Young Brain, Old Brain: A Meta-analysis of Age Differences in Recognition Memory using ERPs

Zilan Ding, Mahek Nirav Shah. Ariel Wu and Anjali Thapar

Psychology, Bryn Mawr College

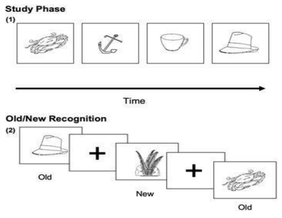
Abstract

Recognition memory is how we distinguish old items from new items. We conducted a meta-analysis on 23 articles that used event related potentials (ERPs) to study age differences in recognition memory to better understand whether the Old/New ERP effect can be observed in both younger and older adults. The result shows that a total of 22 articles out of 23 reported significant Old/New ERP effect in young adults, whereas only 13 articles reported significant Old/New ERP effect in old adults. Reliable age differences in memory performance and in the old/new ERP effect were observed in 22 out of 23 articles. The underlying reasons are still unknown and will be investigated in the fall.

Introduction

Recognition Memory and Aging

"I have seen that person before", "I have heard the tune prior to this", and "I have seen this thing earlier today" - are common phrases we all say or have heard. The ability to discriminate between previously encountered and new items is referred to as recognition memory. This is a crucial part of human memory which aids many everyday skills and tasks, and essentially, how we interact with the world. Research in cognitive aging has repeatedly shown that performance on recognition memory tasks decreases with age (see recent meta-analysis by Fraundorf, Hourihan, Peters, & Benjamin, 2019).



	Old Items	New Items
Identify as Old	Hit	False Alarm
Identify as new	Miss	Correct Rejection

Figure 1. Typical ways to measure performance in Recognition Memory

ERP and Old/New Effect

Considering this broad picture has emerged of age differences in recognition memory, the goal of the current study was to conduct a meta-analysis on research investigating the neural correlates of recognition memory using event-related potentials. Event Related Potentials (ERP) is a non-invasive technique used to study the neural activities associated with brain functioning. The ERPs elicited in response to a stimulus reflect the firing of the neurons, hence the small voltages is post-synaptic potential. Therefore, ERPs can be used to understand the underlying brain activities of participants performing recognition memory tasks. One of the main effects seen in recognition memory using ERPs is the Old/New effect. The Old/New effect is characterized as a more positive response to stimuli correctly identified as old (Hits) than to stimuli correctly identified as new (Correct Rejection) at between 300-800ms.

Research Questions

To understand the age differences in neural correlates of recognition memory, we conducted a meta-analysis of the past research which includes a cross-sectional comparison of healthy young and healthy old adults who participated in recognition memory tasks while also measuring their Event Related Potential (ERP Performance).

Our goal for conducting this meta-analysis is to answer the following questions:

1. Is the Old/New ERP effect reliably observed in both young and older adults?
2. Is there an age difference in the magnitude of the Old/New effect?
3. What characteristics of the task (such as type of stimuli, encoding instructions, test interval, etc.) enhance or reduce age differences in the Old/New ERP effect?
4. What characteristics of the ERP processing pipeline (such as electrode site, time epoch, artifact management, etc.) enhance or reduce age differences in the Old/New ERP effect?

Method

Meta-analysis

Meta-analysis is an analysis design consisting of a quantitative, formal approach to systematically assess results of previous research and gain insights into that body of research, allowing researchers to draw conclusions based on the collective results of previous research.

Literature Search

A computer search was conducted for literature through the end of June 2020 using the PSYCINFO database. The keywords for the search were (age differences) OR (aging) OR (ageing) AND (recognition memory) OR (recognition) AND (ERP) OR (Event related potential).

Inclusion Criteria: Research had to meet a pre-determined inclusion criteria to be included. If a paper reported on multiple experiments, only experiments that met the criteria were included.

a. Used Recognition Memory Task
   - Papers that tested other memory paradigms were excluded.
b. Included health younger and older adult populations
   - Minimum age for older adults was set at 60 years old.
   - Only non-clinical samples were included
c. Uses ERP for measuring neural correlates

The PSYCINFO search resulted in 149 papers. These papers were screened for the inclusion criteria using an inter-rater model. Discrepancies between raters were resolved by discussion. After the screening, 23 articles fully meet the inclusion criteria which we then coded for this meta analysis. Another literature search was performed for the Web of Science database, but we are still in the process of evaluating these papers. This study only includes the results of the PSYCINFO database.

Article Coding Scheme: All articles that met the inclusion criteria were coded for the relevant information (see table below) by two researchers and discrepancies between coders were resolved by discussion. A subset of the variables that were coded for each included article are presented below.

Variable Name	Sample Variables
Basic information	Year of publications, author name, and demographic of sample population
Stimuli characteristics	Stimulus modality (words, pictures,other) and their characteristics (colorful/black/white, emotional, paired)
Study phase characteristics	Intentional/incidental encoding, deep/shadow encoding task, and inter-stimulus interval (ISI), presentation rate
Test Phase characteristics	Yes/No recognition Memory, Source Memory Instruction Task, immediate/delayed testing, item/paired memory task, and ISI
EEG/ERP System Characteristics	ERP placement, ERP measuring method, Filter/Artifact/Re-reference protocols, and Recording time windows
Recognition Memory Behavior Performance	Raw scores for hit and false alarm rate for young and old adults, corrected scores, and reliable age difference in behavior performance
Recognition Memory ERP Performance	Mean ERP scores, number of trials used to create average ERP, Old/New ERP analyses reported (Yes/No), and reliable Old/New ERP seen in different age groups (Yes/No).

Results

Participants	Total # of Old Adults	436 Participants
	Total # of Young Adults	443 Participants
Modality	Experiments w/ Words	12 Experiments
	Experiments w/ Text	6 Experiments
	Experiments w/ Pictures	9 Experiments
Type of Recognition Memory task	Item	21 Experiments
	Associative	3 Experiments
Reliable Age differences in behavior performance	Yes	19 Experiments
	No	5 Experiments
Re-reference protocol	Average Mastoids	16 Experiments
	Average all Electrodes	4 Experiments
	Single Channel	2 Experiments
Electrode sites	Individual	14 Experiments
	Clustered	9 Experiments
Time window	Early/Late Components (300-500; 500-800 ms)	14 Experiments
	Other Time Windows	9 Experiments
Reliable Old/New ERP in Young Adults	Yes	22 Experiments
	No	1 Experiment
Reliable Old/New ERP in Old Adults	Yes	13 Experiments
	No	10 Experiments
Reliable age differences in Old/New ERP	Yes	22 Experiments
	No	1 Experiment

The above table shows the preliminary data analysis, and we will continue to work on data analysis and discussions in the fall.

Conclusions

The results that we found were similar to the recent meta-analysis by Fraundorf, Hourihan, Peters, & Benjamin (2019) which showed a reliable age difference in recognition memory behavior performance. Furthermore, we found a reliable old/new effect in young adults but the old/new effect was not as reliably observed in old adults. Age differences in old/new effect was also observed. We will continue to further explore the reasons for these age differences in Fall 2020.

References

1. Fraundorf, S. H., Hourihan, K. L., Peters, R. A., & Benjamin, A. S. (2019). Aging and recognition memory: A meta-analysis. *Psychological Bulletin, 145*(4), 339–371. https://doi.org/10.1037/bul0000185

Acknowledgments

A huge thank you to Bryn Mawr College and the Summer Science Research program for not only funding us but also making this research possible. We would also like to thank Professor Thapar for guiding us and being a pillar of support as we worked through this research project.