Event-Based Prospective Memory in Young Adults: The Role of Gender Differences

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Abstract. As many as 50-70% of memory problems in life originate from prospective memory. Prospective memory allows a person to recall and carry out previously planned intentions. Gender differences impact a person's prospective memory performance, although consistent findings have not been observed. This study aims to investigate gender differences in affecting memory performance in terms of event-based prospective memory types and the young adult population (college students). The study was conducted in a lab setting, with prospective memory measurements in the N-back Test. The statistical non-parametric Mann-Whitney U test is used in this study since the data is not normally distributed. The results on 69 participants (M_{age}=22.3, N_{men}=13, N_{women}=56) showed significant differences between men and women in the performance of event-based prospective memory. In terms of accuracy, males outperform women in event-based prospective memory. Meanwhile, there was no discernible gender difference in response time performance. Nonetheless, men are acknowledged to be speedier than women. This finding has broad implications for future studies on gender differences and memory, and it is hoped that it will spur further in-depth investigation into the underlying factors.

Keywords: *Event-Based Memory Perspective, Gender Differences, Memory Perspective*.

1 Introduction

Successful prospective memory (PM) enables a person to shape and direct his cognitive resources in search of future activities and plans (1). PM failures represent 50–70% of everyday memory problems (2,3). Therefore, studying PM is essential to resolving this problem.

Previous research has found that there are individual variances in the types of gender that improve PM performance, even though it is still few in sum, and the results are not always consistent. The performance of Event-Based Prospective Memory (EBPM) is higher in women than men in the older adult group, while there is no difference in the young adult group (4). Then, previous research found that young adult males are better than women when it comes to Time-Based Prospective Memory (TBPM) performance (5). Gender differences in EBPM performance were not consistent in young adults. Due to this, this current research is attempting to close the gap.

Only those in the young adult age group are included in this study. It is well established that young adults under high cognitive load are more likely to make errors while setting PM intentions (6). This implies that PM research in young adults is also required to identify patterns that underpin variances in PM performance for everyone in young adults. Additionally, there are not many EBPM studies that concentrate on early adulthood. Thus, this study was carried out to contribute to the results of existing gender differences and look for explanations for them.

This study only employed one type of PM, namely EBPM, in order to avoid the complexity of PM instrument designs. This was also considered in prior research that restricted the use of PM forms to only one type, EBPM or TBPM (7–10). This preliminary study attempts to examine the disparities between men and women in young adults in terms of impacting EBPM performance.

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2 Literature Review

PM is remembering an intention to do a future action (11). PM is also known as the ability to "remember to remember" or "remember to recall" (12). PM consists of several phases: encoding an intention, maintaining the intention in memory while engaged in other ongoing activities, initiating the intention at the appropriate moment, and evaluating the outcome (13).

PM can be divided into two types: event-based prospective memory and time-based prospective memory (14–16). Event-based prospective memory (EBPM) is an event-based task that must be completed when a specified event target emerges in the environment—for example, remembering the intention to look for an important book when passing through the campus library. Meanwhile, time-based prospective memory (TBPM) is a task involving tasks that must be completed at a specific time or after a specific amount of time has elapsed. For example, you might collect class assignments at 12 p.m. or test response sheets when the time runs out.

3 Method

3.1 Participants

The participants were 69 graduate and undergraduate students from four universities in the Province of the Special Region of Yogyakarta, Indonesia (13 males, 56 women; M_{age}=22.3 years). Each participant in the study must conform to the inclusion and exclusion requirements. The following criteria were required for participation in this study: age between 18 and 25 years, status as an active student, male or female, dominant use of the right hand (right-handed), living in Yogyakarta or its surroundings, normal vision or has been corrected to every day/using eyeglass. Following that, the exclusion criteria: having colour blindness; having symptoms of depression and anxiety at mild level or above, as indicated by a DASS-21 scale score, i.e., depression scores > 9, anxiety scores > 7, and stress scores > 14 (17).

3.2 Materials

This study used two instruments: the DASS-21 scale (17) and the N-back test (8), all provided in Indonesian. The DASS-21 scale is only being used to identify people who have disorders such as stress, anxiety, or depression that might skew the findings of the study. Anxiety and depressive symptoms interfere with PM abilities (6,18). The N-back Test instrument was then constructed using the OpenSesame® 3.3 software. The N-back test is a standard tool for determining working memory capacity (19). The N-back test with additional PM tasks then evolved into an instrument that aids in measuring PM, as demonstrated by previous research (8).

