

IMPACT OF CHOICE FEEDBACK ON EXPLORATORY AND EXPLOITATIVE BEHAVIOR
IN THE ONE-SHOT BART

By

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Abstract

The Balloon Analogue Risk Task (BART) is a behavioral instrument which has been reliably used to measure real-world risk-taking behavior. In our one-shot version of the BART, participants are presented with a series of balloons of various sizes, with larger balloons having a higher likelihood of popping. They are offered an economic incentive to inflate the balloon, but earn nothing if it pops. They may also choose to cache a smaller but certain number of points instead of choosing to inflate the balloon, making these decisions representative of an explore-exploit tradeoff. One condition in this version provides information about the outcome of each choice via an audio clip, and the other contains only partial feedback. In the full feedback condition, the participant gains information about the overall risk of inflating the balloon at no detriment to their score. We hypothesized that this condition would inform the participant's future choices more accurately, causing response time to decrease. However, the results seem to indicate that participants are more motivated by the noxious stimulus of the balloon popping, as calculations of the one-way analysis of variance were not significant.

Introduction

The Balloon Analogue Risk Task is a metric of risk-taking propensity. It has been used as a measure of real-world risk-taking behavior in both adolescents and adults, which is demonstrated by its high test-retest reliability ([Li, Pan, et al., 2020](#)). Additionally, it is unaffected by recall bias, as are other behavioral instruments ([Harrison et al., 2005](#)). Some of the risky behaviors it has been correlated with in previous studies include unsafe driving ([Vaca et al., 2013](#)), increased alcohol consumption ([Fernie et al., 2010](#)), drug use ([Hopko et al., 2006](#)), and smoking ([Lejuez et al., 2003](#)), as well as impulsivity and sensation-seeking personality traits ([MacLean et al., 2017](#)).

In the BART, participants are presented with two different kinds of balloons. One is more likely to pop than the other when it is inflated. The participant may either choose not to inflate the balloon for a certain reward or inflate the balloon for the chance of receiving a greater monetary reward. However, if the balloon pops, no reward is gained and the popping balloon produces a loud noise which participants are averse to. ([Lejuez et al., 2002](#)) This creates a nested structure to the task in which the participant is presented with a set of decisions during each trial. Risk-taking involves knowing the odds, but in order to know the odds, one must first learn the odds, making this task an explore-exploit problem. ([Addicott et al., 2017](#)) Because these decisions are sequential and dependent on the participant's previous choice, this means that for someone to learn how much they can reliably inflate the balloon, they must have been risk-taking enough to have decided to inflate on the previous trial.

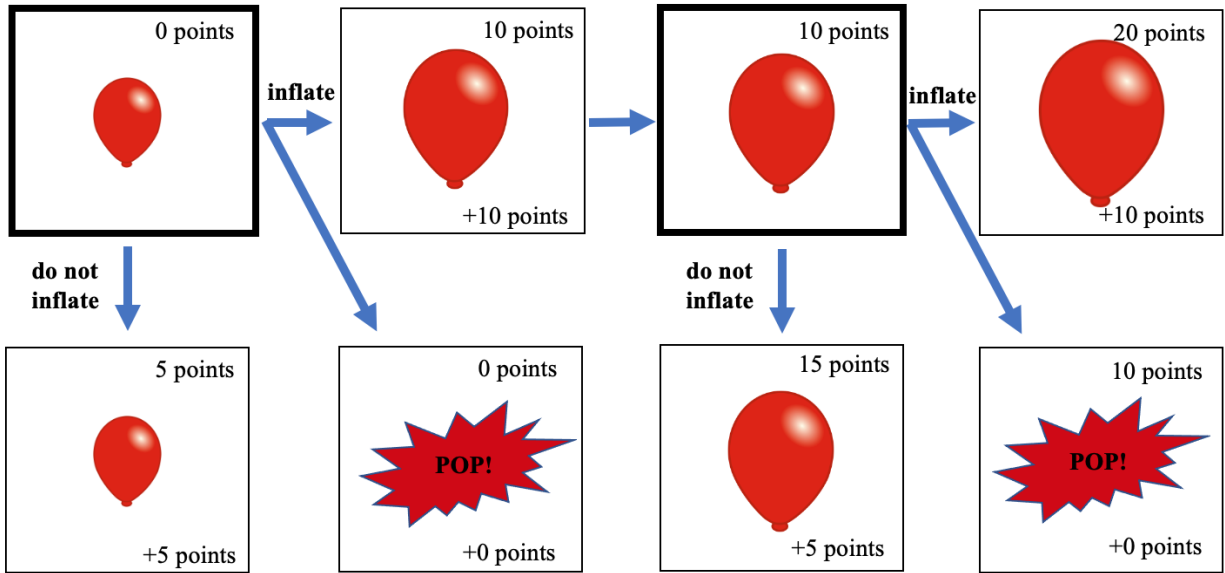
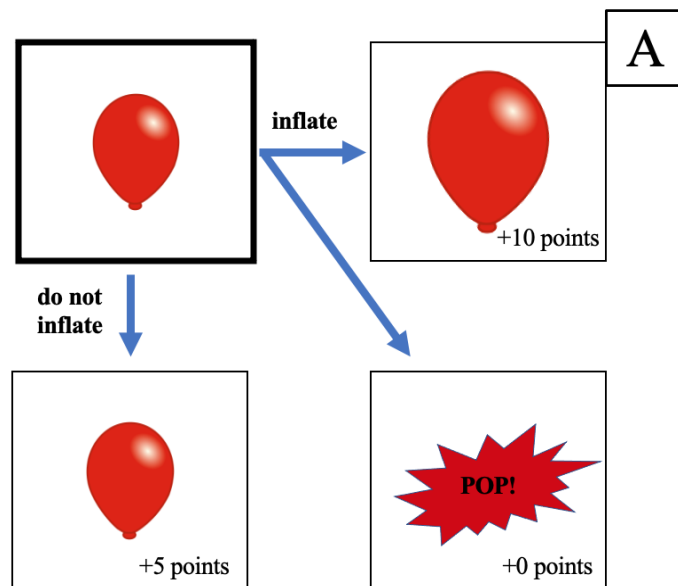


