# Auditory Working Memory-Generalization and Resilience: Reevaluation of Data

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# Important Terms

- Working Memory- A component of memory that consists of short-term memory storage, active information processing, and attention
- Working Memory Capacity (WMC)- How effectively the working memory system can function in complex tasks
- Distractor- The noise presented to participants during a trail intended to make the task more difficult to complete, either a standard or oddball
- Oddball Distractor- The distractor presented at random intervals that differs from the standard distractor and is intended to shift the attention of the participants by presenting a different distractor
- Acclimation- The ability to become accustomed to both distractors and for the oddball distractor to have no significant effect of task performance
- Resilience- The ability to apply the acclimation learned from one oddball to a new oddball distractor
- Generalization- The ability to apply the acclimation and resilience learned in previous tasks to a completely new task

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# Original Study

- Conducted by DiGiovanni, J., Gilmore, C., Mikol, J., Riffle, T., Idrees, A., & Kulasa, K. at Ohio University
- Intended to further the findings of Sörqvist research from 2010 and 2012 by replicating and extending the findings

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# Sörqvist 2012

- 54 participants
- Participants were presented a sound (either standard 440 Hz or oddball white noise) then an arrow pointing right or left
- The participants had to determine weather the arrow was pointing right or left with an emphasize on speed and accuracy
- The response time for each trail was recorded
- The response time for standard vs odd ball trails was compared to determine the affect of the oddball distractor on the ability of the participant to quickly and accurately respond
- Analyzed the data by splitting the participants into 2 groups: High Working Memory (HWM) and Low Working Memory (LWM)

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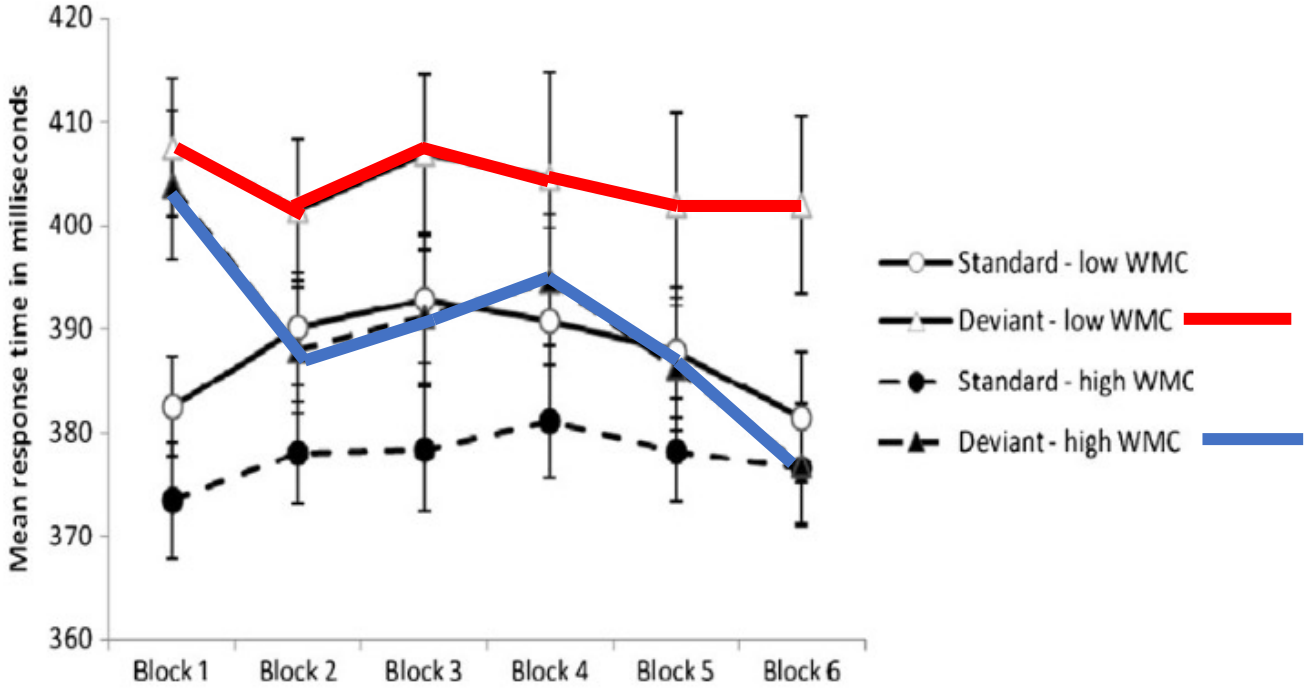
# Sörqvist Results

- Found that though both groups were affected in the first block, the HWM group were better able to adapt to the oddball while the LWM group was not (red line vs blue line)
- The LWM group were not able to adapt to the oddball over the 6 blocks of testing (red line)
- The HWM group showed little difference between standard and oddball trails by Block 6 indicating that they were not affected by the presentation of an oddball sound (end of blue line)

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# New Study Methods

- 12 normal-hearing adults
- Each participant was given the *Woodcock Johnson-3* to measure auditory working memory*
- Then each participant completed 4 Experiments (A-D) with each experiment requiring the completion of a different task

*The *Woodcock Johnson-3* is a standardized test used to measure WMC through a series of tasks That require memory retrieval and sequencing

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# Experiment A-D

- Experiment A- A blue (left) or red (right) was presented followed by a pure tone (440 Hz), then 2 different numbers were presented, one to each ear. Participants than had to determine if the number in the ear corresponding to the color presented at the beginning was higher or lower than the other ear. This sequence was repeated multiple times.
- Experiment B- The same as Experiment A but the 10% of the time, the pure tone was replaced but a white noise distractor.
- Experiment C- The same as Experiment B but the distractor was now an FM modulated tone.
- Experiment D-  A blue (left) or red (right) was presented followed by either the pure tone (400 Hz) or the FM distractor. The participant was than asked whether the number in the indicated ear was odd or even.

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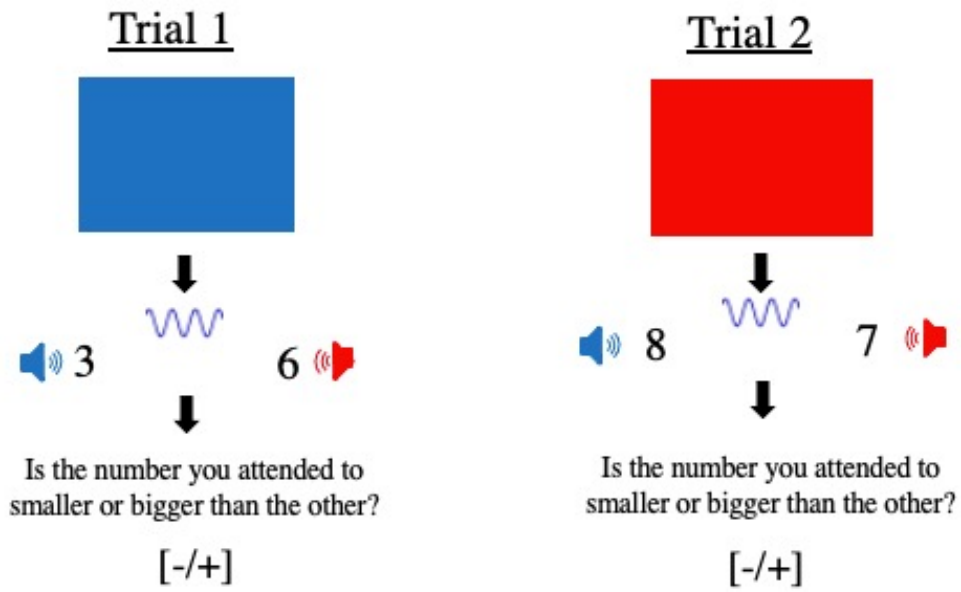
# Example Trial of Experiment