The N-back Test instrument was created by including a PM cue stimulus. The N-back test is further divided into two conditions: 1-back test and 2-back test. The N-back task has three blocks for each condition, each consisting of one training block and two testing blocks. Participants were shown 100 alphabetic stimuli, including two cues for the EBPM task, 49 cues for target N-back, and 49 cues for non-target N-back. Each alphabetic stimulus lasts 2,500 milliseconds, followed by a blank black screen for a maximum of 3,000 milliseconds before transitioning to a new alphabet stimulus. Records of participant responses from the second and third blocks were made to analyse EBPM's performance in terms of response accuracy and reaction time. The accuracy score is between 0 and 4, 4 representing perfect accuracy. The reaction time score is the average millisecond time of the 4 EBPM tasks.

In the N-back task, participants must ensure that each letter is similar to N-previous. Participants were told to put their hands on the keyboard of the computer. Left index finger on the F button, right index finger on the J button, and right middle finger on the K button. They were instructed to:

1. If the current letter is the same as the previous N-letters, press the "F" button; if it is different, press the "J" button.
2. Unless they notice the letter "D" on screen, which is a cue from the EBPM task, participants were told to press the "K" button in response.

In the 1-back condition, the letter that shows now is the same as the previous one letter, for example, "N-P-P". Then for the 2-back condition, the current letter is the same as two previous letters, for example, "S-A-S". Figure 1 shows the N-back Test visualization.

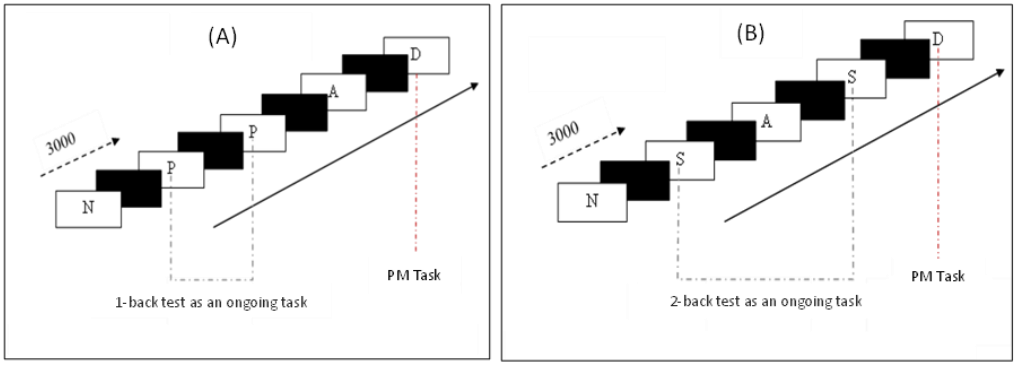

Figure 1. The Blueprint of 1-Back Test (Box A) and 2-Back Test (Box B)

In addition to the instruments mentioned above, we gathered information about participant activities besides lectures and their emotional states before the test. Data was collected utilizing a brief form provided before participating in the research. There are inquiries on this form in Indonesian, such as "Conditions before attending laboratory" with the response choice "Positive/Negative Mood" and "Organizations/Activities besides lectures" with an open answer entry.

3.3 Procedures

We delivered posters outlining the recruitment of research subjects in social media, and those interested fill out the Google form link for the registration form given on the poster. If the applicant fits the requirements in the registration form, the researcher will send the DASS-21 Scale with a Google Form link to the applicant, together with informed consent, to select and ensure the psychological status in the initial screening for symptoms of depression and anxiety.

Participants are invited to a specified schedule at the Laboratory of Mental Process and Behavior, Faculty of Psychology, Gadjah Mada University (UGM). Because the meeting was conducted during the Covid-19 pandemic, strict health protocol was followed. The research assistant presented an informed permission form and a description of the experimental protocol in the opening statement. Participants who agreed to the informed consent were asked to complete a personal identity form.

Furthermore, after that, each participant was sat on a computer and asked to wear headphones. Participants were told to follow all the directions on each block on the computer screen.

