INVESTIGATING THE USE OF PRIOR KNOWLEDGE AND NOVEL INPUT IN A VISUAL SEARCH

By

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Abstract

Detecting new patterns in the environment is important for adapting to new situations, and using previously acquired knowledge allows the learner to be more efficient in the world. Previous studies suggest that novel patterns can draw attention, even if they are irrelevant to a particular task (Zhao et al., 2015). It is unclear whether this bias differs between age groups, particularly younger and older adults. Older adults have more knowledge than younger adults, and both are capable of noticing patterns. We investigated this issue using a visual search paradigm, where the participant had to search for specific everyday objects, such as carrots, on a computer screen. The present study included 37 younger adults and 53 older adults. We will measure reaction time and accuracy differences when the everyday objects appear in patterned locations or non-patterned locations across age groups. We hypothesize that older adults may rely more on their increased prior knowledge compared to younger adults and be less distracted by irrelevant patterns. By contrast, younger adults may use these irrelevant pattern to help them find the everyday objects.

Acknowledgement

I would like to thank my faculty mentor, Rachel Wu, for always working with me no matter the situations. My first graduate student had left, but she made sure I had a project to work with when my first when fell through. I wasn’t sure what I wanted to do anymore since my first idea was scrapped at the beginning of my fourth year. She made sure I had what I needed to succeed even when I wasn’t sure. I would also like to thank the graduate student I worked with, Austin, who let me join his project and make part of it my own. He didn’t have to do that, and he really did me a favor by letting me take over.

I would like to thank my friends and family for pushing me to complete this project for honors. I wasn’t so sure if I wanted to continue with it, but they said it would be a great opportunity for me. I just want to thank them for always believing in me when I didn’t necessarily believe in myself as without them I wouldn’t be where I am today.

Lastly, I want to thank all the members of the CALLA Lab at UCR that helped run participants and were readily available to help me with this project whenever I asked.

Table of Contents

Introduction:

Adapting to new situations is a right of passage in this day and age. People come up with new ways to learn new things all the time. People have to decipher between what they need to know now and put away the irrelevant information for future reference. “Visual experiences increase our ability to discriminate environmentally relevant stimuli at the cost of a reduced sensitivity to irrelevant or infrequent stimuli- a developmental progression known as perceptional narrowing” (Wu et al.,2015). For example, students are told all the time that they will need to know all the formulas they once learned in a Calculus class to use in the future. They need to decipher what they actually need to know in the moment and what would be useful to know in the future. Using a visual search task can provide evidence for deciphering between what is relevant and irrelevant as by presenting targets and distractors simultaneously, visual search tasks require active guidance via attentional templates (Wu et al., 2015). Our experiment will test this as they will need to find a relevant item (food or toy), while at the same time ignoring the irrelevant stimuli.

Knowledge about regularities in the environment can also be used to facilitate memory among other things (Zhao et al., 2013). It is suggested that stimulus that are statistically structured sources of information will receive more attentional priority over noisier sources (Zhao et al., 2013). We used this information to help design our experiment where one side of it had a pattern and the other was just random. We predicted that the younger adults would gain more from the experiment by identifying the pattern, and that the older adults wouldn’t be able to identify as fast as the younger adults which would cause them to not do as well.

Statistical learning has become known as a big factor in identifying statistical regularities in one’s environment. “For example, language acquisition, object recognition and localization, music appreciation, and predictions of everyday phenomena such as estimation of life spans" (Arciuli and Simpson, 2011). It appears that younger adults are the most efficient when it comes to learning new things. Arcuili and Simpson also believed that adults would do better with statistical learning if there was a longer presentation of the stimuli. For our experiment, the stimuli was being presented for 200ms across both age range to allow a level playing field. This goes to show that statistical learning could be the key to optimize learning among the different age groups.

Previous studies observed that age differences in learning were due to age-related deficits in sensitivity to rule-based structure (Simon et al., 2010). There study focused on how rule-governed structure was eliminated by randomly selecting a subset of triplets to occur more frequently than others (Simon et al., 2010). In our experiment, we took this a step further and instead of have one triplet be more frequent, they were placed in patterns where one would not be shown more than another. Simon's experiment predicted that the older adults should learn just as well as the younger ones. We predicted that the younger adults would out perform the older adults when it comes to finding the triplet pattern that the Simon experiment was looking for.