Sample Trial (Experiment A-C)*

1. Blue square presented, focus on left ear
2. Either standard or oddball distractor presented
3. 2 different numbers are presented simultaneously, one in each ear
4. Participant determined if the indicated ear (left) was greater than or less than the other ear

*Experiment D required participants to determine odd/even rather than compare the the two numbers presented

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# Data analysis

- For the original data analysis, a block analysis was preformed.
- The midpoint of the WMC scores was determined and the group was split into high working memory (HWM) capacity for those above the midpoint and low working memory (LWM) capacity for those below.
- The data from the two groups was then used in calculations to determine if WMC had a significant effect on the ability to complete the tasks quickly and correctly.

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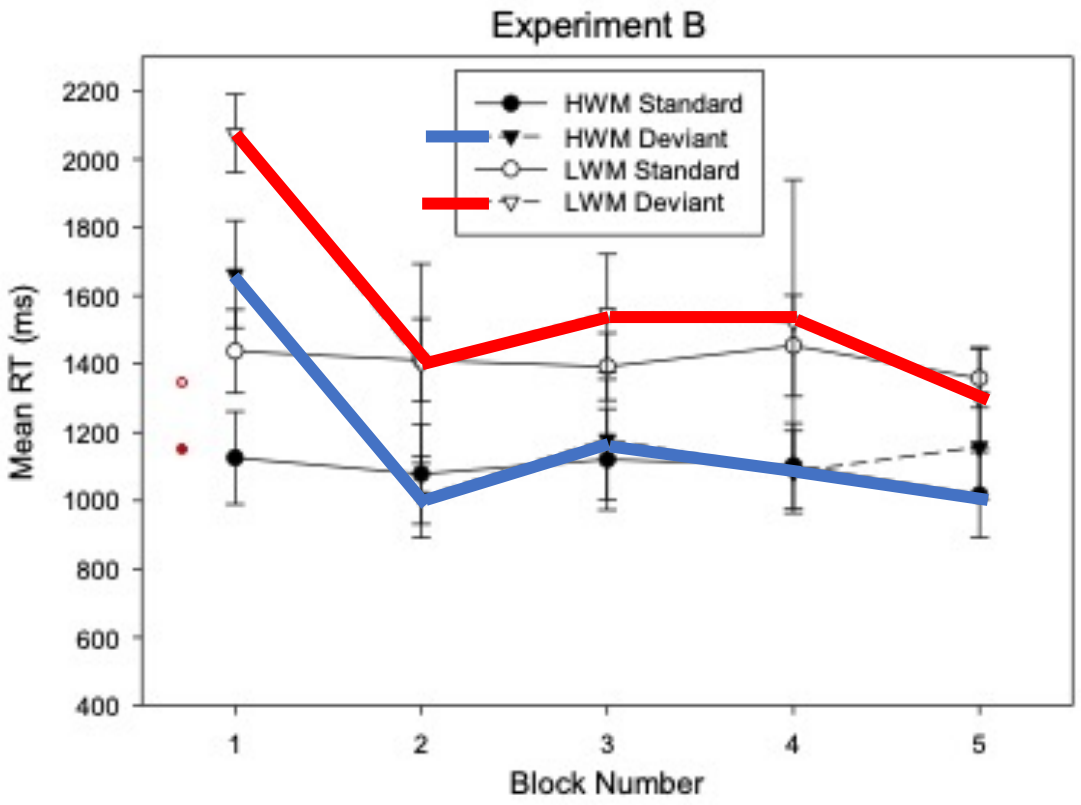


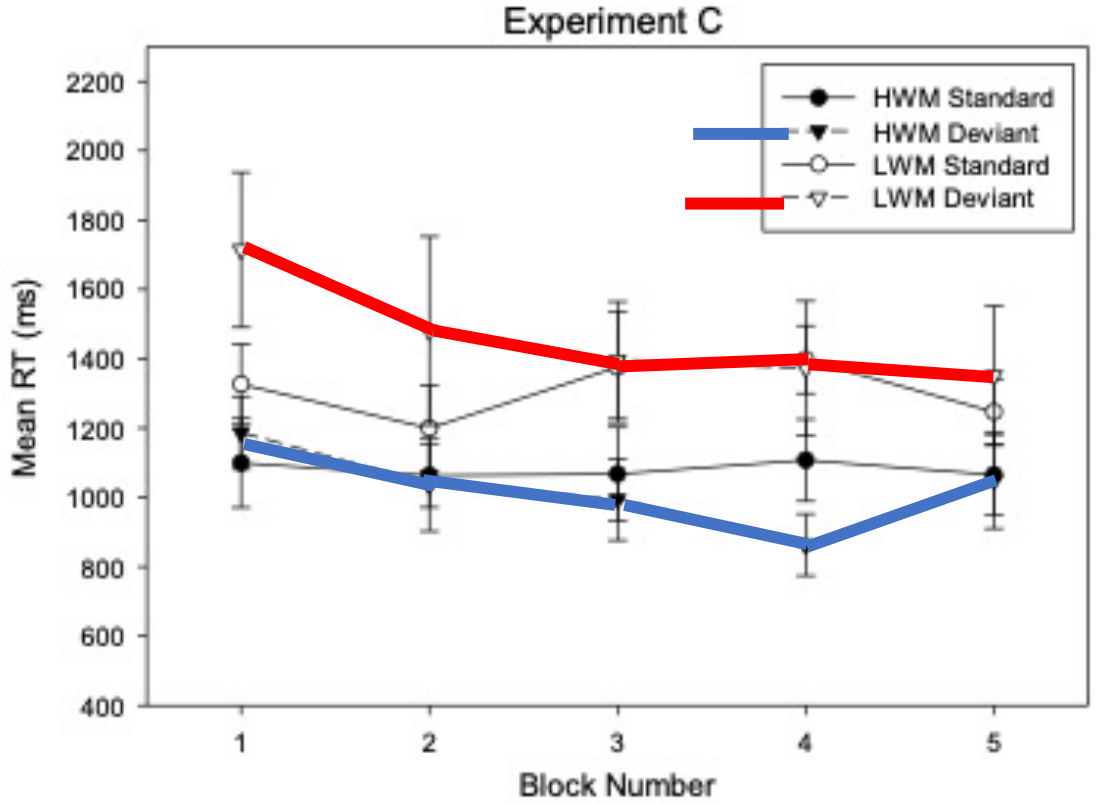


- Experiment A was intended for participants to become familiar with the protocol.
- Experiment B replicated and Experiment C expanded upon Sörqvist's finding that both high and low WMC were affected by the deviant.
- Both HWM and LWM capacity groups showed an affect by the oddball. Both groups were able to overcome the affect, demonstrating acclimation (Experiment B red vs blue line).
- The HWM capacity group were unaffected by the new distractor in Experiment C, demonstrating resilience. This was not seen in the LWM group.

