Higher Order Structure in Visual Statistical Learning

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We readily come to represent the predictive structure of our world. Coherent world models contain not only first-order predictions, but also higher-order structure: the way that predictive regularities themselves group-together. We explicit reason about such structure (Gershman 2016; Schulz et al 2008). But do we **implicitly** and **automatically** come to associatively bind multiple rules? We used a visual statistical learning task to test this question (Fiser & Aslin 2002).

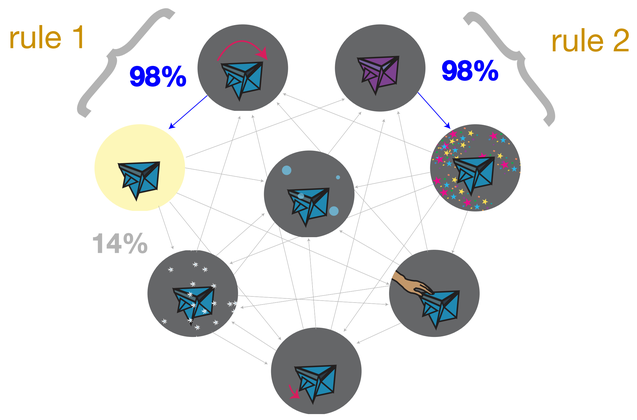
Visual statistical learning task

***Exposure task*:** "Decide if the event is common or rare"

625 events / 15 minutes over 3 segments

stimuli: common alternates

rare alternates



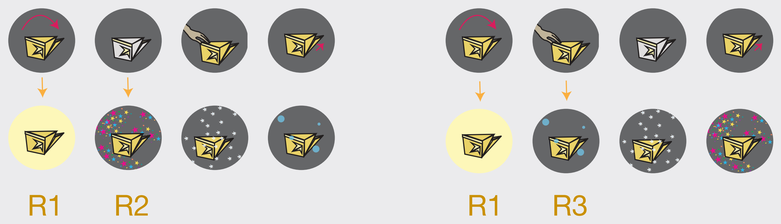
Transition probability structure governing each sequence of events: two strong rules among weaker transitions among 8 events; events matched in overall frequency

Design: rule pairing is consistent or inconsistent

Each participant saw 3 sequences, each cued by a distinct object, which contained the same set of 8 events

Training Objects

Test Object



Subjects saw either the Consistent or Inconsistent test object; stimuli counterbalanced

Minimal explicit knowledge

(1) "Did you notice any patterns in the order of events? Did any events seem to follow each other more than randomly, for any of the objects?"
(2) "Did the videos about each of the objects differ from each other, in terms of which events occurred and in what order?"

Participants noticed an average of .75/4 rules, and only 8/376 participants could describe any differences among the videos

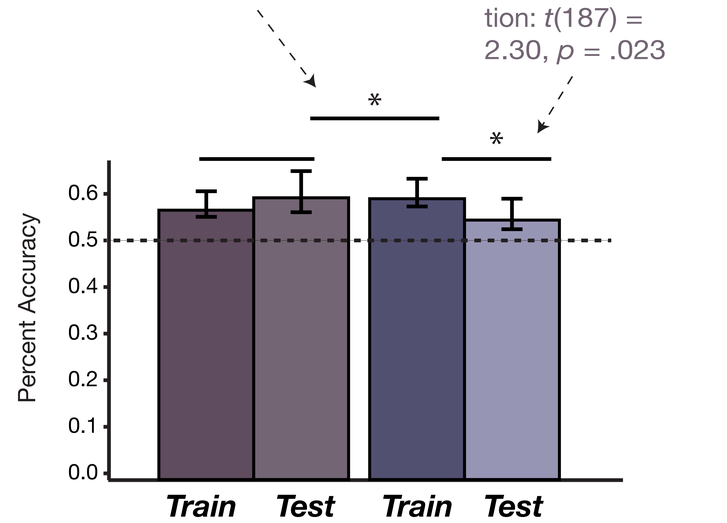
Learning is affected by higher-order consistency

***Forced Choice test*:** "Which is more typical?"

Tests probed knowledge of which specific rule goes with which object; all event pairs tested with equal frequency

Interaction between condition and train vs. test object: $F(1, 374) = 5.33$, $p = .022$.

Test vs. Train performance in the Inconsistent condition: $t(187) = 2.30$, $p = .023$



No differences between groups on training objects, nor any differences between training objects A and B, or knowledge of rules R2 and R3

Conclusions

Learners register how individual predictive relations cohere into higher-order, context-dependent sets, and this knowledge guides their expectation that these rules will continue to cohere this way in the future—despite evidence to the contrary.

Such associative binding can operate over relations themselves, not only their component events.

It operates with minmal awareness and without out task demand to form them.

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online materials
https://osf.io/wzvn2/

pdf of this poster

Fiser, J., & Aslin, R. N. (2002). Statistical learning of higher-order temporal structure from visual shape sequences. Journal of Experimental Psychology: Learning, Memory, and Cognition, 28(3), 458–467.
Gershman, S. J. (2016). Context-dependent learning and causal structure. Psychonomic Bulletin & Review, 24(2), 1–25.
Schulz, L. E., Goodman, N. D., Tenenbaum, J. B., & Jenkins, A. (2008). Going beyond the evidence: Abstract laws and preschoolers' responses to anomalous data. Cognition, 1–48.

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