There are also many stereotypes that go around about the elderly, and as a person gets older, they lose the ability to learn new things. Although many studies have been done to disprove this (Wu et al., 2016), it was still in question whether or not they would do well in a situation that required them to use their prior knowledge. We believe that they will rely on this prior knowledge rather than focusing on learning a new pattern to help them complete the task. Younger adults don't have the amount of prior knowledge, so they will have to rely on finding the pattern to help them with the task.

The main question being asked is if as the older someone gets can they still learn new information or acquire new skills. Studies have shown that acquiring fundamentally new skills that cannot be derived from skills already possessed is the most effective before adolescence (Janacsek et al., 2012). We want to see if this is true for just using prior knowledge to solve a task rather than learning a new skill. We agree that the younger adults should be able to learn the pattern quicker than the older adults, but want to know if the older adults can use their prior knowledge to help boost them ahead of the younger adults.

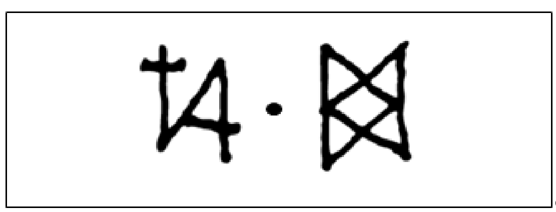
This study aims to answer that question: if there is a bias towards using prior knowledge or finding a pattern to help complete a task given to them. We believe that both age groups are capable of recognizing a pattern, but older adults may decide to use prior knowledge instead since that would be easier. Additionally, we hypothesize that younger adults would have a better reaction time since they will be able to identify the sequential patterns easier than older adults.

Methods

Approval: The following experiment was approved by the UCR Institutional Review Board.

Participants: Thirty-seven younger adults from University of California, Riverside (UCR) were recruited through the SONA system for course credit. Fifty-three older adults from the Riverside community were recruited through senior programs and previous recruits from another study the lab was doing. Participants had to have normal or corrected-to-normal vision and in general good health. This protocol was approved by the UCR Institutional Review Board.

Stimuli Part 1: Runic Symbols were streamed synchronously left and right of a central fixation dot (Figure 1a). One side displayed a structured stream while the other showed unsystematically, with the restraint that runes cannot repeat back to back. The structured stream contained nine symbols grouped into triplets (e.g. ABC, DEF, GHI). The random stream contained nine symbols non-overlapping with the triplets, and the order was randomized (Figure 1b). Only one location showed structured streams (counterbalanced across participants), and the order of triplets were randomized.



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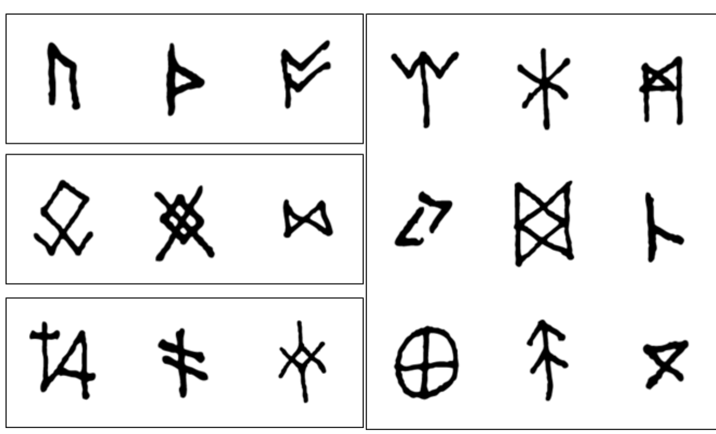

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Figure 1: Sets of runic symbols streamed wither in sequential triplet order (images on the left) or in random order (images on the right)

Stimuli Part 2: Visual search trials occurred randomly after a complete display of a structured stream (ie, after runes A,D, or G), no later than after three triplets. Objects were presented in the same synchronous manner and consisted of two groups with sixteen images: food and toys (Figure 2). The target was either a specific item (e.g. carrots) in a select category (counterbalanced across participants) or the category itself (e.g. food). Only images from opposing category were displayed when a target of the specific item (ID) displayed. The target appeared with equal frequency at each location to prevent selective attention to the structured stream.