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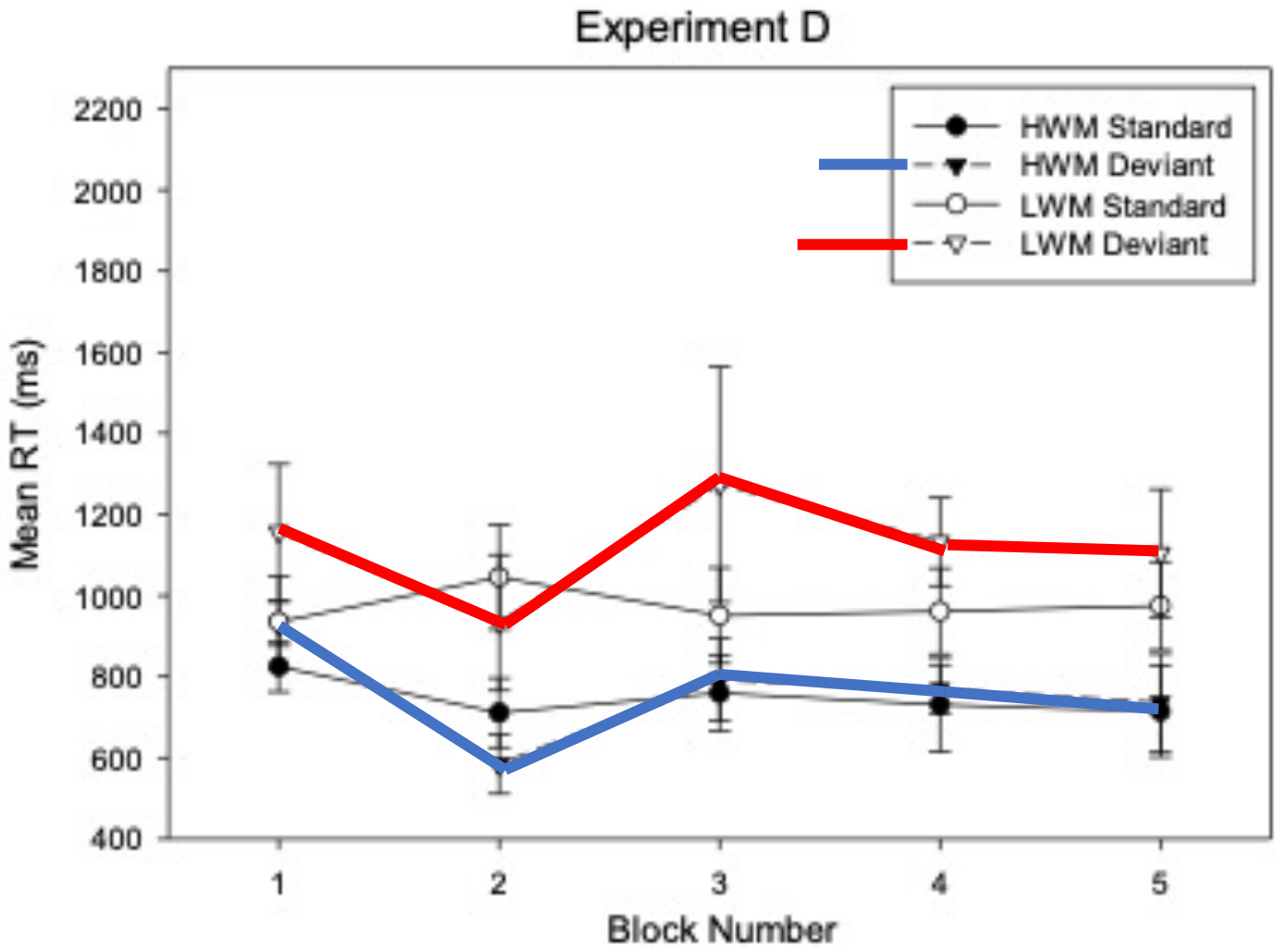


- The LWM group showed greater affect by the deviant than the HWM group even though the task was simpler and the distractor stayed the same from Experiment C.
- This indicates a decrease in ability to generalize to new tasks for LWM individuals when compared to HWM.

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# Conclusion

- The HWM and LWM groups both showed an increase in reaction time when first presented with the oddball.
- Both the HWM and LWM groups acclimated to the oddball as they gained more exposure.
- The LWM group were negatively affected (increased RT) by a change in oddball stimulus; the HWM was unaffected, demonstrating resilience.
- The HWM group were able to generalized their performance to a new task whereas the LWM group did not.

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# Limitations

- Small sample size
  - The new study only had 12 participants while Sörqvist had 54
- Using group analysis is limited with since the number of participants at both extremes is small
  - It is possible that the difference between the HWM and LWM groups was not great enough if the sample group is clustered in the middle WMC scores as would be expected
- Experiment D required less processing, rendering the task easier

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# New Data Analysis

- To counter the possible issues seen in the two-group analysis, the data was analyzed continuously to determine changes in resilience and generalization across WMC scores
- To do this, RT data for each WMC score was grouped and averaged
  - Example: The RT scores for the participants who scored a 3 were combined and averaged to create a single, average RT value for the WMC score of 3
- WMC with less that n=2 was excluded from the analysis
- An outlier from WMC group 16 was removed from the data analysis

