Statistical Learning in a Noisy Environment is Associated with Vocabulary

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Introduction

Background

Classic statistical learning (SL) paradigms have shown robust learning in both linguistic and non-linguistic domains[1,2], however recent findings have indicated that individuals vary in their sensitivity to statistical information across domains[3]. Additionally, SL in a naturalistic environment frequently encounters interruptions by random noise.

Research Questions

1. Can adults learn visual statistical information embedded in a noisy environment?
2. Do adults learn better when the statistical information and interrupting random noise are **different** types (letter vs. image) or the **same** type?
3. Is individuals' statistical learning performance related to their vocabulary?

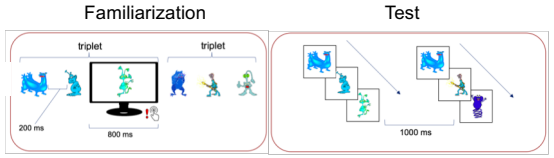
Materials and Methods

Participants

Group	N	Age	Sex (M:F)	Vocab. Score	Structured	Random
Same	27	19.96	2:25	112	Image	Image
					Letter	Letter
Different	28	20.04	7:20	111	Image	Letter
					Letter	Image

Groups are matched for age, sex, and vocabulary.

Stimuli

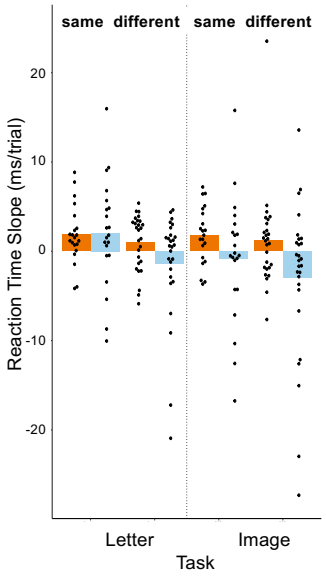


Procedure

- We examine visual SL in interleaved structured and random sequences. The **structured** stream was made of four triplets repeated 24 times each. The **random** stream contained 12 randomly-ordered stimuli.
- Each stream was spliced into 6 blocks, which were interspersed to form a continuous stream.
- Participants performed a target detection cover task
- NIH toolbox Picture Vocabulary task after the SL tasks

Online Learning

Reaction Time Slope

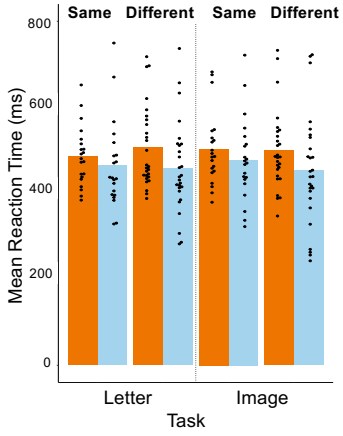


1. Marginally greater RT acceleration (more negative RT slope) in the Structured than in the Random condition:
F(1,42) = 3.74, p = 0.06

2. Greater RT acceleration (more negative RT slope) in the Image task than the Letter task:
F(1,42) = 4.52, p = 0.04

3. Greater difference between Structured and Random conditions in the Image task than the Letter task:
F(1,42) = 6.17, p = 0.02

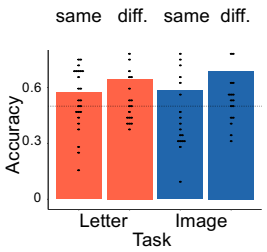
Mean Reaction Time



Lower mean RT in the Structured condition than the Random condition:
F(1,42) = 15.6, p = 0.0003

Offline Learning

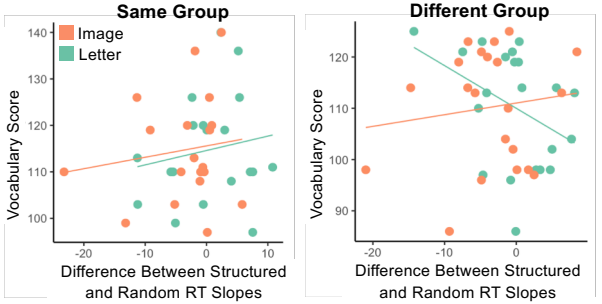
Test Phase Accuracy



Above-chance learning in both groups and in both tasks:
Same letter: 0.57 (>0.5, p=0.027)
Diff. letter: 0.65 (>0.5, p=0.00035)
Same image: 0.58 (>0.5, p=0.058)
Diff. image: 0.69 (>0.5, p=7.081e-05)

Different Group performed marginally better than Same Group: $F(1,51)=3.37$, p=0.072

Online Learning and Vocabulary



Only in the Different Group, greater sensitivity to structured letter sequences is uniquely correlated with vocabulary score (r = -0.39, p = 0.04).

Conclusion

1. Adults are capable of learning statistical information scattered in a noisy environment.
2. Results indicates potentially different cognitive resources supporting the statistical learning of images and letters.
   - Marginal group differences on accuracy between **same** and **different** conditions
   - Letter SL explains more variability in vocabulary than image SL, hinting at linguistic-specific constraints on vocabulary learning.

References

1. Saffran et al., Science, 1996.
2. Saffran et al., Cognition, 1999.
3. Siegelman & Frost, J Mem Lang, 2015.

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