

Emotional Valence & Intentions: Comparing Event, Time and Activity Based Prospective Memory

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Prospective memory deals with remembering and executing future intentions. The execution of intentions is dependent on event, time or activity that acts as cues to signal the remembrance of the intention and its successful execution. The present study attempts to compare the efficiency of these cues on prospective memory tasks. Further, the study also evaluates the role of stimuli valence on event, time and activity based cues on prospective memory tasks. To complete the study the prospective memory tasks that were dependent on event, time and activity cues were developed. Emotional and neutral words from Affective Norms for English Language (ANEW), selected using pre-designed criteria were presented to subjects as ongoing tasks. The subjects were required to execute actions following the event (press key on six-letter word appearance), time (press key after every 30 seconds) & activity cue (returning filled in questionnaire about emotional task). The data obtained were subjected to mixed model 2 x 3 ANOVA with valence (positive, negative) as between subject & prospective memory type (event, time, activity) as subject factor which revealed significant main effects of prospective memory type [$F(1, 38) = 70.59, p < 0.001, \eta^2 = 0.54$]. Repeated measure ANOVA comparing positive & neutral and negative & neutral across all types of prospective memory revealed better accuracy of prospective memory tasks across positive than negative or neutral stimuli. The results of the study indicate clear difference among cue types with event based cues being most effective in remembering future intentions. In addition, the positive emotional stimuli benefitted the remembrance of future intentions.

Keywords: Emotion, Prospective Memory, Retrospective Memory, Valence

Planning for future and executing acts to accomplish these plans are everyday affairs. To complete future acts, people develop and execute a variety of intentions. To remember and execute future intentions is termed as prospective memory. An example of prospective memory is the act of taking medicines at fixed times round the clock. Failure to take medicines (execute future intentions) on the assigned time may lead to severe complexities and complications.

Prospective Memory

Prospective memory involves forming an intention (includes decision to act in a particular way in future), the action (what we plan to do), and execution of the intention (when we plan to do it). Methods that test prospective memory require the distinction between retrospective memory - which is remembering information

from the past, and prospective memory, - which is remembering information for the future. Prospective memory requires retrospective memory because one must remember the information itself to act in the future (Reese and Cherry, 2002). For example, remembering to buy groceries after work (prospective memory) requires the ability to remember what type of groceries are needed (retrospective memory).

There are different types of prospective memory tasks that includes time based task (remembering to make a phone call at a specific time), an activity based task (delivering a message to an acquaintance after dinner) and event based task (remembering to buy groceries on your way to home) (Brandimonte, Einstein, & McDaniel, 1996). These prospective memory tasks can also be differentiated process involved to execute the tasks.

Event based prospective memory task is a cue based task which is executed at an occurrence of a specific cue whereas time-based, and activity-based tasks are self-initiated processes and have no connection to cue appearance. Therefore, cue identification is one of the prominent aspects of event-based prospective memory task. Since event-based prospective memory tasks are cue dependent most experiments testing event-based prospective memory employ cue variations in terms of familiarity and distinctiveness or emotional valence. However, according to a model proposed by Kvavilashvili and Ellis (1996) one should also distinguish activity-based prospective memory tasks (remembering to do something after finishing a certain activity) which, unlike event- and time-based tasks, do not require an interruption of an ongoing activity and therefore should be easier to remember than event- and time-based tasks. One aim of this study was to test this prediction by studying the effects of type of task on young participants.

Emotion & Prospective Memory:

It has been reported in studies on retrospective memory that emotional information is better remembered than non-emotional information (Murphy & Isaacowitz, 2008). Emotional stimuli are more meaningful and thus are better remembered (Kensinger, Piquet, Krendl, & Corkin, 2005). Emotional target cues both positive and negative and benefit event-based prospective memory for both elderly and young adults by forming strong emotional attachment, which in turn, make the cue more self-relevant and easier to remember. For example, an aversive picture of a snake biting a person or a positive picture of a dog licking its owner are easier to remember because they evoke emotional responses, as opposed to a neutral picture of an animal that does not evoke an emotional response (Altgassen et al., 2010).

Researchers have also compared emotional and neutral cues on prospective memory performance in young and older adults. The result of these studies suggests that positive event-based prospective memory task were

performed more accurately relative to both negative and neutral tasks (Rendell et al., 2011). In a recent study (Schnitzspahn, Horn, Bayen & Kliegel, 2012), age effects were found to be minimal in emotional valence conditions compared with a neutral condition which supports the view that emotional reactivity may be stronger in older adults compared to young adults. Studies on prospective memory suggests that emotional salience of cues enhance event-based prospective memory performance. There are very few inconclusive results available for effects of cue valence on time and activity-based prospective memory.