Figure 2: Complete sets of stimuli used in the visual search array.

Design: Two visual tasks (3 blocks per) were administered in the following order: exemplar and category. Both tasks used the same image placement of runes and objects. The exemplar task displayed an ID as the target (counterbalanced across participants), whereas the category task used the opposing category. For example, if the target for exemplar is carrots, then the target for the category task would be toy. Target IDs and Target categories were shown in twenty-eight and thirty trials, respectively (split between location). The exemplar task had twenty-eight additional trials in which images from both categories (excluding the ID) were shown ("foil" trials). For example, if the ID is carrot, a strawberry (within the same category as carrots) and a ladder (item from a separate category) might show. Each location equally displayed the shared category ID (e.g. 14 trials of carrots on left, 14 on right). Four and thirty trials of target-absent were included in exemplar and category tasks, respectively, totaling up to sixty visual search trials for each task: 28 target IDs +28 foils +4 target-absent (exemplar), 30 target categories +30 target absent (category). Target-absent trials just displayed items not within the target category. For example, if the target is food, the two objects would be toys. Items were restrained from appearing in both locations at the same time. The interuption of visual search trials were restrained to 20 trials after rune triplets were streamed in each of the following ways (Figure 3): one complete triplet (e.g. ABC), two complete triplets (e.g. ABC, DEF), and three complete triplets (e.g. ABC, DEF, GHI). There were a total of 360 rune trials ([3x20 for one complete set] + [6x20 for two complete sets] + [9x20 for three complete sets]). The total sum of trials per block for exemplar and category was 420 (360 runes + 60 visual search).

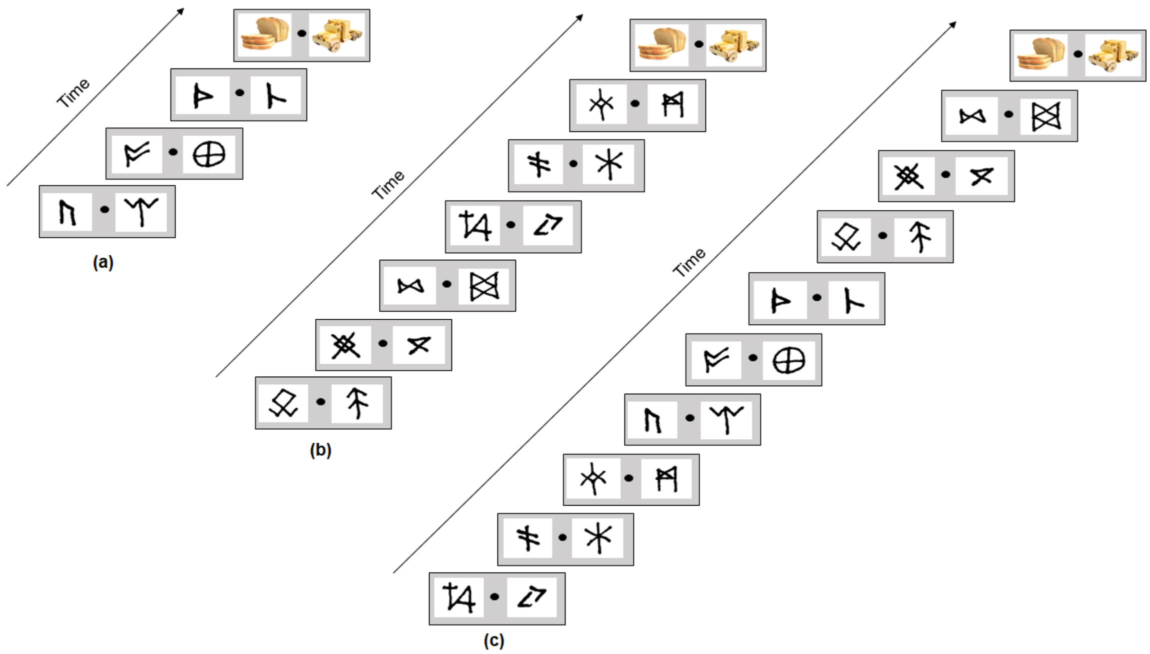


Figure 3: Examples of how many rune trials showed up before the visual search trial. A total of 3 (a, one complete triplet), 6 (b, two complete triplets), or 9 (c, three complete triplets) rune trials were shown before the visual search taasks. The order of triplets were randomized.