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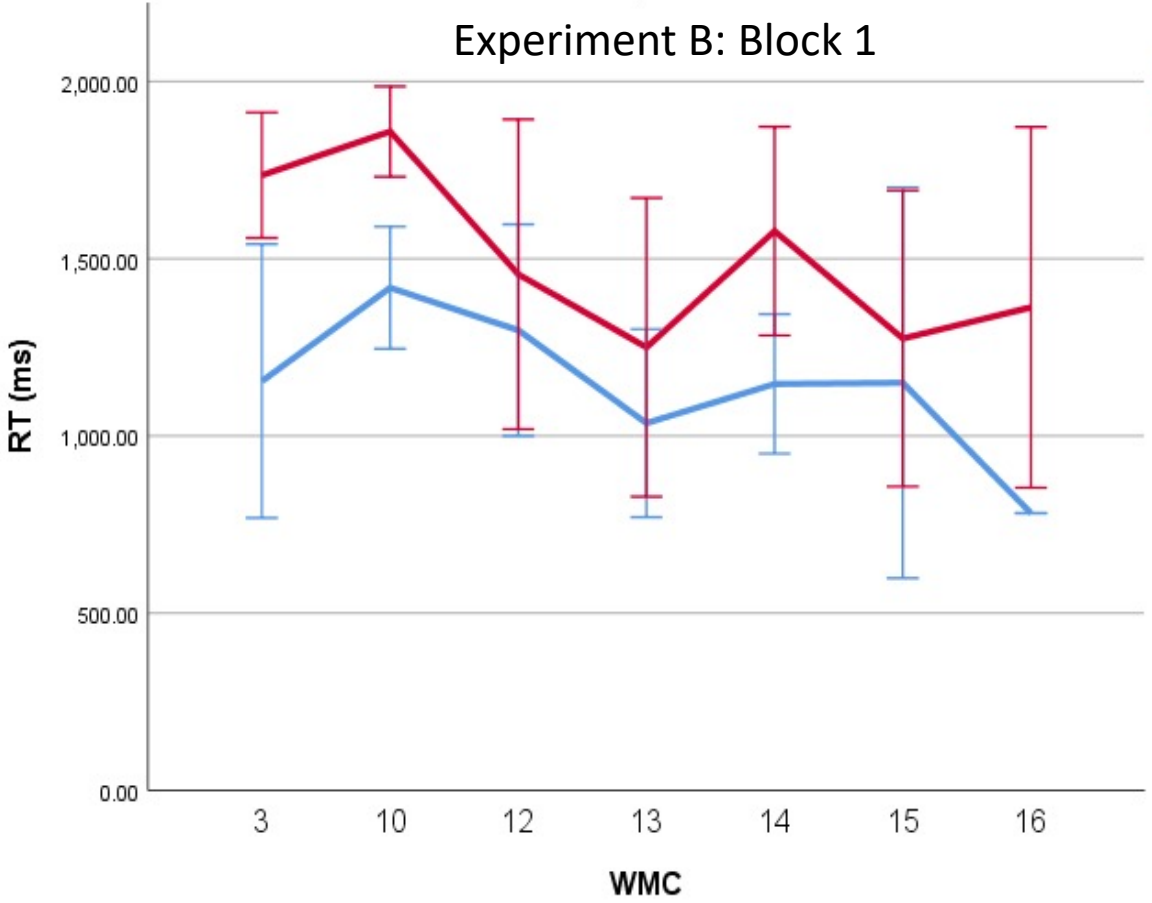


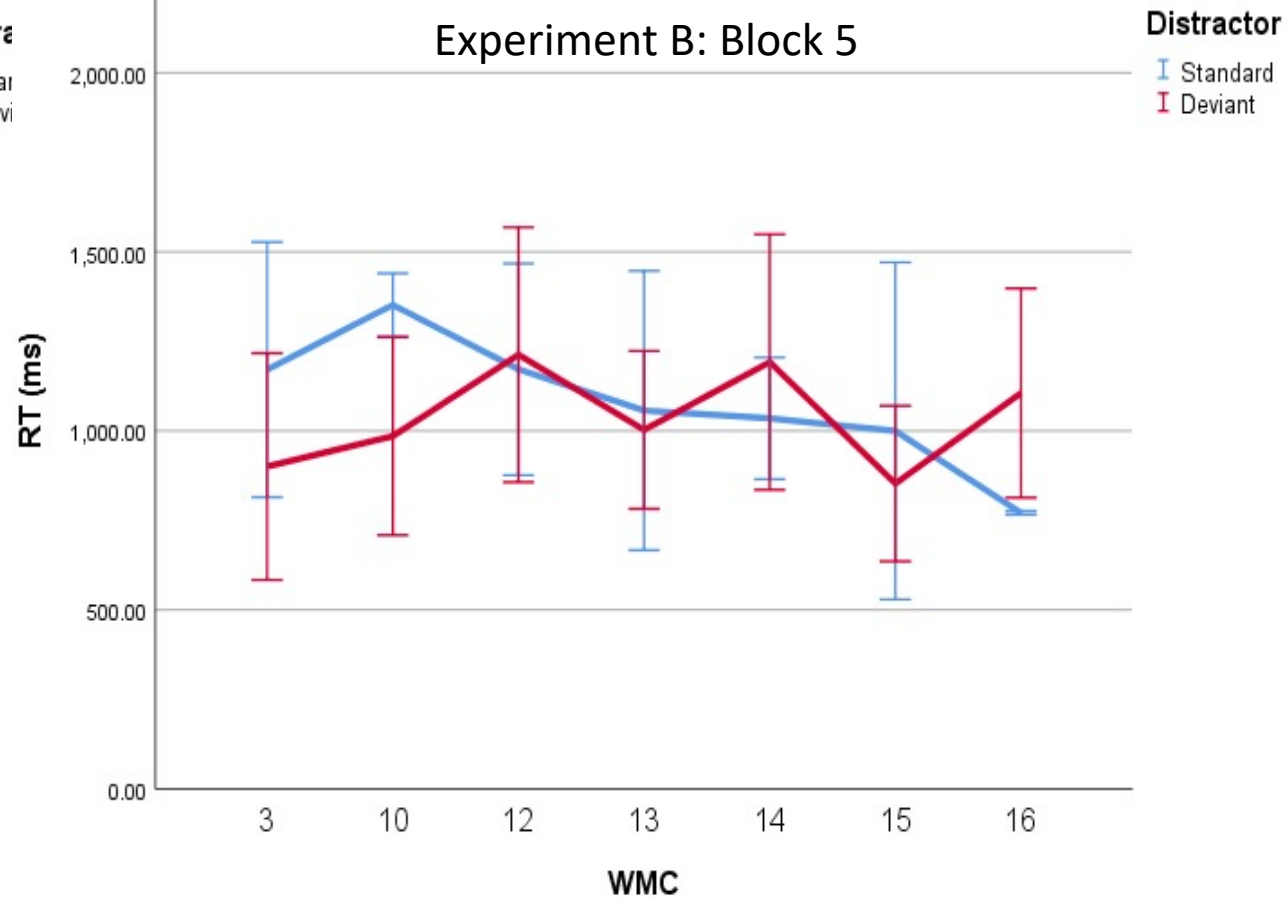


- In Block 1, the presentation of the deviant distractor resulted in slower reaction time across all WMC groups (red line is higher than the blue line)
- By Block 5, all groups showed a decline in reaction time (red and blue lines show similar reaction times)
  - Thus, all WMC scores showed similar reaction times for both standard and deviant.
  - This shows all WMC were able to acclimated to the deviant