The present study

The present study tries to investigate the effects of emotional cue on event, time and activity-based prospective memory. Time-based, and activity-based tasks are self-initiated processes and we are interested in knowing whether they share the same effect of emotional valence as event-based task. Studies on time-based prospective memory tasks suggest that they require more self-initiated processing and perhaps greater attentional demands compared to event-based tasks, so the effects of emotional cue may not be same as an event-based task (Craik, 1986, Kliegel, Martin, McDaniel, & Einstein, 2000).

Activity-based prospective memory task also requires self-initiated processing but, the task completion can act as a cue itself for execution of prospective memory intention. It has been found that the end of one task might serve as an environmental retrieval cue for the intended activity, but the end of task may be a less salient cue to generate a prospective memory response. All three prospective memory types (event-based, time-based, & activity-based) mainly rely upon the cue as well as the process that is initiated during the performance. Event-based prospective memory is more dependent on external cue and thereby requires less attentional demand. In contrast, time-based and activity-based tasks are less relied upon external cue, so they undergo a self-initiated procedure and therefore produce varying results

when compared to event-based prospective memory task.

In the present experiment we propose to test the effects of emotional cue on all types of prospective memory by means of varying tasks. The tasks used for measuring prospective memory in the present experiment were designed in house and were based on standardized tasks meant to measure the three types of prospective memory.

Method

Participants:

Undergraduate students (mean age= 25.6 \pm 3.18) from Indian Institute of Technology, Guwahati volunteered in exchange for partial credit toward a course requirement. Each participant was tested individually in sessions that lasted approximately 15 mins. Participants (N=40) were randomly assigned equally to both positive and negative emotional group. Each participant completed a personal data form (including demographic details), informed consent sheet, a mood questionnaire, and positive and negative affect schedule (PANAS; Watson et al., 1988).

Material & Procedure:

The prospective memory task was embedded in working memory task. For each group of participants (positive / negative) there were 100 trials of the working memory task, with equal number of valence (positive /

negative) and neutral [50 valence & 50 neutral] words. These words were selected from ANEW (Affective Norms for English Words) prepared by Bradley & Lang (1999). The selections were based on valence (mean ratings - positive: 8.0 \pm 1; negative: 2.0 \pm), word frequency (mean frequency: 50 \pm 15) & length of words (mean length: 6 \pm 2). The words were presented using E-prime software (ver. 2.0).

Definitions of tasks used in the experiment

a) Ongoing task: At the beginning of the experiment, participants read the instructions for lexical decision task in which both prospective memory tasks (event-based & time-based) were embedded. In the lexical decision task, the participants were shown words on the screen for 5 seconds. The participants had to categorize the words as abstract or concrete words. This task is thought to place relatively heavy demands on working memory and information processing resources. Participants were instructed to press "a" to indicate abstract words & "c" to indicate concrete words.

b) Event-based prospective memory task: In this task, participants needed to press "s" whenever any six-letter word appears on the screen. In total 20 targets appeared during the ongoing task. All participants were made familiar with the 20 targets in an earlier session spaced well before the actual experiment. Every hit on the target key that occurred within 5s after the presentation of the target was scored as success.

c) Time-based prospective memory task: In this task, participants needed to press "1" as target key at 30s interval from the start of ongoing task as accurately as possible. To analyze time-based prospective memory performance, we set a target window of 30 s (\pm 5s). Every hit on the target key within this time window was scored as success.

d) Activity-based prospective memory task: For this task, the participants were given a questionnaire, which comprised of questions related to their experience during the experiment. Participants were asked to recall the words they saw during the ongoing task

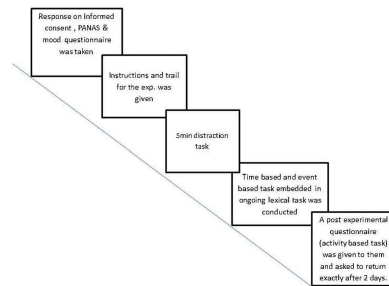


Figure 1: Task Flow for the Prospective Memory Experiments

of the experiment in the questionnaire. They were told to fill the questionnaire at home and drop it in the drop box kept at a certain place in the department (Kliegel & Jager, 2006). In addition, they were instructed to write the date, day & time of returning on the right top of the questionnaire. Based on their returning time, score of 1 was assigned if the participant posted the questionnaire exactly after the session. A score of 1 was assigned if the participants returned the questionnaire on an incorrect day and a score of 0 was given if the participant failed to return the questionnaire back. Additional score of 1 was given to participants who remembered to write the date, day and time according to the instructions given to them.

The two groups of participants (negative & positive) were exposed to all the prospective memory tests in a pre-defined study design. Data obtained from the tests were recorded and scored according to the demands of the prospective memory task.

