

# EMOTIONAL CUES COULD IMPROVE PROSPECTIVE MEMORY IN SUBJECTS WITH NEUROCOGNITIVE DISORDERS

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**Abstract.** There are a number of ways in which memory can fail us, forgetting to perform a previously formed intention at the appropriate occasion depends on prospective memory (PM). This type of memory involves binding in memory a cue to an action (during encoding), as well as successfully recognizing it and acting upon it when it is later encountered in ones environment (at retrieval). Studies have shown that the nature of the emotional cues (neutral, positive or negative) can either aid us in completing prospective memory tasks, or on the contrary impede us in doing so. The main purpose of the current article is to review some of the findings in the literature with regard to these effects, in both healthy and clinical populations (subjects with neurocognitive disorders).

**Key words:** prospective memory, emotional cues, subjects with neurocognitive disorders

# STIMULII EMOȚIONALI AR PUTEA ÎMBUNĂȚĂȚI MEMORIA PROSPECTIVĂ LA SUBIECȚII CU TULBURĂRI NEUROCOGNITIVE

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**Rezumat.** Există multiple modalități în care memoria poate eșua. A uita o anumită acțiune pe care ne-am planificat să o executăm într-un anumit moment viitor, reprezintă un eșec al memoriei prospective (PM). Acest tip de memorie implică asocierea mentală a unui anumit stimul cu o anumită acțiune (în procesul de codificare a informației), identificarea stimulului atunci când apare în mediul extern și efectuarea acțiunii asociate acestuia (în procesul de recuperare a informației). Numeroase studii au arătat că natură stimulului (neutru, pozitiv sau negativ) poate avea fie un efect stimulator fie unul inhibitor asupra memoriei prospective. Prezentul studiu își propune să revizuiască studiile care au investigat influența stimulilor emoționali asupra memoriei prospective, în populații sănătoase și în populații clinice (subiecți cu tulburări neurocognitive).

**Cuvinte cheie:** memorie prospectivă, stimuli emoționali, subiecți cu tulburări neurocognitive

*“He was still too young to know that the hearts memory eliminates the bad and magnifies the good, and that thanks to that artifice we manage to endure the burden of the past.”*

Gabriel Garcia Marquez, Love in the time of cholera

## INTRODUCTION

The events in our lives that are the most memorable are usually those that are highly emotionally arousing. So in that sense, the minds memory tends to agree

with the hearts. However, with regard to magnifying positive events while eliminating negative ones, it seems that the brain is less willing to allow us to forget burdens of the past no matter our age.

Because it seems that both young and old individuals' memory is enhanced by emotional cues (both positive and negative).

This idea, that emotional material attracts more attention or can better preserve encoded material has been well documented [1, 2]. Most studies agree that arousing events, whether positive or negative exhibit a time dependant advantage in memory compared to neutral events. However there is less of an agreement when it comes to positive memories compared to negative ones. Though some studies have shown that positive material is superiorly remembered to both negative and neutral material [3]. As well as specific instances where we "actively" forget or repress bad memories. However, the concept of repression, that forgetting protects the heart, or as Freud put it, the psyche from threatening thoughts or memories, has a very controversial history and is beyond the purpose of the present review.

The advantage of emotions on memory have been investigated for different memory systems, however the present review will mainly focus on prospective memory (PM). PM plays a central role in individual's ability to plan and execute daily activities and can be very important in maintaining social activities, health, independence and safety. The ability to fulfill certain tasks in the future is dependent on PM, this is essential in ensuring that people carry out their intentions at the appropriate occasion. PM is the ability to remember future intentions, as well as performing that intended action at the appropriate time, while involved with ongoing activities [4, 5]. To successfully complete a PM action, individuals have to remember its content (retrospective memory component) as well as to perform it in the future (prospective memory component). The PM action has to be carried out either at a set time (time-based PM) or when encountering a specific cue (event-based PM) [6].

There are two ways in which PM can fail: by forgetting to execute a task termed - omission error (e.g. taking a pill) or by mistakenly repeating the completed task - repetition error (e.g. taking the same pill twice).

