Exposure to Short-Term Acoustic Regularities Has Limited Impact on Representations and Behavior

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Introduction

Efficient coding of auditory information

Recent research suggests that auditory processing system rapidly and efficiently codes regularities experienced through passive exposure (Lu, Liu, Dutta, Fritz, & Shamma, 2019; Stilp & Kluender, 2012; Stilp, Rogers, & Kluender, 2010). Particularly, experiencing a high correlation between two acoustic dimensions is thought to improve discriminability along that dimension and reduce discriminability along the orthogonal dimension.

Passive statistical learning

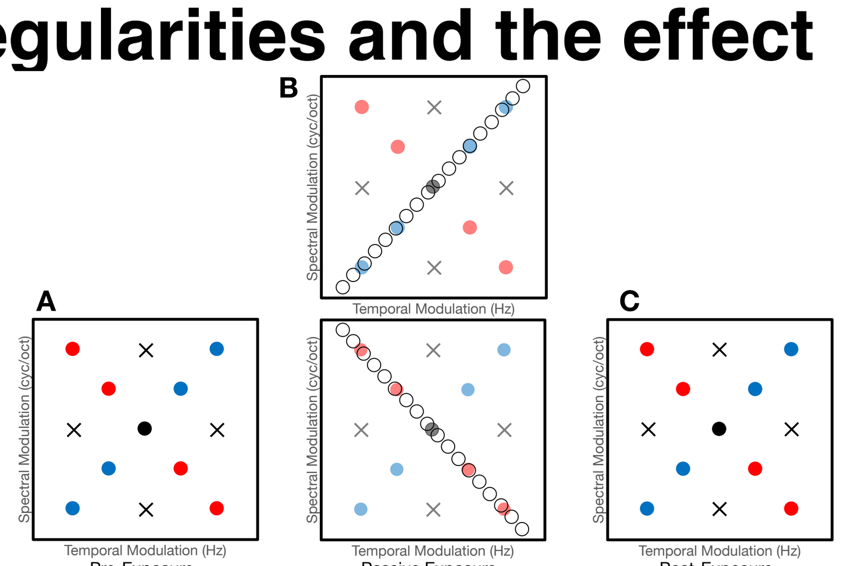
Another line of research suggests that infants and adults are even able to build auditory category information based on passive exposure to the distributional regularities in the input (Maye, Werker, & Gerken, 2002; Aslin, 2017; but see Cristia, 2018).

What is the broader impact of this experience?

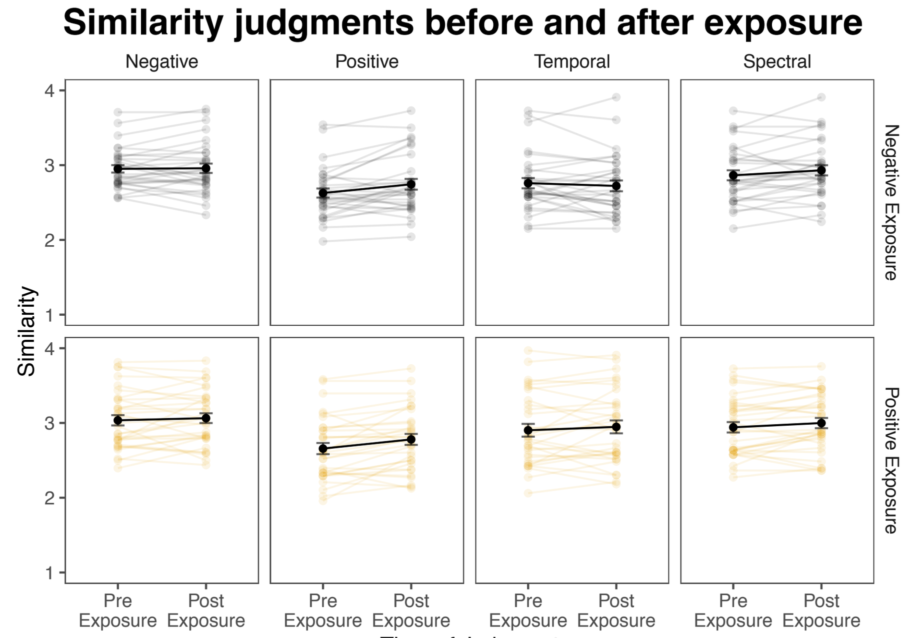
However, how short-term experience with these regularities impacts perceptual **representations** and impacts **subsequent learning behavior** remains unknown. We examined the effects of passive exposure to short-term acoustic regularities on similarity-based representations and category learning behavior.