Results

Emotional valence effects on prospective memory type

A mixed model of 2 x 3 ANOVA with valence (positive, negative) between group & prospective memory type (event, time, activity) within the group and repeated on all factors, was used to test the effects of emotional valence on prospective memory. The dependent variable for event & time prospective memory were accuracy scores while successes (as explained above) was dependent measure for activity prospective memory. Significant main effects for prospective memory type [F (1, 38) = 70.59, $p < 0.01$,

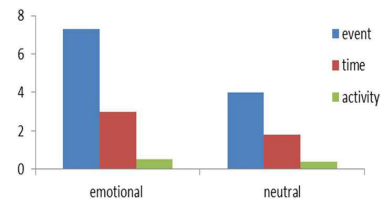


figure2. representing mean scores of prospective memory tasks across emotional and neutral words

mean (8.1, 2.7, 0.45), $\eta^2 = 0.547$] suggested irrespective of valence (positive / negative) prospective memory performance differs across prospective memory types. This would suggest that emotional valence did not have a differential effect on all the prospective types, significantly. All other effects turned out to be non-significant.

Positive vs Neutral cue effects on prospective memory

A repeated measure of 2 x 3 (ANOVA) with valence (positive, neutral) between the group & prospective memory type (event, time, activity) within the group (repeated on all measures), and accuracy scores (as mentioned above) as dependent measures was applied to the data. Significant main effects for valence [F (1, 19) = 5.039, $p < 0.05$, mean (positive = 3.87, neutral = 2.1) $\eta^2 = 0.21$], prospective memory type [F (1, 19) = 38.027, $p < 0.01$, mean (event = 6.4, time = 2.17, activity = 0.4) $\eta^2 = 0.67$] & significant interaction effects (valence x task) [F (1, 19) = 6.07, $p < 0.01$, $\eta^2 = 0.24$] were obtained. Interaction effects were followed up by computing simple mean effects (LSD) which revealed smaller accuracy scores for the neutral stimuli than emotional stimuli ($p < 0.001$). The positive stimuli group revealed better accuracy scores on all prospective memory types while in the neutral group only event-based prospective memory revealed better accuracy results.

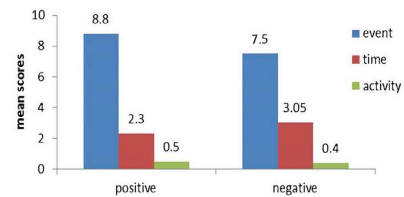


Figure3. representing mean scores of prospective memory task across emotional valence (positive & negative)

Negative vs Neutral cue effects on prospective memory

A repeated measure 2 x 3 ANOVA with valence (negative, neutral) between group & prospective memory type (event, time, activity) within group (repeated on all measures), and

accuracy scores (as mentioned above) as dependent measures was applied to the data. Significant main effects for valence [$F(1, 19) = 8.67, p < 0.01$, mean (negative = 3.71, neutral = 2.13), $\eta^2 = 0.31$], prospective memory type [$F(1, 19) = 30.881, p < 0.01$, mean (event = 5.78, time = 2.5, activity = 0.45), $\eta^2 = 0.62$], & significant interaction effects (valence x task) [$F(1, 19) = 4.92, p < 0.05, \eta^2 = 0.20$] were obtained. Interaction effects were followed up by computing simple mean effects (LSD) which revealed smaller accuracy scores for the neutral stimuli than emotional stimuli ($p < 0.001$). The positive stimuli group revealed better accuracy scores on all prospective memory types while in the neutral group only event- & time-based prospective memory revealed better accuracy results.

Discussion

The present study aimed to examine the influence of emotional valence (positive & negative) on the ability to carry out different types of prospective memory intentions. For this purpose, participants were invited to the laboratory and they performed time-based and event-based tasks embedded in an ongoing task. They also performed activity-based tasks in a naturalistic condition. Consistent with the research on retrospective memory (Denburg et al., 2003; Gruhn et al., 2005), emotional prospective memory cues were better remembered than neutral cues in both the conditions. This indicates that difficulties to carry out intentions are reduced when they are associated with emotional cues.

Prospective memory types and performance

Regarding the performance on prospective memory tasks, a significant difference was found among all three prospective memory types. This result suggests that different processes are involved in different types of prospective memory intentions, which have been reported in previous studies. Event-based prospective memory requires fewer executive resources than time-based as event-based prospective memory task must be executed at an occurrence of a

specific cue whereas time-based prospective memory relies more heavily on internal control mechanisms and the self-initiated reactivation of one's intention, given that no external cues are available (e.g., Einstein et al., 1995).

Activity-based prospective task is executed after completion of some other activity (e.g., the timer going off) which itself serves as a cue, and automatically reactivates one's prior intention. Kliegel, Ramuschkat, and Martin (2003) report that both event- and time- based prospective memory tasks relied on different executive processes, with event-based tasks requiring inhibition and time-based tasks requiring shifting. The executive functions of inhibition and shifting explain the ability to flexibly switch between tasks, when a reconfiguration of memory is required, by disengaging from previous goals or task sets (Mayr and Keele, 2000).