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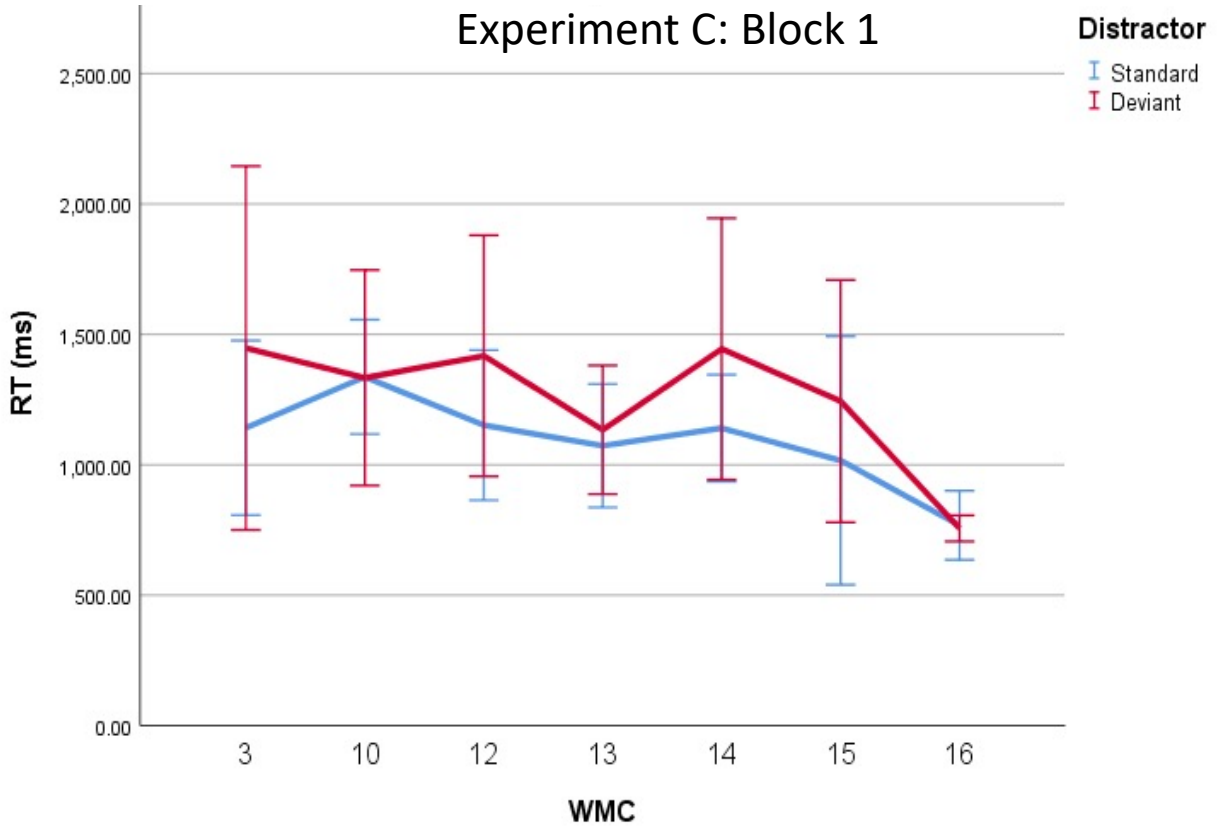


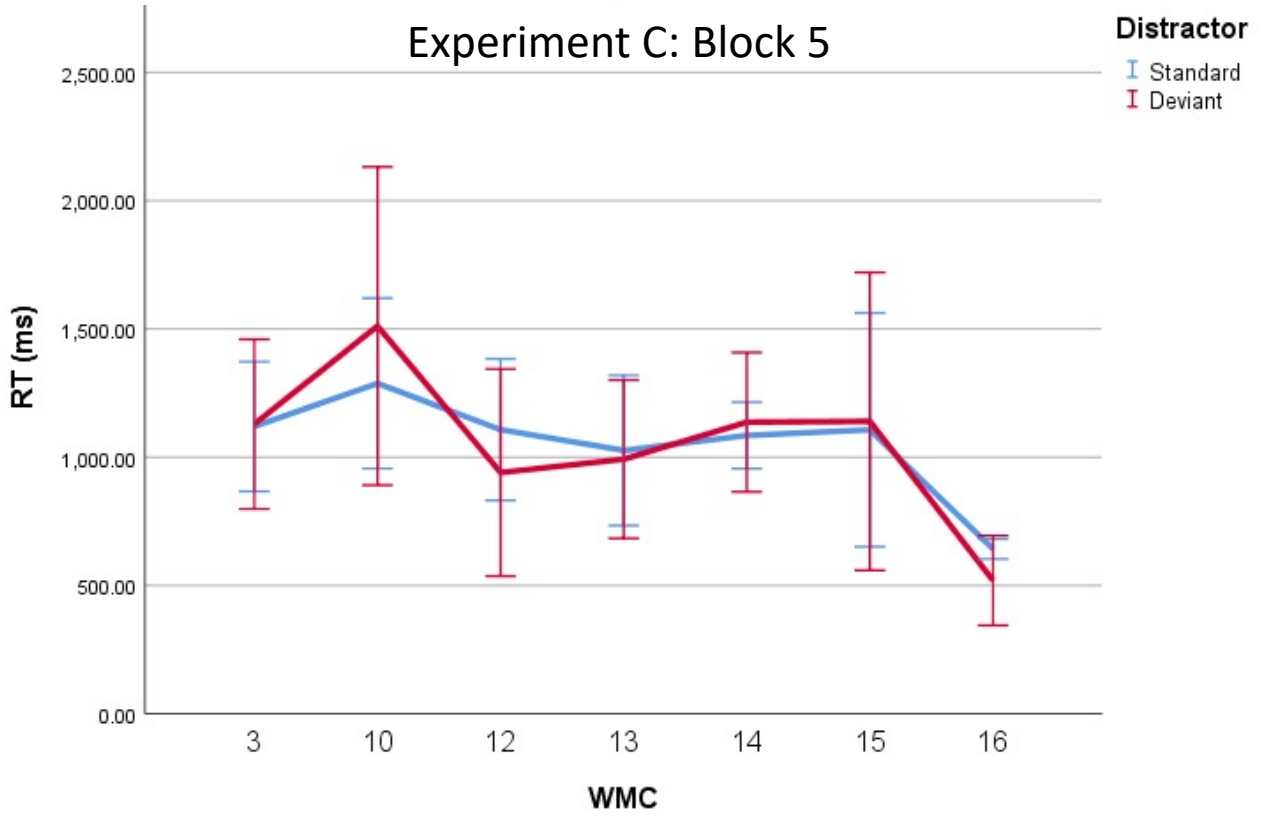


- In Block 1, all groups showed minimum affect by the introduction of a new oddball distractor (red line and blue line are roughly the same)
- In Block 5, the same trend was seen as in Block 1 (red line and blue line are about the same)