Cue manipulation in PM paradigms has mainly been done in terms of cue familiarity [4, 7] or focality [8]. Interestingly, it has also been observed that PM cues with emotional valence are better remembered than PM cues with non-emotional content. The distinctiveness of an emotional cue may reduce the need for controlled monitoring of the cue as its detection is facilitated, and this may result in better PM performance [9, 10]. This view is supported by feedback theory of emotion [11] which proposes two ways in which cognition is influenced by emotion. Through conscious moods and through more automatically means of appraisal which arise when stimuli are encountered. Research suggests that PM may be influenced by emotional stimuli through encoding or retrieval processes or, in synergy through both [12]. Deriving from the more general literature of cognition and emotion it's been proposed that emotion is likely to improve encoding processes by enhancing attention and visual processing [13, 14, 15]. It could also enhance the retrieval process by increasing the likelihood of detecting cues, because it's been shown that emotional stimuli attract more attention as compared to neutral stimuli [16, 17]. This finding holds both for consciously attended stimuli, in visual search tasks [18, 19, 20] and involuntarily, with subliminally presented stimuli [13, 16, 21]. This finding is in accordance with McDaniel and Einstein's [4] hypothesis that PM retrieval is supported by both automatic spontaneous retrieval and conscious monitoring processes.

The current paper aimed to review and synthesize some of the literature that has investigated the influence of emotion on PM and refer to some of the cognitive mechanisms that have been proposed to

support these effects by providing examples from clinical populations.

### **Research on emotional cues and PM in healthy populations**

May et al. [22] explored the potential benefits of emotional cues in improving PM performance for both young and old individuals. They showed that both groups had higher PM execution rates (fewer omission errors) for the emotional arousing compared to neutral cues. With regard to the second type of failing in PM (repetition errors) they showed in a second experiment, that older adults had significantly less repetition errors with emotional than with neutral cues. They concluded that emotional cues can be used effectively to both initiate action and reduce repetition errors.

However, these findings are not always consistent in the PM literature. In a study by Altgassen et al. [23] PM performance was better for both positive and negative compared to neutral cues, but this result was only significant for older participants. A similar finding was reported by Schnitzspahn et al. [24] where older but not younger adults showed heightened PM with emotional cues relative to neutral cues. However, Rendell et al. [3] found better PM only for positive and not neutral and negative targets for older and younger adults and Altgassen et al. [25] reported the same pattern with young adults when compared to a depressed group. It seems that at least in some circumstances emotional cues can be more distinctive, and even more so for older compared to younger individuals.

A more conclusive understanding of these effects is presented in a recent synthesis conducted by Holster, Wood and Armitage [12]. They examined 67 effect sizes from 17 articles and found that overall, PM was enhanced when positively valences rather than neutral cues were presented ( $d = 0.32$ ). Contrastingly, the synthesis revealed that cues that had a negative valence only improved PM performance when presented

both during encoding and at retrieval ( $d = 0.40$ ), and impair performance when presented only at encoding ( $d = -0.25$ ). The main finding however is that cues with a positive valence do improve individual's performance on PM task [12].

### **Research on emotional cues and PM in clinical populations**

Several studies proposed that this effect of emotion on PM performance is due to the nature of the structures that support it. Proposedly these item-emotion bindings are dependant on the amygdala, which enhances memory consolidation for this kind of stimuli [26] resulting in both enhanced long-term [27] and short-term memory [27]. Accordingly this type of binding is less rapidly forgotten than item-context bindings, supported by the hippocampus. While the hippocampus has a very unique physiology, it exhibits a high rate of neurogenesis and cell death that makes it more prone to forgetting. The amygdala is somewhat spared from forgetting because it's exposed to less cell death and less interference from new cells [28]. Another advantage may be that the amygdala is simply more resistant to interference because of fewer competing experiences (neutral events are more frequent compared to highly emotional ones).

A limited number of cases, with selective amygdala lesions (very rare) provide evidence toward this hypothesis. Cahill et al. [29] tested participants delayed recognition (one week) for a set of slides accompanied by a story that included neutral materials and negative arousing materials. They found no advantage for the patient group (bilateral amygdala damage) in recognizing the negative slides, though they performed well on the neutral ones. This lack of a memory advantage for negative stimuli has been observed with both verbal and visual stimuli when tested both for recall and recognition [30].

Research examining patients with lesion to multiple MLT regions, such as the

hippocampus, amygdala and surrounding perirhinal cortex, have also found a reduced effect of emotion on memory [31]. This however still seemed to be due to damage to the amygdala rather than the other regions. Namely, when investigating recognition memory for negative versus neutral pictures, both patients with selective hippocampus damage and controls exhibited an emotional memory advantage in recognition tests, though no such advantage was seen for immediate test [32]. When examining patients with damage to MLT that do not include amygdala, an emotional advantage is found, even when controlling for overall memory performance [33]. Amygdala pathology was associated with reduced recollection for emotional but not neutral words in patients with temporal lobe epilepsy, while in hippocampus pathology reduced recollection was seen for both types of words.