Procedure: The experiment consisted of two phases: exposure phase involving the stream of runic symbols and test phase using the images from the two categories. During exposure, trials consisted of two symbols: one from triplet and one from random for 200ms (Figure 1a). Participants were instructed to focus on a central dot while attending to the images present during each trial. During the visual search array, participants must respond on the keyboard by pressing the left arrow key if the target stimuli was present and the right arrow key if the target stimuli was absent. Images remained on the screen until responses were given, followed by an intertrial interval of 200ms (Figure 4). At the end of each block, participants were given feedback on their accuracy and reaction time to correct responses.

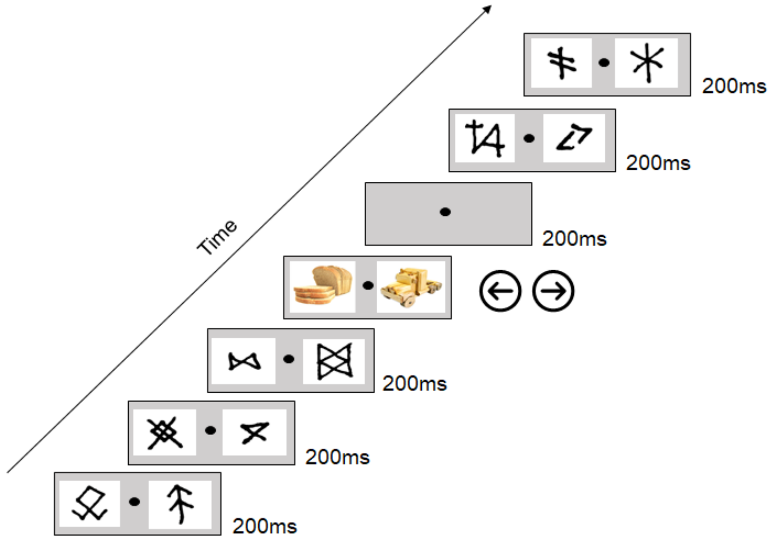
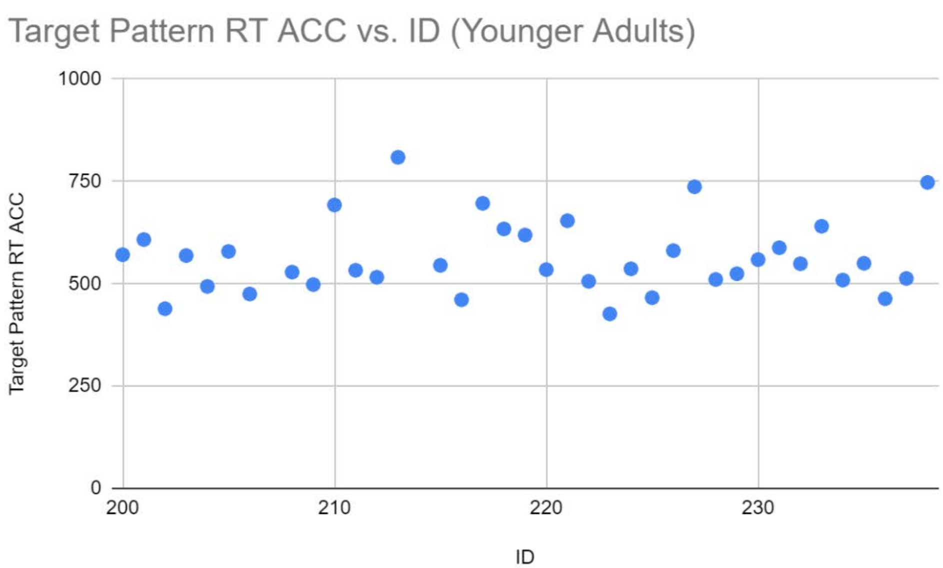


Figure 4: Example of a block a particpant would complete with the rune trials and visual search trials.