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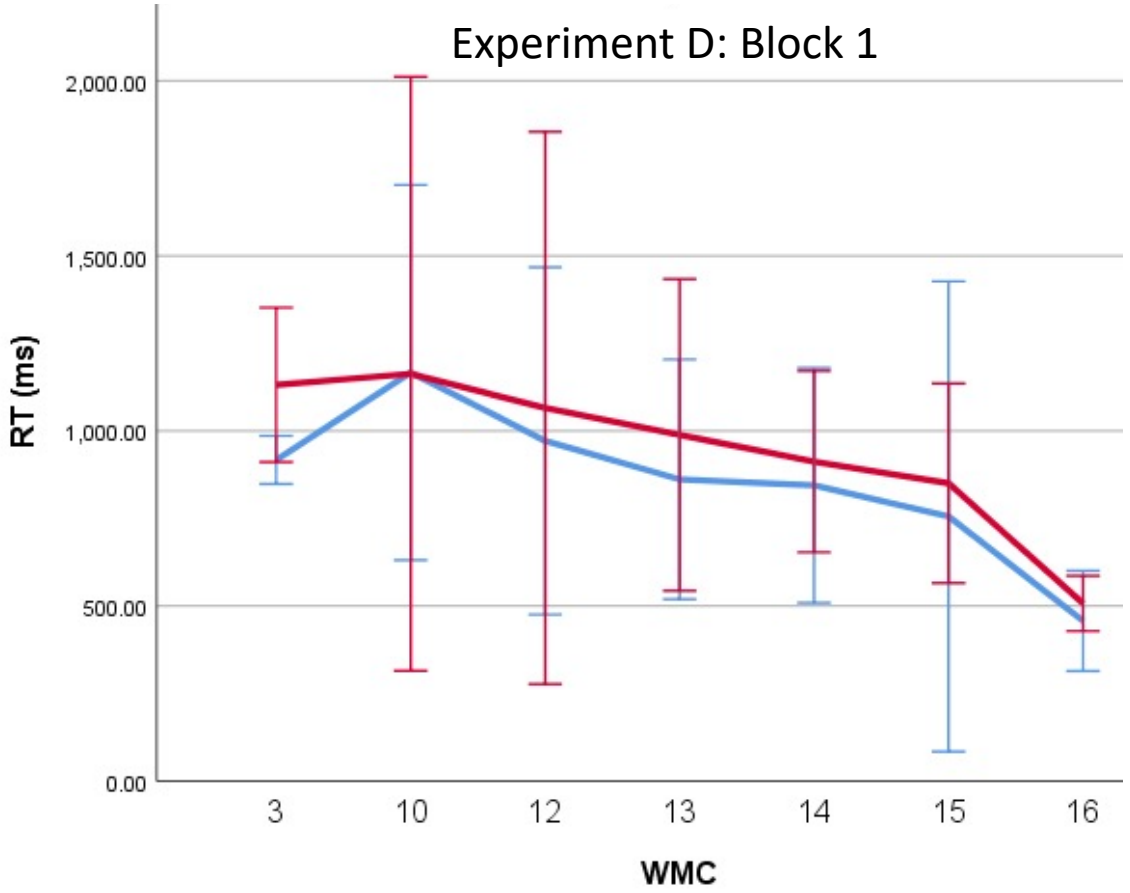


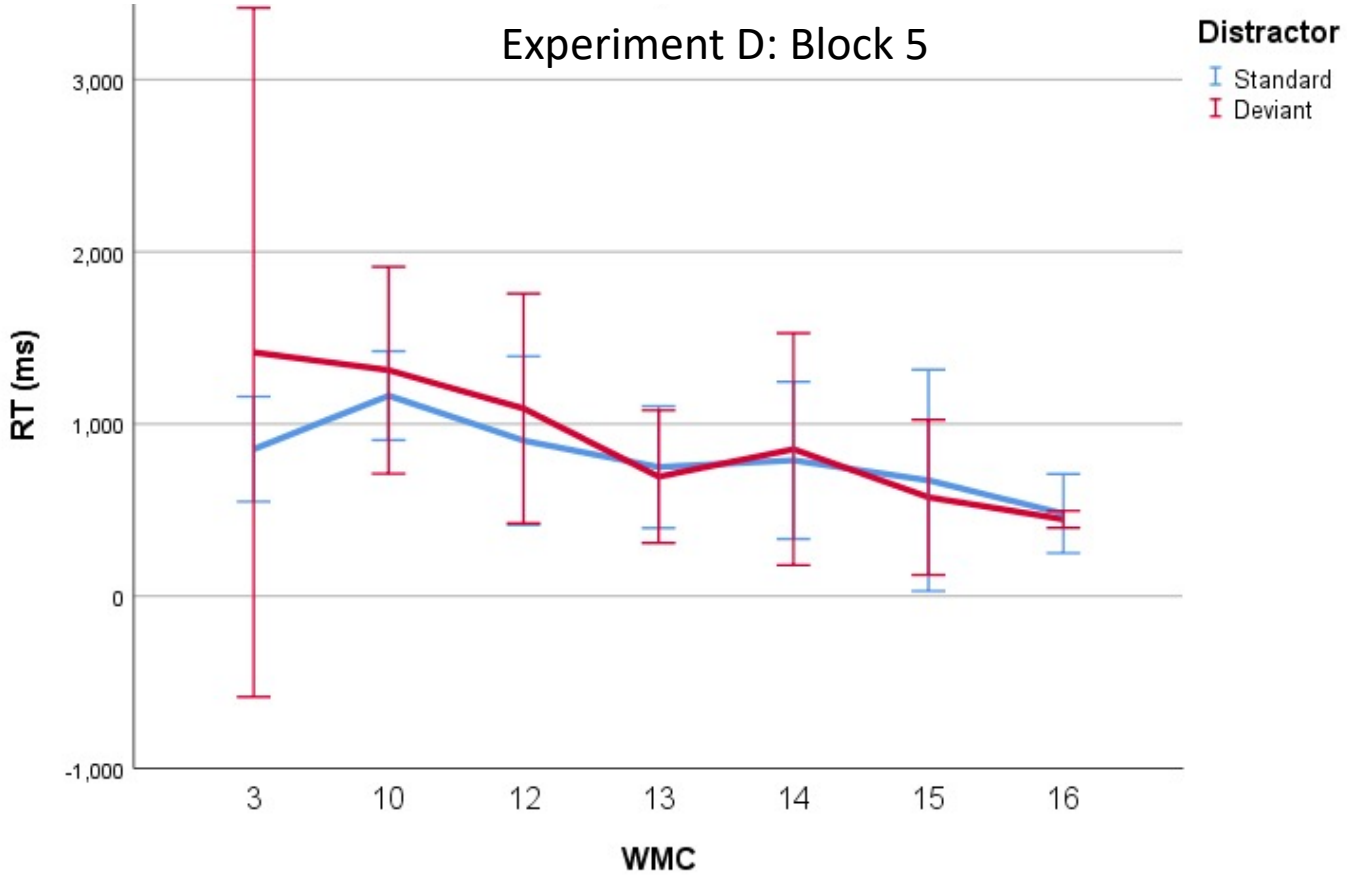


- In Block 1, there was little affect on reaction time between standard and oddball distractor (red line and blue line are the same)
- The same is seen in Block 5 (red line and blue line are the same)

