Learning sequential probabilistic associations in a simple four-choice RT task

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Abstract

Making decisions under uncertainty requires information about the underlying probabilistic relationships among events. Because learning these relationships is critical to decision making, we used an implicit learning task, the Triplets Learning Task, to investigate whether people can learn the relative probabilities of multiple event sequences. Extending previous research showing that people can learn to distinguish large differences in probabilities, our results demonstrate that people also learn subtle probabilistic differences. We argue that this task can be modified into a decision making task to explore complex decisions among multiple options as well as the learning of relationships that underlie decision making.

Introduction

Implicit Learning

•Previous studies have shown that people are sensitive to predictive relationships in the world around them (Reber, 1989).

•Our lab has shown that people can implicitly learn to differentiate between events that occur with very different probabilities - 0.9 vs. 0.1 or 0.8 vs. 0.2 (Howard, Howard, Dennis, & Kelly, 2008).

•Here we investigate implicit learning of more subtle probabilistic differences.

Methods

Participants

Age	Sample Size	Digit Span-F	Digit Span-B	Digit Symbol	WAIS Vocabulary
18.75 (.87)	12 (10F)	10.5 (2.71)	6.08 (1.68)	76 (16.72)	44.58 (6.52)

Triplets Learning Task

•Subjects see a series of 3 events called a triplet.

•Subjects respond to the spatial location of the third event.

•The first two events predict the third event, but with varying probability between .08 and .74.

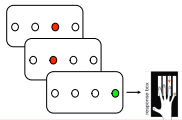
•Feedback on speed and accuracy was given at the end of each block to encourage participants to respond at 92% accuracy.

•Four different predictive relationships were used, called Triplet Types:

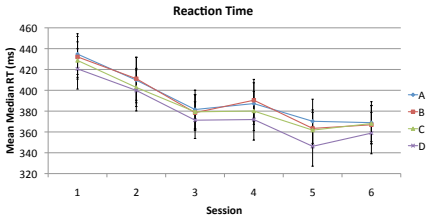
	A	B	C	D
N	19	14	10	5
Joint Probability (JP)	.0132	.0179	.025	.05
Mean Conditional Probability (CP)	.2596	.3153	.3841	.5631

•We assigned the JP of each triplet type, but the JP and CP for individual triplets were highly correlated (r=.71).

6 sessions
5 blocks/session
50 trials/block



Results



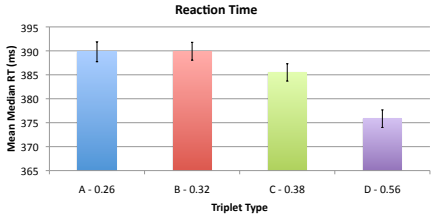
Significant skill learning shown by main effect of session (p<.001), but there was also a main effect of triplet type (p=.008).

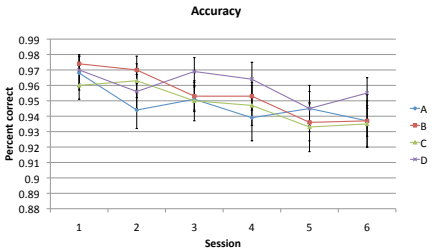
•Triplet Type D showing significantly faster reaction times than the A or B

•A vs. D (p=.025)

•B vs. D (p=.016)

•C vs. D (p=.119)





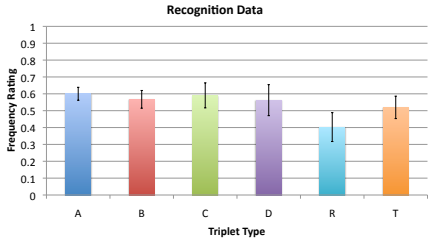
Subjects were highly accurate with no main effects or interactions

• Session (p=.109)

•Triplet Type (p=.353)

•Interaction (p=.078)

•Subjects were not explicitly aware of the differences in triplet frequency (p=.387).



Discussion

Implicit Learning

•Subjects were sensitive to subtle differences in the probabilities of events but, had no explicit awareness of these differences.

•Performance on this task has been linked to striatal dopamine function (Simon, et al., 2011).

Implications for Decision Making

•We believe this task measures the implicit, striatal-based learning that underlies decision making (Balleine, Delgado & Hikosaka 2007, Frank, Cohen & Sanfey 2009, Frank, Doll, Oas-Terpstra & Moreno, 2009, Daw, Niv, & Dayan 2005).

Future Directions

•We have adapted this task to investigate decision making by asking subjects to predict the final event based on the first two events.

•Many decision-making tasks require subjects to make binary decisions; this task would extend the number of options of possible choices and allow exploration of more complex decision-making.

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