Monsell and colleagues (2002) have demonstrated that reaction time depends on the preparation to task changes, namely mean reaction time is longer (and error rate usually greater) when the task changes (shifting) than when the same task is performed as on the previous trial (inhibition). Different from event-based and temporal cues, in activity-based tasks no interruption of the ongoing task is required to retrieve the intention and execute the prospective memory task (Kvavilashvili & Ellis, 1996). As a result, we expected to have better results for prospective memory task. But, the results revealed lesser accuracy scores in activity-based task as compared to the other two prospective memory tasks. Such results can be attributed to the fact that activity-based tasks are followed by other activities and the end of one task acts as less salient cue than the typical event-based cue that often occurs in the focus of attention (Hicks, Cook & Marsh, 2005).

In comparison to event-based prospective memory task, which is an independent kind of task being retrieved by some external cue, activity-based tasks are performed at the end of the other activity, which means that retention period for this task is filled with other intentions that can lead to failure of activity-based tasks. However, if one has learned to perform the activity-based intention at critical junctures

in a variety of different circumstances, then any cognitive load may not have the same deleterious consequences that have been observed in this experiment. This means that practice also influences execution of prospective memory tasks. Other than these there can be variations among prospective memory intentions, depending on the characteristics of the prospective memory task, the nature and demands of the ongoing task (i.e., focal processing of the target, degree of engagement, and demands of the ongoing task), and the characteristics of the individuals.

Okuda et al. (2007) conducted a positron emission tomography study on young adults to examine event-based and time-based prospective memory. They found that different sub regions of the rostral prefrontal cortex were involved in event-based and time-based, and reported additional activation of several frontal, parietal, and temporal cortices, as well as the cerebellum in the time-based prospective memory task, suggesting the engagement of additional processes in time-based prospective memory. The identification of distinct neural substrates for the two tasks supports the idea that different cognitive processes are involved in event-based and time-based prospective memory.

Prospective memory types and valence

Another important finding of the study is it indicates the impact of emotions in all the prospective memory tasks. As compared to neutral cues participants performed better with emotional cues across all three task types and conditions (positive, negative). The data is consistent with the notion that emotional items are more distinctive or salient than neutral items, and that they may spontaneously trigger the prospective memory intention and reduce the need for deliberate processing. Previous studies more directly explain the idea that performance is better for emotional than for neutral cues in event-based prospective memory tasks (Altgassen et al., 2010; Rendell et al., 2011).

Altgassen et al. 2010 demonstrated better prospective memory for emotional than for

neutral prospective memory targets, although this finding was reliable for older but, not younger adults. In addition, Rendell et al. 2011 found significantly better prospective memory for positive than for neutral cues for both younger and older adults, but the difference between negative and neutral cues was not reliable. Both studies indeed suggested that emotional prospective memory cues may be more salient than neutral cues, at least in some circumstances, but the methodologies across these studies limited any strong conclusions that could be drawn about prospective memory and emotion.

While comparing the accuracy scores of two valences (positive & negative), hit rates for positive and negative items did not differ much from each other. But, based on mean scores we report a better response for positive valence compared to negative valence cue which shows similar pattern of results to Rendell et al., 2011. However, the effect found is not significant enough to prove differential effect of both positive and negative valence on prospective memory tasks. The plausible explanation attributed to neural regions that are involved in regulating positive and negative emotions. The regulation of positive and negative emotions commonly involved the left superior and lateral frontal regions (BA8/9) (Mak et al., 2009).

Another study on prospective memory reported that positive cues improved the prospective component, while negative cues improved the retrospective component in old people, but valence has no significant main effect on younger adults on an overt accuracy measure of prospective memory (Schnitzspahn, Horn, Bayen, & Kliegel, 2012). For younger adults, amygdala activation during picture encoding is associated with superior memory compared to old people for emotionally positive and negative information (Cahill et al., 1996). This implies that processes underlying emotional effects on prospective memory may differ depending on valence and age. However, the issue of emotional valence in context of prospective memory remains unraveled because of existing discrepancies in results due to methodological

limitations that require further researches in the area to implicate clear understanding about emotional valence and its effect on prospective memory.

Conclusion

The data reported in this study suggests that in line with previous studies emotion is relevant in understanding prospective memory functions. Further, our data indicate better effect of positive and negative emotions in prospective memory task compared to neutral across all prospective memory types. Lower significant difference was found in positive and negative emotion and needs further experimentation. The activity-based task results were not very satisfactory and should be tested using newer efficient designs in future studies.

This study added evidence to the fact that the association between emotional variable and prospective memory performance might be reversed in everyday life relative to the laboratory situation. However, further research is clearly necessary to replicate these findings on a larger sample.

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