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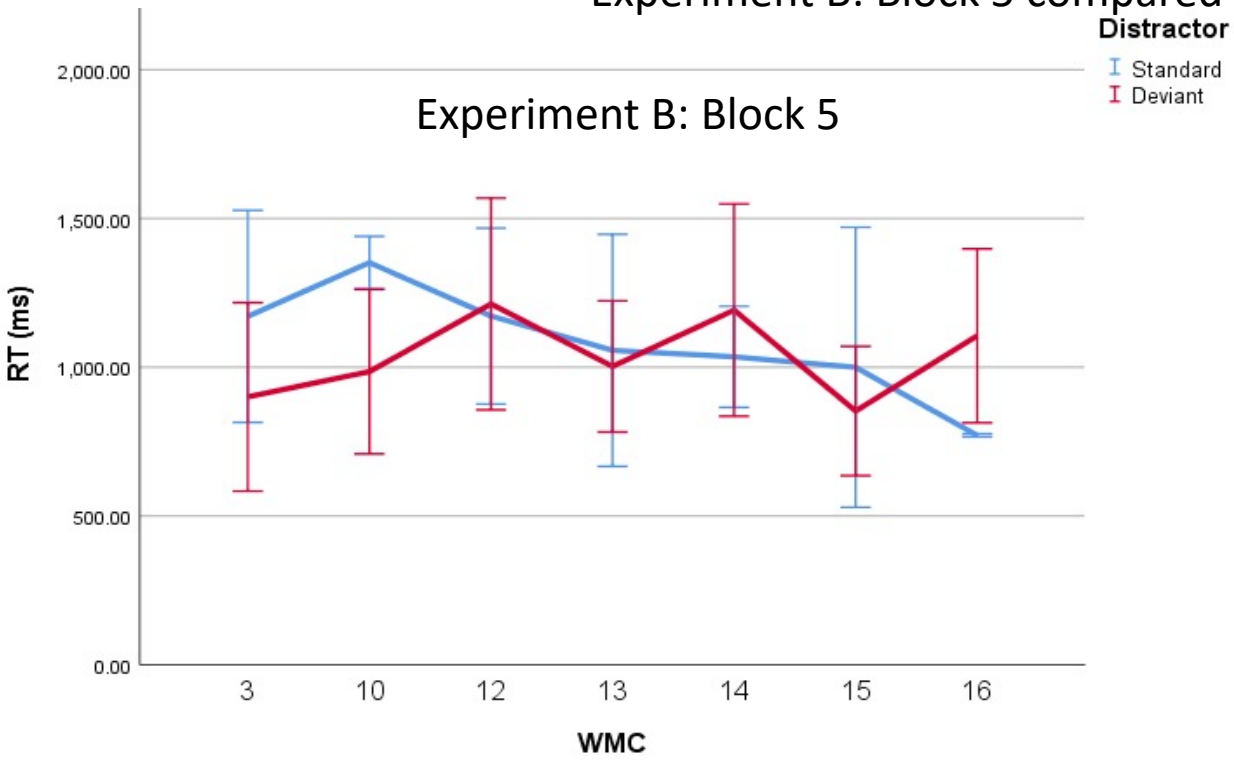
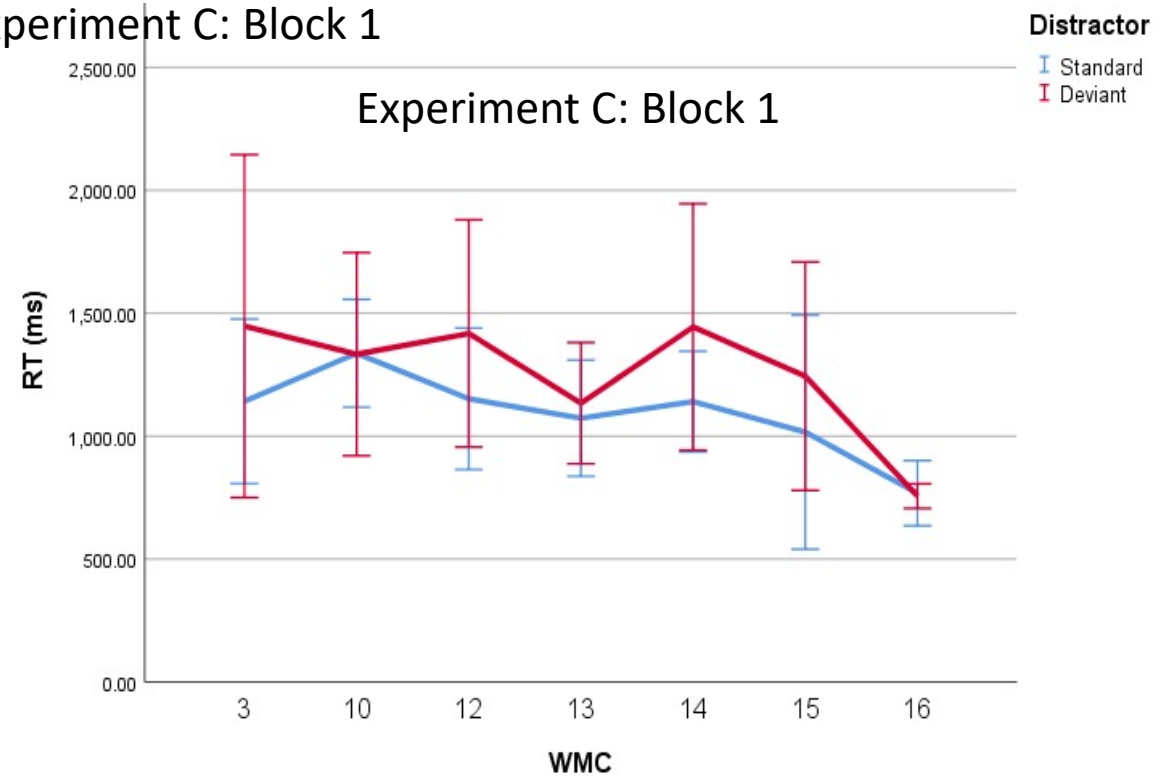
# Experiment B: Block 5 compared to Experiment C: Block 1




- In Experiment B: Block 5, there is no significant difference between the oddball and standard distractor across all WMC scores indicating that all groups assimilated (red line and blue line are the same)
- In Experiment C: Block 1, though the length of reaction time has changed, there is no significant difference between oddball and standard distractor across all WMC scores despite the new oddball (red line and blue line are the same)
- The lack of significant difference for oddball and standard in Experiment B: Block 5 and Experiment C: Block 1 demonstrated resilience
  - All WMC groups were able to apply the learned acclamation in Experiment B to a new oddball in Experiment C, thus showing resilience to a new distractor since performance did not degrade when it was introduced