Results

Figure 5 displays the reaction time accuracy when there was a pattern present in the stimuli. Figure 5a is displaying the data seen with the younger adults and figure 5b is displaying the data seen with the older adults. As one can see, there is a slightly faster reaction time for the younger adults than what was seen for the older adults. The results hint at what we hypothesized to be true with younger adults being able to identify a pattern better than older adults. The younger adult data also displays that more of them are around the same range, whereas the older adults have a more widespread data set.



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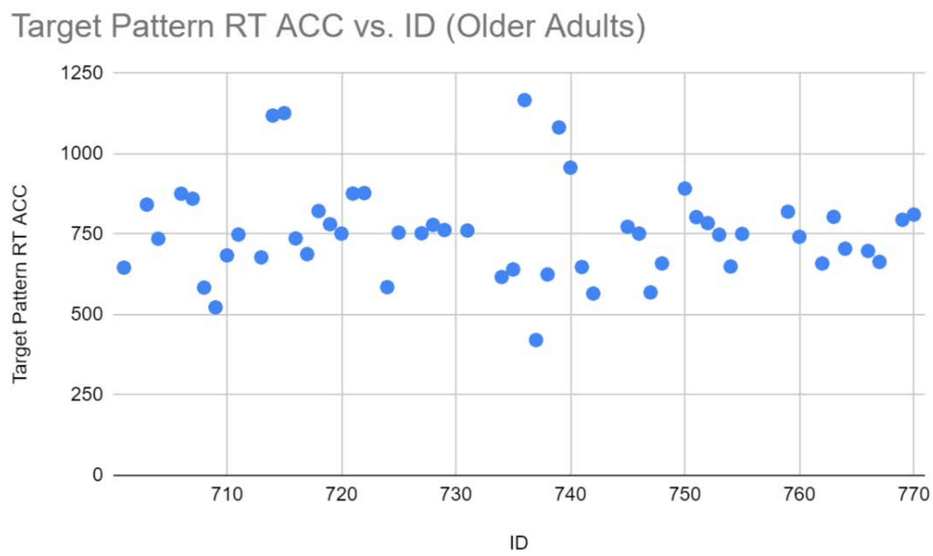

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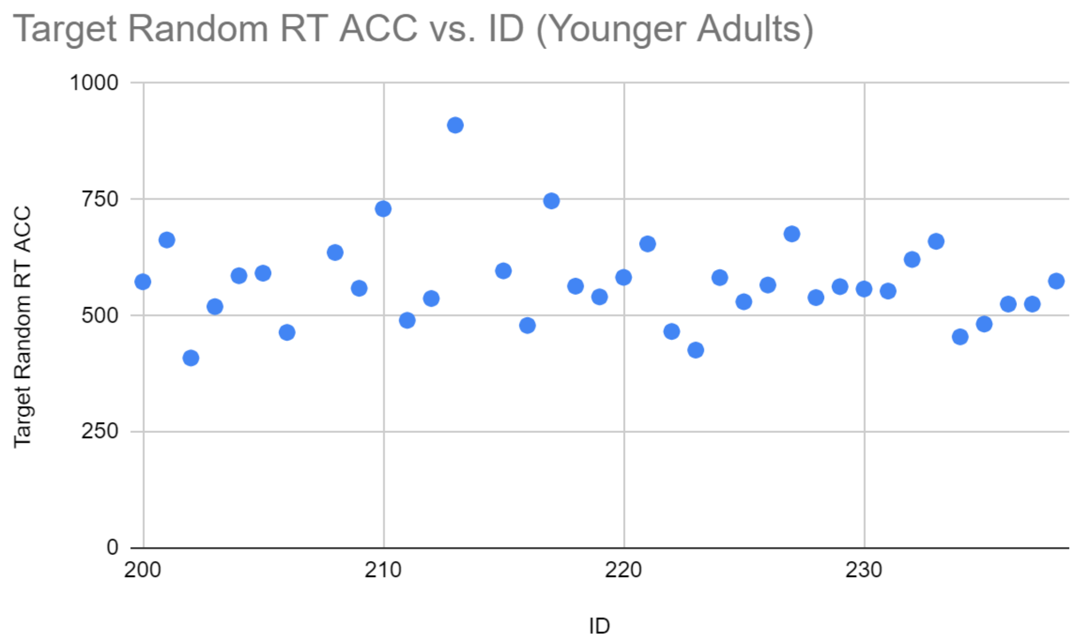
Figure 5: Graphs displaying the reaction time accuracy when a pattern was present within the stimuli.