Experiment 1: Exposure to short-term regularities and the effect on perceptual representations

- Participants ($N = 64$ CMU undergraduates) were randomly assigned to Positive correlation exposure (n = 33) or Negative correlation exposure (n = 31).
- Assess perceptual representations before and after passive exposure to correlation between two acoustic dimensions via similarity judgments across the acoustic space.



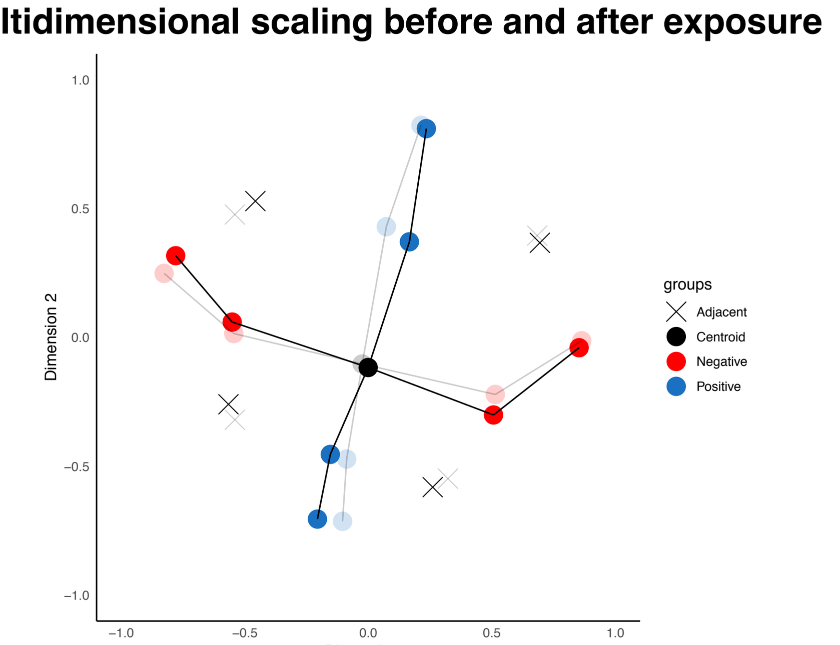
Similarity judgments before and after exposure



No interaction between exposure type and dimension varied ($F(3,183) = 0.94$, $p = .42$, $\eta_p^2 = .02$) or effect of exposure type ($F(1,61) = 0.38$, $p = .54$, $\eta_p^2 = .006$). There was a significant effect of the dimension varied ($F(3,183) = 6.32$, $p < .001$, $\eta_p^2 = .09$).

Error bars are standard error of the mean (*SEM*)

