Mismatch Negativity (MMN) Predicts Pattern Separation

Deena Herman[1] and Stevenson Baker[1], Jaime Cazes[1], Claude Alain[2,3], Shayna Rosenbaum[1,2]

[1]York University, Toronto, Canada; [2]Rotman Research Institute at Baycrest Hospital, Toronto, Canada, [3]Department of Psychology, University of Toronto, Canada

INTRODUCTION

Background

- **Pattern separation**: A memory process whereby highly similar stimuli are encoded in non-overlapping representations
  - → typically studied in the visual domain with previously known stimuli (e.g., objects)
- **Mismatch negativity (MMN)**: An event-related potential (ERP) indexing the brain's perceptual discrimination
  - → typically studied in the auditory domain with abstract sounds (e.g., pure tones)
  - → Humans can detect novelty within hundreds of ms, as measured by the MMN

Theory

- **Predictive error**: mechanisms of hierarchical inference, such as predictive error, are responsible for the MMN and also facilitate pattern separation

Question

- Although similar processes may support MMN and pattern separation, little attention has been paid to how they are correlated
  - → **to what extent does our capacity to discriminate auditory inputs, as measured by the MMN, influence mnemonic discrimination of long-term memories?**

METHODS: Participants & Stimuli

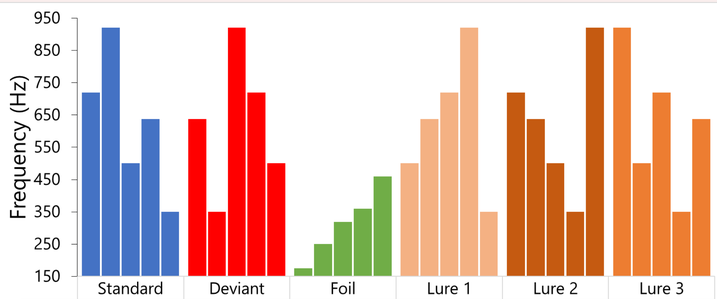
Participants

- 31 young adults (YA), age range 18–32, 18 female

Stimuli

- Six novel auditory sound patterns: non-melodic and non-semantic
- Five of the six comprised of the same five 100-ms tones arranged in different order
  - → Foil micropattern pitched lower
- Study micropatterns: Standard and Deviant
- Test micropatterns: Standard and Deviant, as well as three Lures and one Foil

Experimental Micropatterns — Six Auditory Sound Patterns



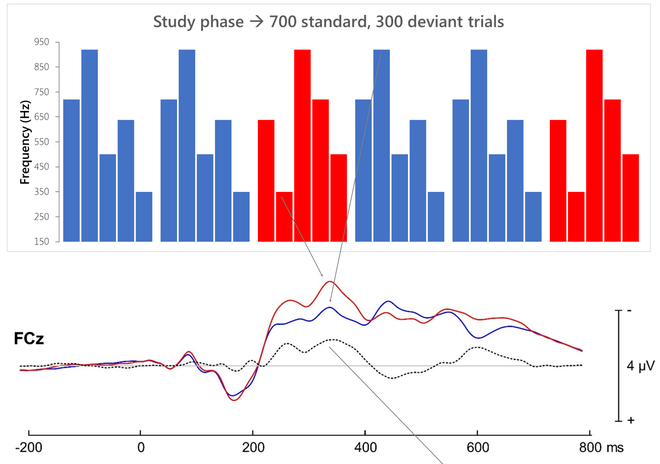
	Standard	Deviant	Foil	Lure 1	Lure 2	Lure 3
100 ms	720	638	175	500	720	920
200 ms	920	350	250	638	638	500
300 ms	500	920	319	720	500	720
400 ms	638	720	360	920	350	350
500 ms	350	500	460	350	920	638

METHODS: Study phase

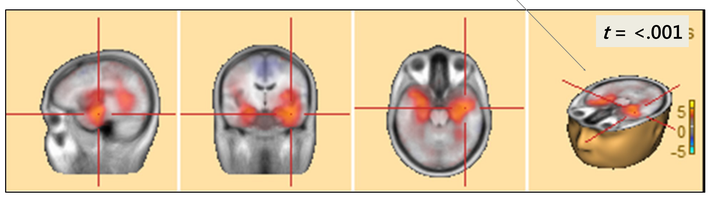
Passive listening (25 minutes):

- Participants watched a muted movie while listening to random presentations of Standard and Deviant micropatterns
  - → **Event-related potentials measured to determine the existence and strength of an MMN signal**

RESULTS: Study phase



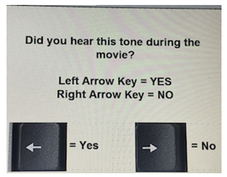
Average frontal-central pole (FCz) ERPs in response to the standard (blue) and the deviant (red) micropatterns. **The dotted black line indicates the MMN waveform.**



CLARA source analysis. Red and yellow shading represents areas of the brain at this latency where deviant micropattern activity is significantly greater (P<.001) than standard micropattern activity.

Methods: Test phase

Test Phase

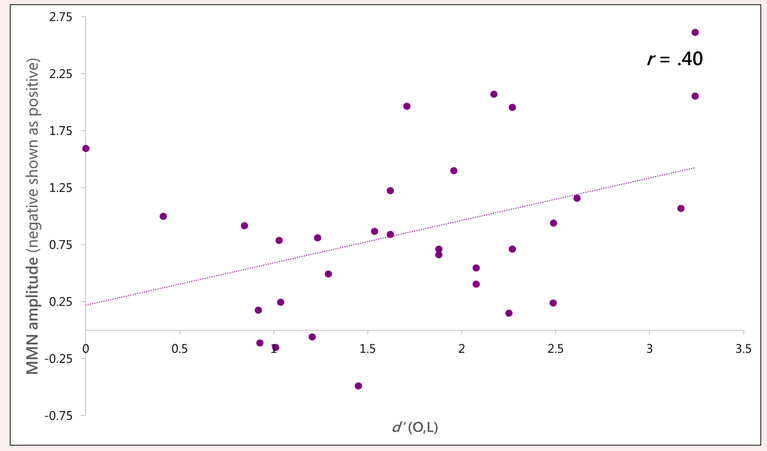


- Evaluation of participants' recognition memory
- The six micropatterns (two old, three lures, one foil) were presented ten times each over the course of the test phase, for a total of 60 trials, in randomized order
- Participants indicated via a button press whether or not they heard the tone while watching the movie

RESULTS: Test phase

- To verify that the MMN predicted behavioral pattern separation, we correlated the MMN amplitudes with recognition *d'* scores for lure discrimination, ***d'*** **(O,L)**
- After correcting for multiple comparisons, we found the **MMN was significantly related with *d'* (O,L)**, $r = -.40$, 95% BCa CI [–.69, –.02], $p = .013$, one-tailed.

MMN correlation with pattern separation



CONCLUSION

- The primary finding that the MMN and *d'* (O,L) are correlated is consistent with our prediction that strong mnemonic representation is formed from the MMN and that it predicts pattern separation
- Therefore, the MMN paradigm provides a test of both recognition memory and pattern separation for auditory objects
- **Our investigation is the first to show that our capacity to discriminate auditory inputs, as measured by MMN, gives rise to unique, long-term memories**

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