Figure 6 displays the reaction time accuracy when the runes/stimuli were randomly placed within the test. Figure 6a displays the data seen with younger adults, and figure 6b displays the data seen with the older adults. As seen like before, the data set between the two groups is very similar with the younger adults having slightly faster reaction times than the older adults. The data displays that both age groups did around the same for pattern and random stimuli. The reaction times were from 400ms to around 800ms for younger adults for both patterned and random stimuli. For older adults, the reaction times ranged from 500ms to 1250ms. This goes to show that there really isn't a statistical difference between the two age groups meaning that they are learning and completing the tasks in the same way where neither relied more so on prior knowledge or identifying a pattern over the other.



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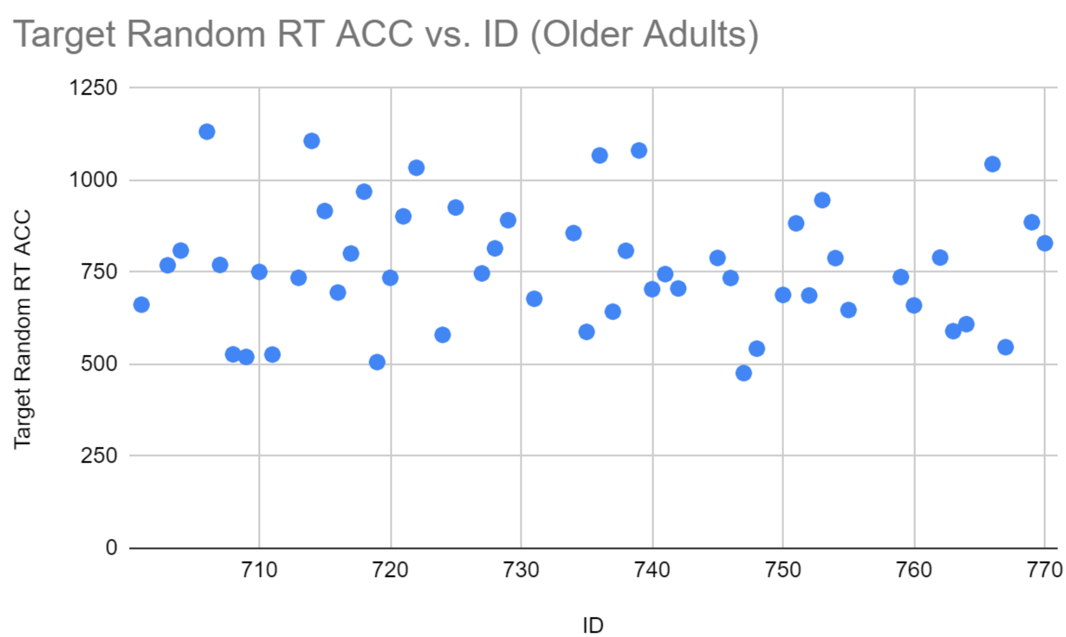

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Figure 6: Graphs displaying the reaction time accuracy when the stimui was presented randomly within the test.

To take the experiment a step further, we compared the reaction times between the different age range of older adults that we tested. This was to see if there was a difference in adults and older adults. This would also go to check the theory that the older you are the more you rely on prior knowledge.