To the best of our knowledge, only a small number of studies have investigated emotional enhancement in PM on clinical populations. A study by Mioni et al. [34] addressed the question of emotionally related improvement in PM performance in Parkinson Disease (PD) patients. They found that PM actions with emotional valence were better performed compared to PM actions with neutral valence, particularly with a greater enhancement of stimuli with positive emotional valence. However, the PD patients in their study had a lower performance than the control group, independently of the emotional valence of the PM cue. Consistent, with former studies assessing older adults [3] and other clinical populations [35] positive PM tasks were more likely to be performed than negative and neutral tasks.

Rendell and colleagues [35] tested multiple sclerosis patients and matched controls with Virtual Week, controls outperformed patients on both event based and time based tasks. However, a positive enhancement for event-based tasks was found for both groups.

Altgassen and colleagues [25] have tested whether or not emotional cues could be potentially advantageous for event-based PM with patients suffering from depression. They found that healthy controls outperformed individuals with depression across all PM conditions (neutral, positive and negative targets), and also found a positive effect in the control group only. While for depressed patients, performance was superior on neutral as compared to both positive and negative cues. Suggesting that, in the case of this clinical population, emotional valence does not yield any benefit on PM performance [25].

As far as we know, no studies have investigated emotionally valence material with PM in an Alzheimer's disease (AD) population. This may be due to the controversy around whether or not AD patients benefit from emotional enhancements. It is believed that this enhancement relies on limbic regions. However, while the neural substrate supporting this effect has not been thoroughly investigated, these may include the frontal lobe, as well as limbic circuits. Kensinger et al. [36] found that the presence of AD reduces all emotional enhancement effects. Their results showed that both young and old adults, but not AD patients, have better memory for emotionally valence material. They also found that both elders and AD patients show no benefit when items are embedded in an emotional context as opposed to a neutral context, while younger adults do [36].

Nonetheless, while a hallmark of Alzheimer's disease (AD) is memory impairment, there is speculation that recall may be enhanced when an emotional component is associated with an event [37]. For example, Fleming et al. [37] showed better recall for emotionally valences material, as compared to neutral material, on a sample of AD patients. All subjects were tested with three word lists on three trials. The words were either of positive,

negative, or neutral valences and matched for concreteness, emotionality, and pleasantness. Controls outperformed AD patients, more importantly however; the pattern of recall for the emotions was different. Control groups recalled all emotions equally, whereas AD patients recalled significantly more negative words than positive or neutral words. These findings of improved immediate memory for emotional material in AD lend support to the notion that mnemonic functions are differentially affected in the disease [37]. The benefit of using emotional material to improve memory of Alzheimer's patients has also been assessed in memory and cognitive stimulation programs. Sandman [38] included 11 dyads of subjects with AD in a study using primarily a dyadic approach; however no control group was used. In this study, an attempt was made to stimulate memory by provoking emotional memories to produce "flashbulb" memories. (The author did not precisely define what are emotional or "flashbulb" memories—that is, the kind of emotions that should have been triggered by the memories and the required degree of emotional intensity). The patients and caregivers had to pay attention to specific information presented in films or pictures. The pictures contained information about the other subjects in the program. The

training was carried out over 4 weeks. The author did not provide information about the duration and weekly frequency of the sessions. Memory was formally assessed at baseline or follow-up with a neuropsychological evaluation. Only the amount of information retained was recorded after the training. This study demonstrated that the emotional memories were best remembered: the patients retained six items in the high arousal condition, compared with approximately two items in the low arousal condition. There was no follow-up evaluation.

## CONCLUSION

Thus far, for those populations that have been investigated, the evidence from the literature seems to collect in favor of positively valence material when attempting to enhance PM performance. However, while the extant studies are suggestive, additional data is needed for a more complete understanding of the interplay between PM and emotion processing, especially in clinical populations [39]. Finally, investigating possible emotional enhancement in PM performance in these populations could have important implications for rehabilitation programs, which would significantly enhance patient quality of life as well as reduce caregiver burden [39].

## Conflicts of interest

The authors declare no conflicts of interest.

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