Multidimensional scaling before and after exposure

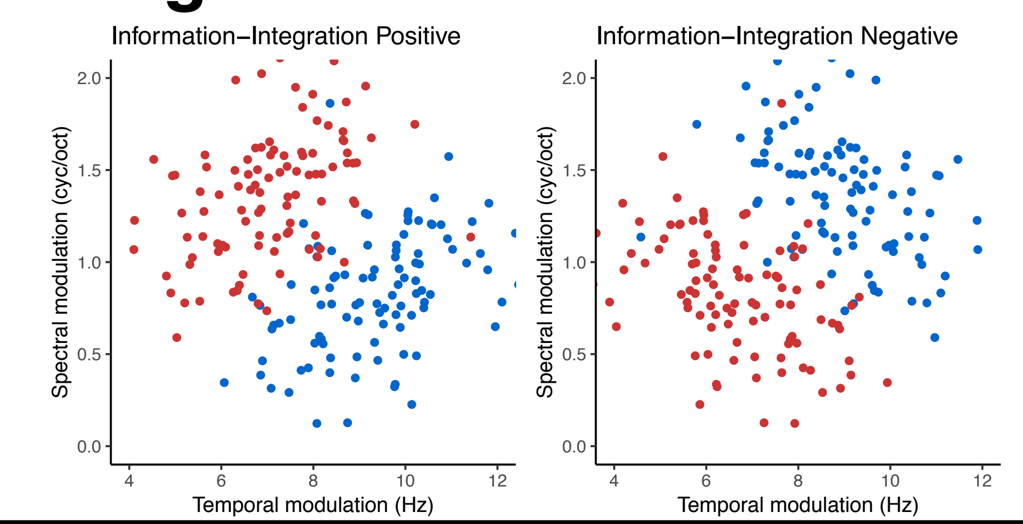


- The exposure regularity (Positive, Negative) did not differentially affect similarity judgments across the acoustic space. Instead, for either exposure type, stimuli along the positive axis and spectral dimension were judged as more dissimilar after exposure. Stimuli along negative axis or temporal dimension were not judged differently before and after exposure.
- MDS analyses showed that the structure of the similarity space was not substantially altered by the passive exposure experience. The stimuli vary in the perceptual space in a way such that the MDS dimensions align with the positive and the negative axes in the acoustic space.

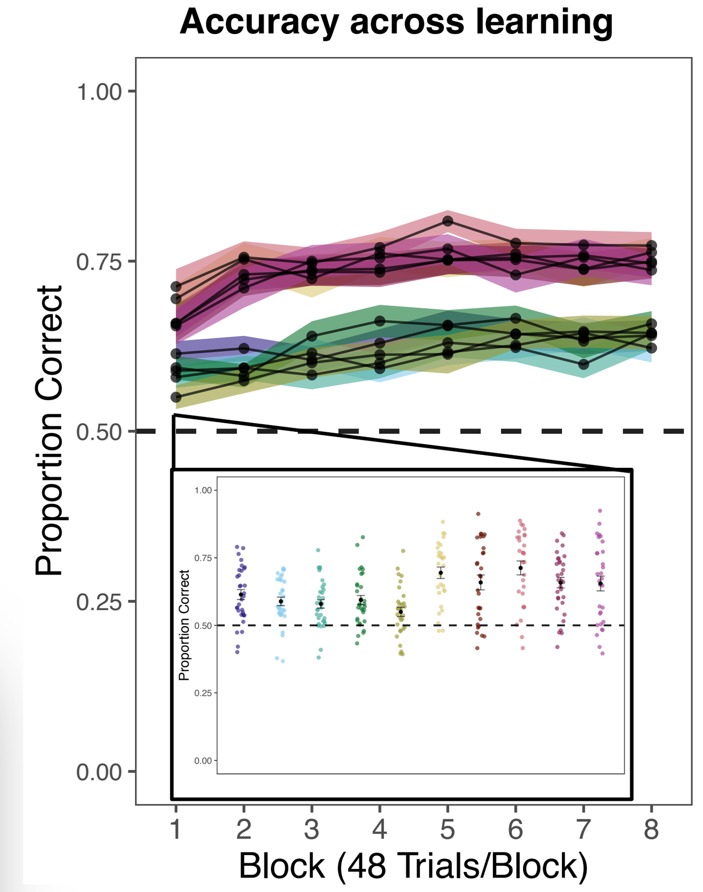
Conclusion: Passive exposure to a correlation between two acoustic dimensions had limited influence on similarity-based representations.

Experiment 2: Exposure to short-term regularities and the effect on category learning performance and strategies

- Participants ($N = 305$ CMU undergraduates) were randomly assigned to an exposure condition (Naïve, Positive, Negative, Spectral, Temporal) and a category type (II-Positive, II-Negative). There were approximately 30 subjects in each condition.
- Assess the impact on category learning performance (accuracy across blocks and early in learning) and strategies (decision bound computational models).