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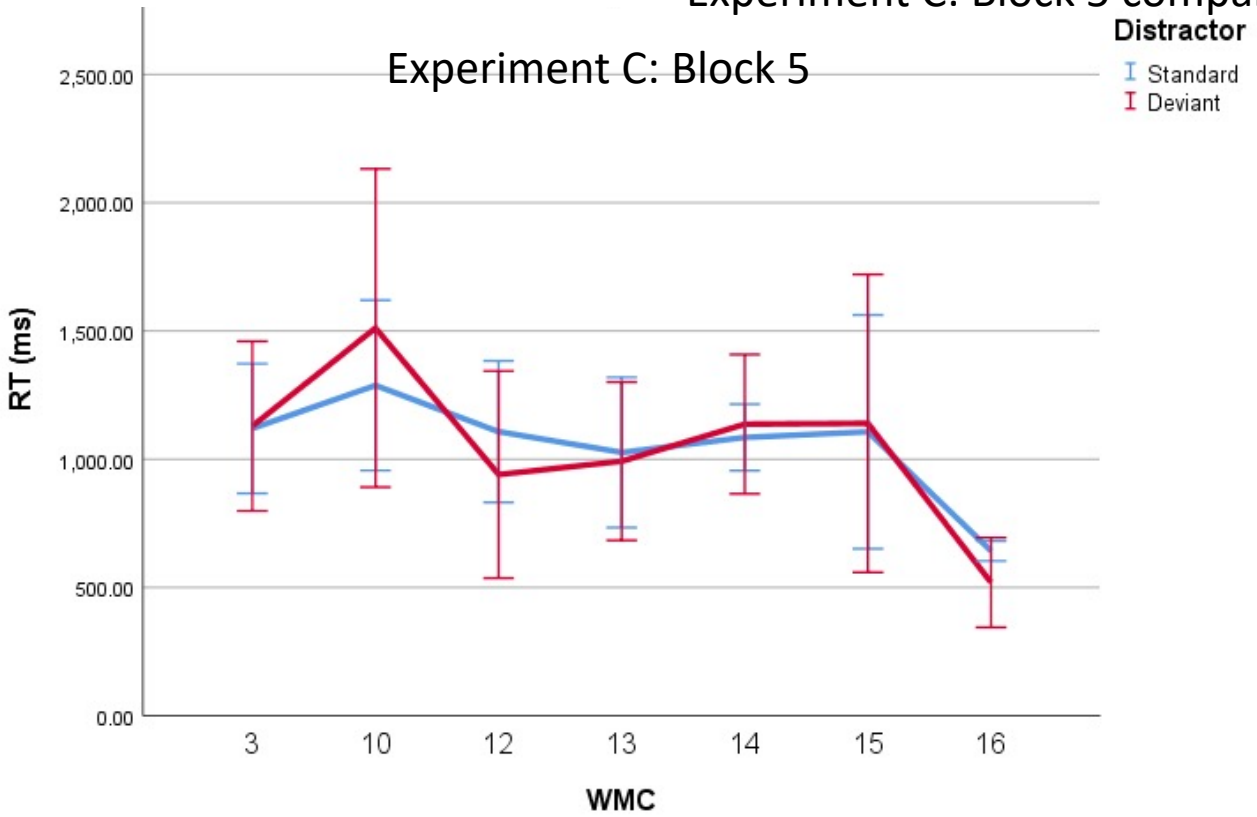
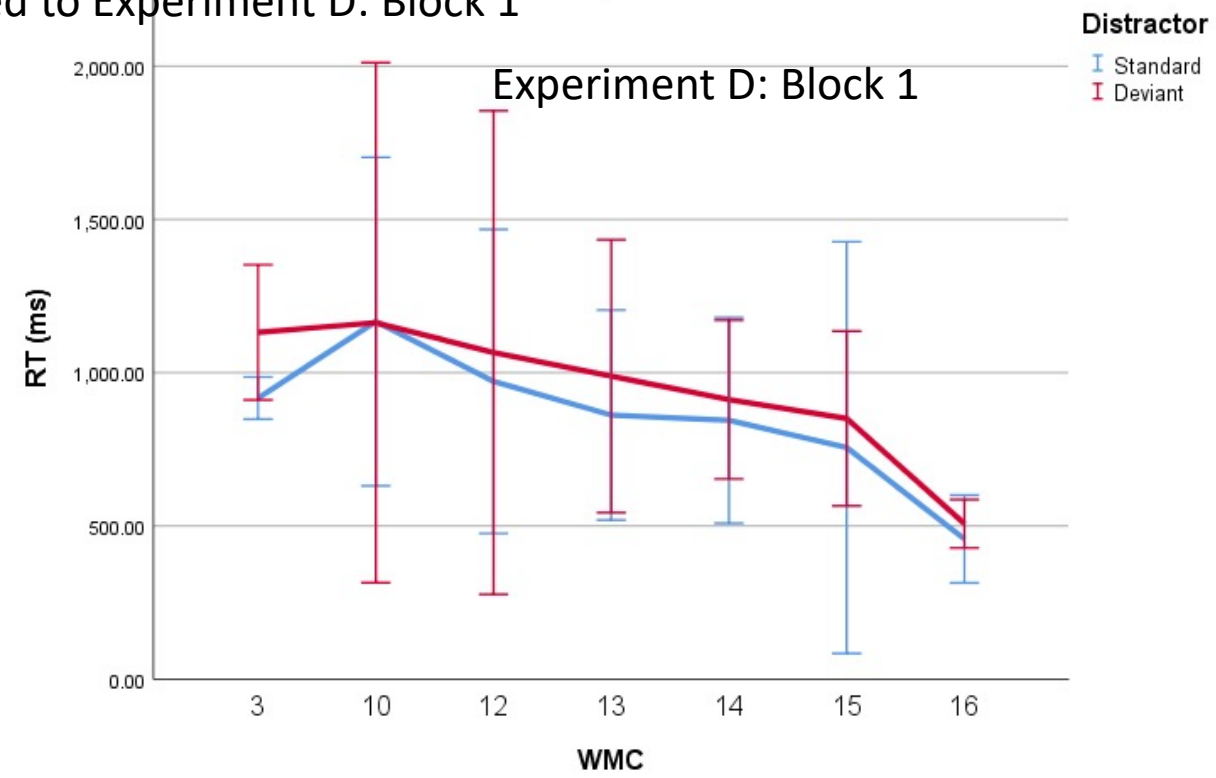
# Experiment C: Block 5 compared to Experiment D: Block 1




- In Experiment C: Block 5, there is no significant difference in RT between oddball and standard distractor across all WMC scores, indicating acclimation (red line and blue line are the same)
- In Experiment D: Block 1, there is no significant difference in RT between oddball and standard distractor across all WMC scores (red line and blue line are the same)
- The lack of significant difference in RT between oddball and standard distractor despite the new task indicates the ability of all groups to generalize
  - All groups were able to take the acclimation learned in Experiment C and apply it to a new task (Experiment D) which show generalization
  - Performance across tasks could not be compared directly given the task change, therefore the performance difference between the standard and deviant distractors were compared

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# Overall Takeaways

- Both the two-group and continuous analysis showed acclimation and resilience for all groups
- The two-group analysis showed that LWM capacity group were not able to generalize to a new task while the continuous showed that all WMC scores were able to generalize
- The continuous analysis provided greater detail about performance across a range but was still limited in the results due to small sample size

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# Sources

Sörqvist, P. (2010). High working memory capacity attenuates the deviation effect but not the changing-state effect: Further support for the duplex -mechanism account of auditory distraction. Memory & Cognition, 38(5), 651-658.

Sörqvist, P., Ljungberg, J. K., & Ljung, R. (2010). A sub-process view of working memory capacity: Evidence from effects of speech on prose memory. Memory, 18(3), 310-326

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