Plinko: A spatial probability task to measure learning and updating

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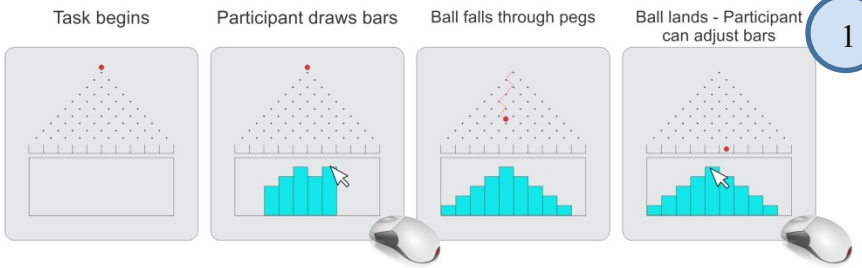
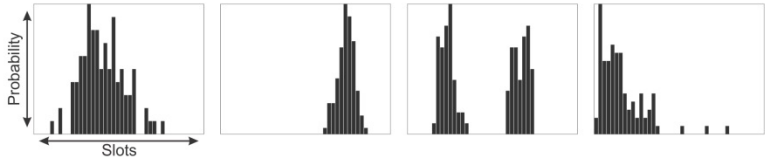
We tested participants' ability to match changing probabilities using Plinko.

1



Two groups played against four different distributions of ball drops.