Participants will get instructions and simulations at the beginning of each block, and they will be required to complete three tasks in response to visual cues displayed on the computer screen. After finishing the test, all participants received a debriefing and an incentive of 40,000 rupiah (Indonesian currency, or around $2.50 in conversion).

3.4 Design and Analysis

This study compares differences between two independent groups with the dependent variable, with gender differences as the independent variable and EBPM performance as the dependent variable. In order to analyze the significance of the differences between the men and women groups, we used a non-parametric statistical test, the Mann-Whitney U test. The purpose of the Mann-Whitney U test is to evaluate the relevance of the impact of gender variations on EBPM performance from data that is not normally distributed. And then, the compare means test is used to compare men's and women's EBPM performance. The IBM Statistics SPSS 23 tool was utilized to aid the analysis.

4 Result

The findings on the gender factor revealed that there were significant differences in EBPM accuracy between men and women (p=0.004), but not in reaction time (p=0.945). We found that male participants had a higher EBPM accuracy score than women (M_{men}=3,846 > M_{women}=3,036). Regarding reaction time, male individuals were slightly faster than women participants in delivering memory responses (M_{men} = 1079,712 M_{women} = 1088,951). Table 1 offers a comprehensive overview.

Table 1. The U-Test Results of Gender Differences in EBPM Performance

	Gender	N	M	SD	*t*	*p*
Accuracy	Men	13	3.846	0.376	2.791	0.004
	Women	56	3.036	1.026		
Reaction Time	Men	13	1079.712	190.919	-0.132	0.945
	Women	56	1088.951	234.100		

Additional data related to participant activities was collected, and it was found that 31% (N=4) of male participants had no other activities besides lectures, 54% (N=7) had one activity other than lectures, and 15% (N=2) had two activities other than lectures. No male participants engaged in more than two activities besides lectures. However, the female participant data is more diversified, with up to four activities, with 20% (N=11) having no other activities besides lectures, 46% (N=26) having one activity besides lectures, 18% (N=10) having two activities besides lectures,13% (N=7) having three activities besides lectures, and 20% (N=11) having four activities besides lectures. Figure 2 demonstrates specifics.

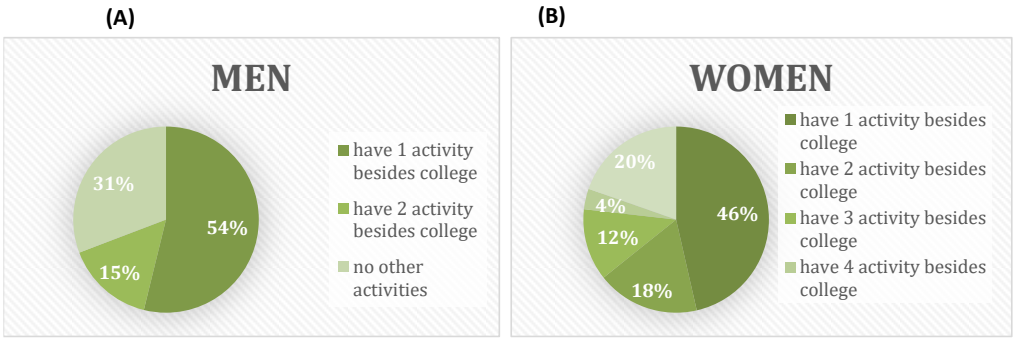

Figure 2. The Count of Participant's Activities Outside of Lectures (Box A for Men and Box B for Women)

Additional data on the participants' moods were taken prior to the test, and it was reported that all male participants had a good mood, but 5% (N=3) of female participants had a negative mood, and 95% (N=53) had a happy mood (See Table 2).

Table 2. Distribution of Data on Participants' Emotional State

Mood	Men	Women
Positive	13 (100%)	53 (95%)
Negative	0	3 (5%)

5 Discussion

5.1 EBPM Accuracy Performance

Men exhibit greater EBPM accuracy than women (Mmen=3.846 > M_{women}=3.036, t=2.791, p=0.004). This conclusion contradicts a recent study that reported no gender differences in young adult participants but showed women superior EBPM abilities in the elderly (4). It also contradicts earlier research that shows young adult women outperform men in EBPM performance (20). However, other research found that males and young adults did better in TBPM than women and older adults (5). They explain that this is because men have slightly better working memory, perceptual organizational factors, and processing speed than women. Furthermore, it was confirmed by Huppert et al. (21), who claimed that men are strongly and directly connected to having high PM performance in dementia. Although studies investigating gender differences in prospective memory have not been consistent, this finding could be novel to the results of PM studies using the EBPM type.