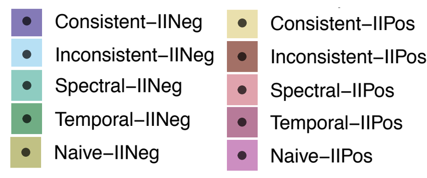


Accuracy across learning

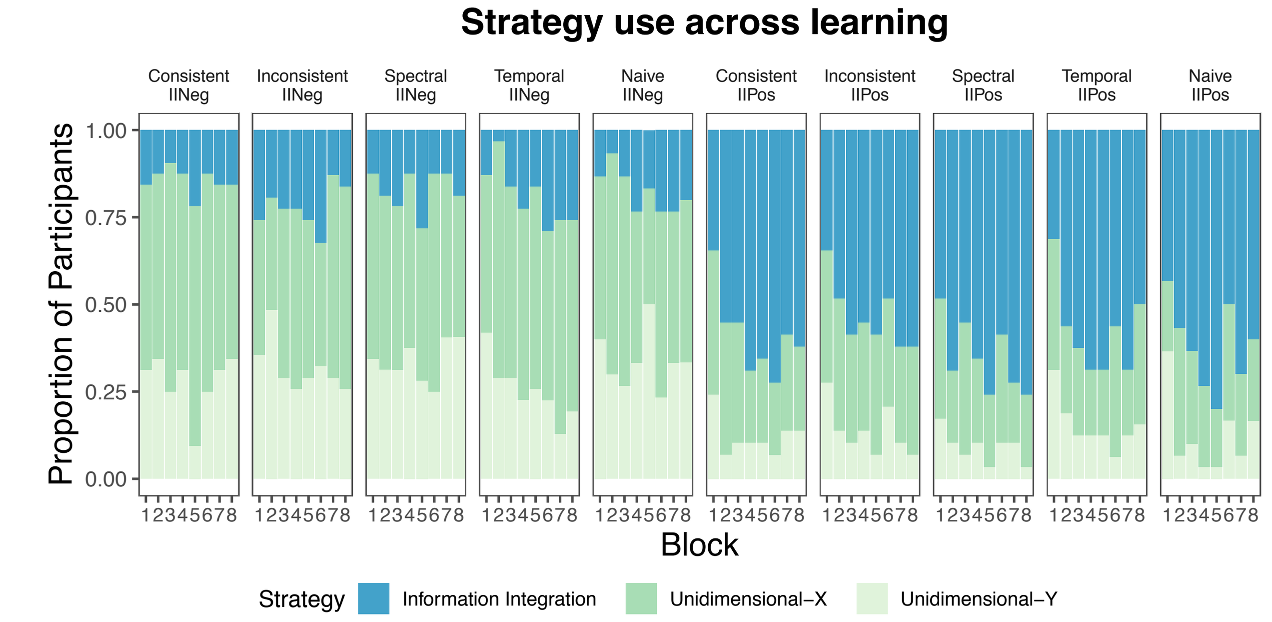


Exposure type did not affect learning ($F(4,295) = 0.22$, $p = .93$, $\eta_p^2 = .003$). However, accuracy for II-Pos categories was consistently higher than II-Neg ($F(1,295) = 126.9$, $p < .0005$, $\eta_p^2 = .30$). There was no interaction between exposure type and category ($F(4,295) = 1.07$, $p = .37$, $\eta_p^2 = .014$).

Error bars are standard error of the mean (*SEM*).



Strategy use across learning



The pattern of strategy use in the first block (and across learning) was not significantly different across exposure types (Fisher's exact tests $ps > .23$). However, the pattern of strategy use across the two category types (II-Pos, II-Neg) was significantly different across all blocks (Fisher's exact tests $ps < .0005$). II-Pos learners found the optimal integration strategy early on and applied it consistently and II-Neg learners applied suboptimal rule-based strategies.

Conclusion: Exposure type had no impact on category learning performance or strategies. There were, however, large and persistent differences between the two statistically identical category types, indicating that existing biases place strong constraints on learning.

Conclusions

These experiments demonstrate that the impact of short-term exposure to acoustic regularities has limited impact on perceptual representations or behavior, and that other perceptual biases may place stronger constraints on the course of learning.

References and Acknowledgements

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