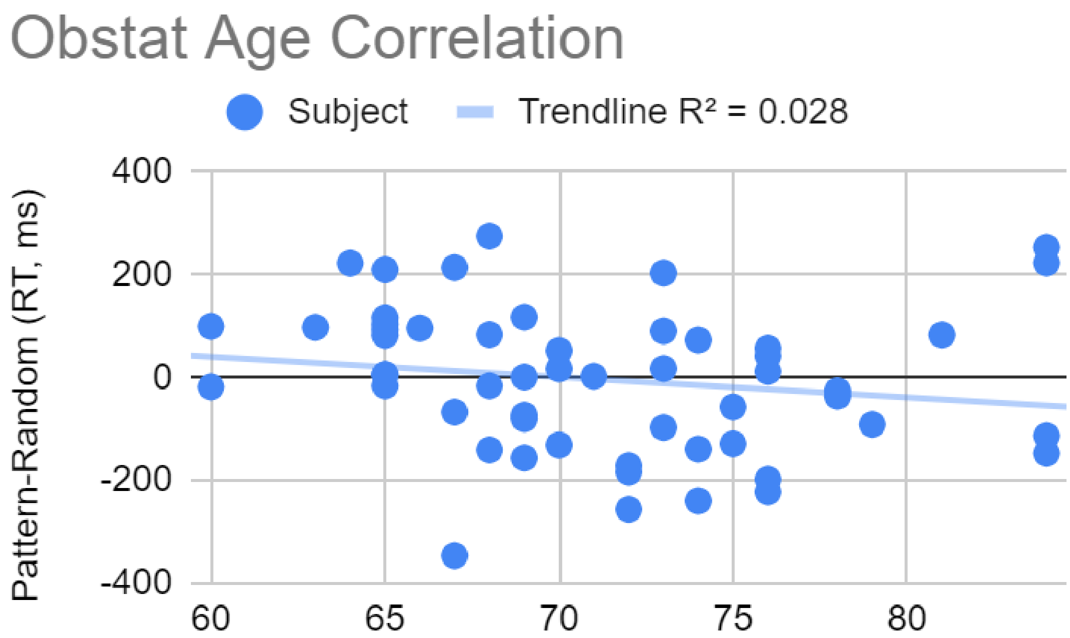

Figure 7: Displays the different reaction times for pattern and random stimuli across the different age ranges seen with the older adults.

Conclusion/Discussion:

As seen in the results, there was not much of a difference between the reaction times in younger adults and older adults. This means that the older and younger adults were okay with identifying a pattern to help complete the tasks, as well as being able to use prior knowledge to help with the random stimuli. This also helped go against the stereotypes that the elderly aren't capable of learning new things because not only were they able to complete the tasks, but their reaction times were almost the same as the younger adults.

Although there wasn't much differences in the range of data, it still suggests that the older adults were not as consistent as the younger adults. There seem to be more outliers in the older adult data when compared to the younger adults. This may be because older adults may lose focus when completing the task as their attention may drift to something else. The argument that older adults may experience temporary lapses of attention or executive control that contribute to greater inconsistency of performance may be a reason for the difference in reaction times seen in our data (Hultsch et al., 2002). Since our data for older adults is fairly similar to that of the younger adults, we can see this as a possibility as to why the reaction times were higher, but it might not be true for our case.

The results could also be an indication of fatigue as they had to sit through many blocks to complete the tasks. "Differences in inconsistency were independent of practice, fatigue, and age-related differences in mean level performance, which highlights the importance of considering moment to moment changes in performance" (Williams et al., 2005). Therefore, the older adult results could be from sitting in a chair for a long amount of time complete the same task over and over again. Overall, the results indicate that there weren't many differences seen in the older adult and younger adult performances as the data set ranges were very similar. The results also indicate that the use of prior knowledge wasn’t very helpful to complete the task at hand since the older adult numbers were still higher than the younger adults. This is suggested by Janacsek who’s experiment displayed that after adolescence it became harder for people to learn new skills by relying on prior knowledge. The results do indicate that younger adults were able to find the pattern faster than older adults. This indicates that they were able to distinguish between the relevant and irrelevant stimuli a little better than the older adults. In the end, the results were too similar to say that one group overpowered the other.

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