More specifically, when looking at gender variations in the count of activities apart from lectures, it can be shown that males only participate in a maximum of two activities, and most have 0 - 1 other activity. The fascinating part is that most women have three or four additional activities besides lectures. This might explain why males outperform women in terms of EBPM's accuracy performance. Because they are in a less intensive state of activity, young adult males, particularly college students, have more significant cognitive resources to perform prospective memory tasks. However, young adult women's cognitive resources are sufficiently vast to be utilized for their activities, partly because they are pretty engaged in various social roles outside of lectures. As a result, when given a PM task, there are just a few resources available to process it, which causes it to have poorer memory accuracy than males. Human has limited cognitive resources (22–26). When the demand for resources exceeds cognitive capability, memory performance will suffer.

Additional information on the participants' mood before the test revealed that all of the male participants were in a pleasant mood, while some of the female participants were in a bad mood. Even though the proportion is tiny, it may be one of the reasons why women score less well than men in EBPM accuracy tests. According to earlier studies, young adults' EBPM performance worsened when they were in a bad mood (27). Emotions affect the cognitive load on limited resources, emotion regulation, motivation, and memory (28). Negative emotions appear to serve as an additional cognitive load and may also limit the transfer of information into long-term memory by disrupting the information store principle (29).

Even if the additional data are supporting data, the following explanation can help identify potential causes that lead to males performing better than women in EBPM. The data on the mood of the participants had not gone through psychological and physiological tests. Therefore, this study's positive and negative moods were merely personal information from the participants. Also, it is hoped that in the future, other researchers will be able to investigate the genuine influence of cognitive load and mood in PM studies.

5.2 EBPM Reaction Time Performance

This research reveals that men and women did not significantly differ in their ability to influence EBPM speed performance regarding response time. However, with the result from the mean comparison, men have a slightly faster response time than women. There has not been much prior study on reaction time performance in PM, but several studies on response time performance in memory in general have not produced consistent findings. Men have substantially quicker episodic memory than women (30). On the working memory, the response times of men and women are equal (31). The disparity between our findings and other research shows that more investigation into the reaction time of EBPM in terms of gender differences is required.

The group of participants with better accuracy (men) may have acted cautiously to ensure the response's correctness, which might account for this insignificant outcome in reaction time. Because of this, the male participants tended to disregard their reaction times in their quest for maximum accuracy. This is illustrated by recent research, which found that accuracy cannot always be predicted by reaction time. Therefore, a longer time can indicate either increased or reduced accuracy (32). This issue may be caused by characteristics that vary between male and female traits.

Furthermore, we employed 1-back and 2-back tests in this study to represent low and high loads, respectively. As a result, the participants' changing conditions from low to high load may have influenced our findings of considerably greater accuracy but without significant change in response time. Future studies should be able to dig further into the influence of cognitive load conditions on gender differences and PM performance.

6 Conclusion

We conclude that there are significant differences between men and women in influencing the performance of EBPM accuracy. Men are thought to be far better than women in giving accurate responses. However, no significant difference in EBPM reaction time accompanied these findings. When focused on accuracy and being careful of all visual stimuli, participants tend to neglect temporal factors. Additionally, social roles and participant emotions could be another aspect that contributes to understanding the individual differences between men and women in

terms of how EBPM performance is impacted. These findings are expected to enrich research results regarding gender differences and be useful for young adults in practically evaluating their memory skills.

We recognize that there are still numerous limitations in this preliminary study; thus, further research is expected to continue on various factors. Given the relatively small and unbalanced sample size in each group, we must proceed with caution when concluding, so further research should use a larger sample and balanced group size. Future research with a meta-analysis might also assist in clarifying the magnitude of this gender impact. Then, to ensure the effect of mood, psychological assessments related to emotional states or mood must be used. We need to dig further into the analysis of other variables and compile more psychological and physiological measurements. Also, a deeper comparison of the 1-back and 2-back responses is also required to understand the function of cognitive load. Moreover, it is hoped that other vulnerable populations, such as children and the elderly, would be included in the research.

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