2

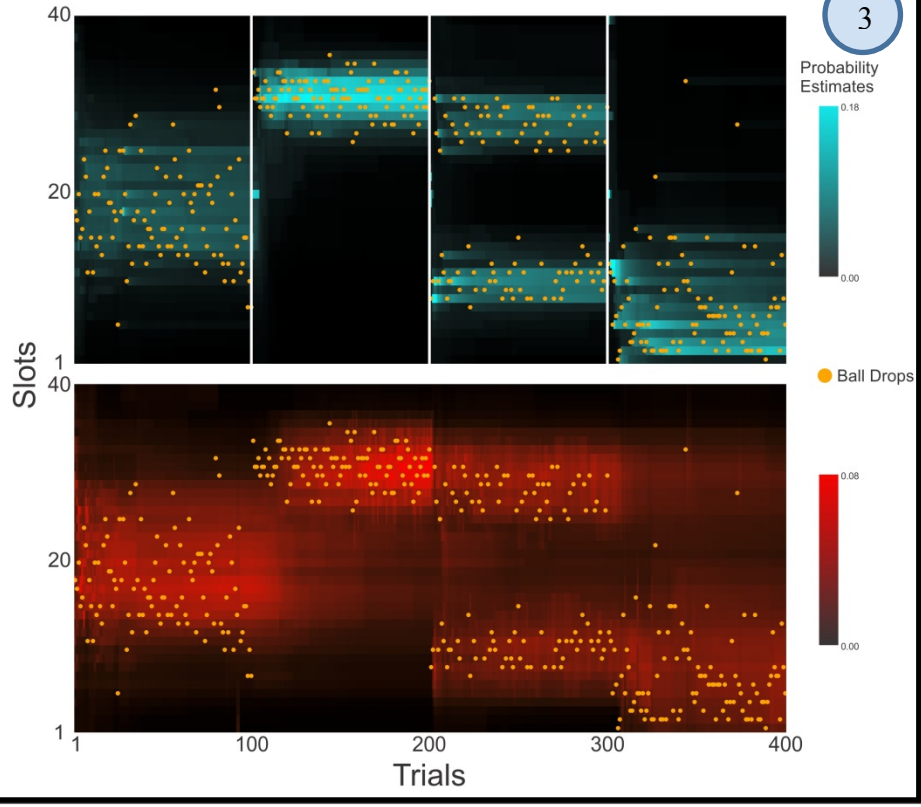


Break: Participants are given a break between distributions

Continuous: Participants get no break between distributions

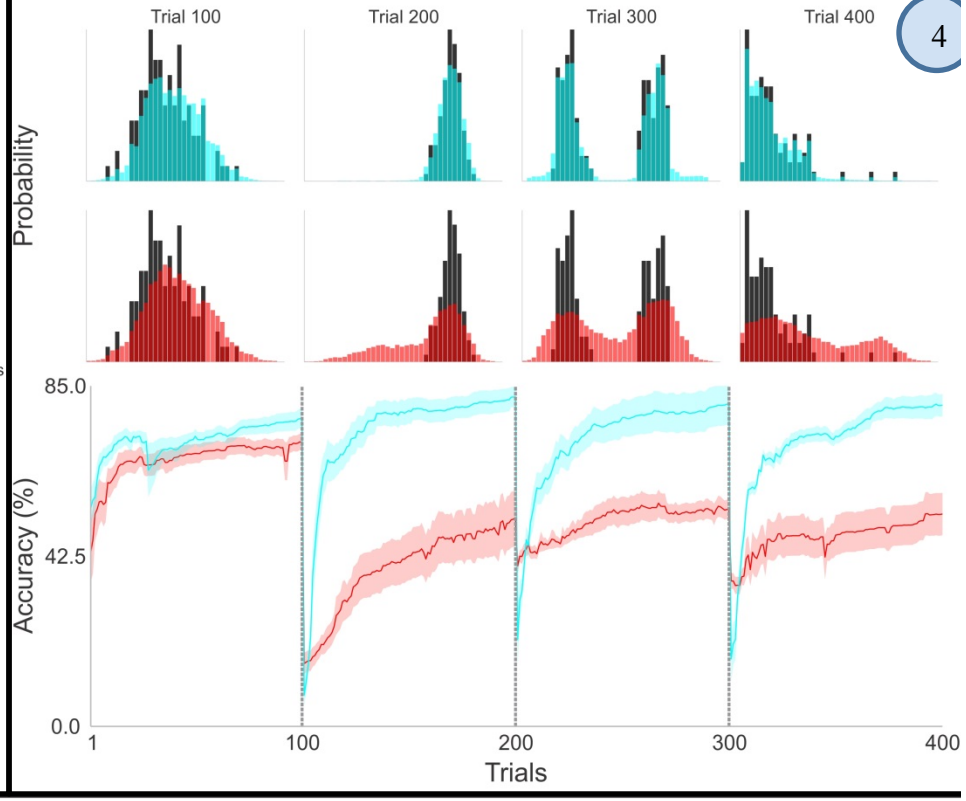
Participants can use Plinko to track changes in ball probability...

3



...and give trial by trial information about likelihood estimations and accuracy.

4



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1. ***How do we capture an online measure of participant expectations?*** Research has demonstrated that our expectations influence our ability to detect and adapt to changes in our environment[1]. However, measuring participant expectations at any given point throughout a task presents a significant challenge. We created a task based on "Plinko" to overcome this difficulty. In this task, participants see a ball fall through pegs and land in slots. Their goal is to predict the likelihood that a ball will fall in any slot on a particular trial. Participants indicate their estimations by drawing bars under each slot using a computer mouse. They are told that taller bars represent a higher likelihood that a ball will fall in a particular slot and shorter bars represent a lower likelihood. These bars are set before participants observe any ball drops and can be adjusted at the start of each trial. The bars represent a participant's expectations on each trial. By manipulating the location of the ball drops, we can measure how quickly and efficiently participant expectations are updated when faced with changes in ball probability.

2. ***Participants played Plinko against different distributions of ball drops.*** To test the effectiveness of our task, we exposed participants to four sequences of 100 ball drops (400 trials in total) generated from four distinct probability distributions: 1) a wide Gaussian distribution, 2) a narrow Gaussian distribution, 3) a bimodal distribution, and 4) a positively skewed distribution. Each participant was exposed to the exact same order of ball drops. Participants were assigned to one of two groups. The first group (termed the "break" group) was given a break between each distribution and pressed the space bar when they wanted to continue. The second group (termed the "continuous" group) were exposed to the exact same sequence of ball drops, but were switched from one distribution to the next without any break in the task.

3. ***Participants effectively used Plinko to track changes in bal drops.*** The heatmaps show the changes in participan probability estimations over the course of the task. Areas o higher saturations (blue or red) represent areas that participant assigned higher probability to specific slots whereas areas o low saturation represent areas of lower probability. These graphs show that participants in both conditions used the ba heights to track changes in ball probability, but that participant in the break group seemed to do so more accurately.

4. ***Plinko provides trial by trial information about participan expectations and accuracy.*** To measure how accurately participants represent any of the computer's distributions, we can measure the percentage of overlap between a participant's estimations on any trial and the actual distribution of compute ball drops. This overlap provides an accuracy score that can then be compared between groups. We can see that participant in the break condition were able to match the computer's distribution very accurately and did so very quickly in each condition. In contrast, participants in the continuous condition had more difficulty representing each of the computer's distributions. This difference in performance seems due to a "hangover" effect in the continuous condition, where a participant's estimates on previously viewed distributions influenced the efficiency with which they detected and adapted to changes in ball probability.

Overall these results demonstrate that our task provides a detailed tria by trial representation of participant expectations, and can be used to measure the efficiency with which participant adapt to environmenta changes.

[1] Stöttinger, E., Filipowicz, A., Danckert, J., & Anderson, B. (2014). The effects of prior learned strategies on updating an opponent's strategy in the rock, paper, scissors game. *Cognitive Science*. (ahead-of-print), 1-11.