term "sadness" should be used more frequently than "depression" to avoid confusing emotional experiences with psychological disorders. At the end of the discussion, it's appropriate to mention the potential long-term adverse effects of these emotions, such as depression. This imbalance of attention allocation might lead to an ill-recall event when the scales tip toward negative and the neutral or positive elements are underweighted or simply forgotten. Sadness can also influence the depth and quality of memory encoding by the brain. During sad periods, low motivation and low availability of cognitive resources probably promote shallow processing of information. Since the processing is shallow, one can expect that the memory traces formed under these conditions would be less elaborate and probably even more prone to distortion. Sadness also affects this process, which is a phase of memory in which initially fragile memories are stabilized into long-term memory. Physiological and other emotional states sequentially linked with sadness, such as a decrease in dopamine levels and an increase in cortisol, can interfere with the consolidation of memories, thus making them less stable and more distortion-prone throughout time. To test this hypothesis in an empirical/experimental way and establish how sadness actually impacts memory processes, researchers carried out a study regarding the influence of emotional states on event memory. The study consisted of sad mood induction in subjects by means of the observation of sad movie clips. This is a well-established methodology in emotional research because movie clips can easily elicit predetermined emotional responses in a laboratory setting. After the induction of sadness, the participants were asked to remember specific events in the movie clips they saw. accorded to the negative aspect while giving less attention to information that is either neutral or positive. Changing such a priority in the course of processing is evidence of the role emotions play in shaping our memories. Memory effects of sadness must be understood, and it is important in developing ways of amelioration of the "negative" impact of sadness on memory performance; this is more so in the clinical environment where mnemonic distortions are theoretically linked to the exacerbation of

DOI: 10.54254/2753-8818/63/20241604

depression or anxiety disorders. Possible future research could relate to the intervention techniques developed to appropriately balance attention and other cognitive resources during states of sadness for improved accuracy and completeness when carrying out memory retrieval processes. The outcome of the experiment was interesting. Participants under a sad emotional state were able to recall more details that they associated with negative emotions. Their memories were vivid with scene details about any particular event that made them sad, desperate, or any other feelings attributed to negative emotions. On the other hand, when recalling scenes carrying neutral or positive information from the videos, the memory was very vague and less detailed. This finding suggests that states of sadness do alter the priorities in information processing, reorienting subjects to become more attentive to negative rather than neutral or positive material. Further analysis indicated that the results of these influences were not only upon the content of what was remembered but also on the completeness and accuracy. Those participants who had initially induced a state of sadness exhibited a greater tendency for misremembering or forgetting the non-emotional details about the events. It thus supports the hypothesis that sadness induces a narrowed attentional focus, recruiting cognitive resources for processing negative information at the expense of a broader, more balanced memory representation. These results have great implications for the understanding of the formation of memories through affective states. These findings support the notion that remembering is not a static record of events that happened previously; it's dynamic and may be influenced by current emotional states. The fact that sadness emphasizes negative information but does not pay much attention to other details causes a create action of a short-term view of past experiences with the potential to reinforce and perpetuate negative emotional states. As an inhibitory emotion, sadness has large effects on memory processing, especially in the distortion of memory details. Empirical research by This aligns with Amilliah Kenya and Charles Vuyiya's [4] findings that discuss the neurobiological effects of emotional states like anxiety and depression on memory, emphasizing the long-term implications of such emotional states on learning and memory retention in academic settings. Researchers suggest evidence of event memory bias under the influence of sadness; more attention is focused on negative information at the expense of neutral or positive information. Changes in priorities for the processing of information suggest a big role for emotional states in shaping our memories. Such findings have implications for the development of techniques that might compensate for or reduce the negative impact of sadness on memory. Clinical settings are one area in which memory distortions can have a more serious consequence, contributing to problems like depression and anxiety disorders. Future research may take this a step further by investigating interventions designed to better equalize attention and other cognitive resources during states of sadness to encourage full and accurate memory recall.

3. Conclusions

Emotions and how they interrelate with memory processes have been widely focused upon by the scientific community, particularly the roles that anxiety, happiness, and sadness play. For years, most empirical studies have proven that anxiety disrupts the encoding and retrieval phases of memory, leading to a diminution in memory performance and a heightened susceptibility to distraction. It is usually interconnected with worse academic and professional outcomes. Conversely, happiness has been shown to significantly enhance the efficiency with which newly learned information is encoded, as well as the ability to retain emotional memories. This positive emotional state increases the activation of the brain's reward pathways, thereby promoting a more robust and more durable memory trace. Sadness is distinguished by memory distortions in a negative direction, namely, about a person's memories, by decreasing authenticity and completeness of personal remembrances. This emotional state can bias memory to negative remembrance and suppress neutral or positive memories, which may contribute to a more constant state of sadness or even depression. Knowing about these dynamics helps to develop interventions that will mitigate the negative effect of negative emotions on memory and further enhance the beneficial impact that positive emotions have on it.

Despite valuable insights from current studies, limitations exist such as small sample sizes and the potential influence of cultural backgrounds on emotional expression and experiences which might affect

DOI: 10.54254/2753-8818/63/20241604

the generalizability of results. Future research directions in the study of emotions and memory should broaden their scope to include a wider array of emotional experiences. While much of the current research has been centered around anxiety, happiness, and sadness, there is a significant opportunity to expand these studies to encompass emotions like anger, surprise, or disgust. This expansion could provide deeper insights into how various emotions specifically influence memory processes. Additionally, there is a need to shift some focus toward the long-term effects of emotions on memory. Most existing studies concentrate on immediate impacts, but understanding how emotions affect long-term memory formation and stability could have profound implications for both theory and practical applications. Moreover, conducting cross-cultural research is crucial. This approach would help elucidate how different cultural contexts influence the interplay between emotions and memory, which is essential for creating educational and psychological interventions that are effective across diverse populations.

References

[1] Baddeley, A. (2012). Working memory: Theories, models, and controversies. Annual Review of Psychology, 63, 1-29.

[2] Schacter, D. L., Addis, D. R., & Buckner, R. L. (2007). Remembering the past to imagine the future: The prospective brain. Nature Reviews Neuroscience, 8(9), 657-661.

[3] Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. Journal of Verbal Learning and Verbal Behavior, 5(4), 381-391.

[4] Kenya, Amilliah, & Charles Vuyiya. (2020). The Neurobiological Effect of Anxiety and Depression on Memory in Academic Learning: A Literature Review. Journal of Contemporary Chiropractic, Parker University, 20 Feb. 2020.

[5] Robinson, Oliver J., et al. (2013). The Impact of Anxiety upon Cognition: Perspectives from Human Threat of Shock Studies. Frontiers in Human Neuroscience, U.S. National Library of Medicine, 17 May 2013.

[6] Tyng, Chai M., et al. (2017). The Influences of Emotion on Learning and Memory. Frontiers in Psychology, Frontiers, 10 Aug. 2017.

[7] Ashby, F. G., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition. Psychological Review, 106(3), 529-550.

[8] Lisman, J. E., & Grace, A. A. (2005). The hippocampal-VTA loop: controlling the entry of information into long-term memory. Neuron, 46(5), 703-713.