Fig. 1. Possible outcomes of the BART

While the BART has high ecological validity and is quick and engaging, it also has very few trials and fails to disambiguate more nuanced cognitive processes- such as learning and decision noise- that are related to risk-taking in this task. Additionally, although some cognitive computational models have been developed to try to tease apart these different processes, many of these models do not recover their parameters and do not reflect how participants actually make decisions in this task. ([Park et al., 2021](#), [Wallsten et al., 2005](#)) To combat these issues, we created a novel variant of the BART with two conditions to alter the value of information gained in order to understand how exploration drives behavior in this task.

Methods



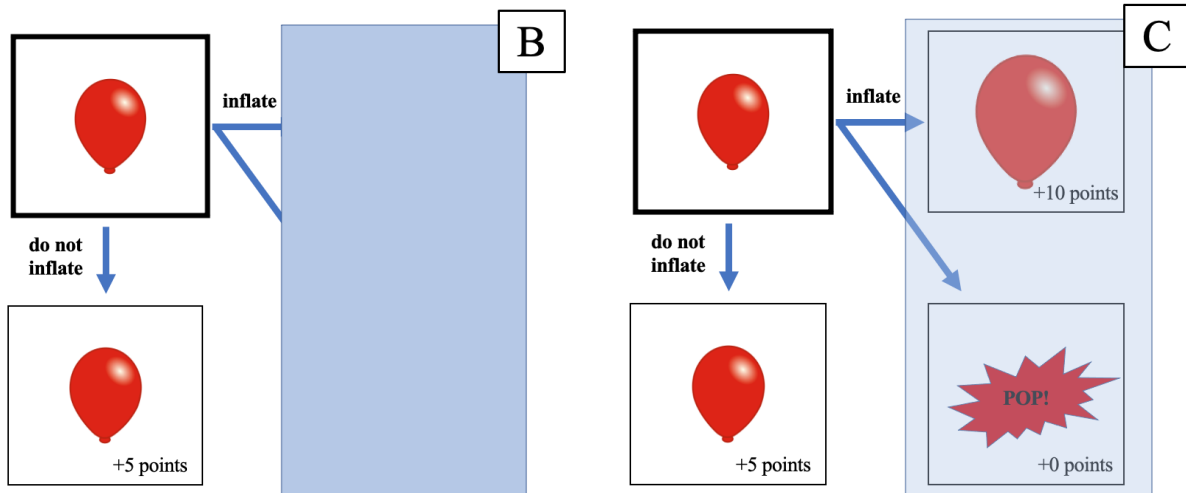


Fig. 2. (A) Possible outcomes of the one shot BART, with (B) partial and (C) full feedback conditions

In this one shot variant of the BART, participants did not continuously inflate each balloon until either deciding to move on or causing the balloon to pop, but rather were presented with partially inflated balloons of varying risk and directed to make a single choice on whether to inflate or not inflate the balloon. One condition in this version provides information on whether the balloon would have popped or continued inflating via a short video clip, and the other contains only partial feedback.

When full feedback is given, the participant will have gained information about the overall risk of inflating the balloon at no detriment to their score. I hypothesize that this condition will inform their future choices in the BART and predict that response time will be decreased. It will also be of note if this information does not affect behavior and participants are more motivated by the noxious stimulus of the balloon popping.

Subjects participated in an online version of the one-shot BART created using JSPsych. Data from a total of 317 participants were included in our analysis, and the data were visualized and analyzed with R Studio Cloud, R version 4.0.5.

Results

I constructed three graphs in total. One plotted the probability of the participant choosing to inflate the balloon against the relative size of the previous balloon with “full feedback” and “partial feedback” subsets. In the second and third graphs, I plotted the probability of the participant choosing to inflate the balloon versus the probability of the balloon popping. The conditions in the second graph displayed when the participant chose to inflate the last balloon shown and gained a monetary reward, when the participant chose not to inflate the last balloon, and when the participant inflated the last balloon and it popped. The third and final graph showed when the participant chose to inflate the current balloon and when they elected not to.

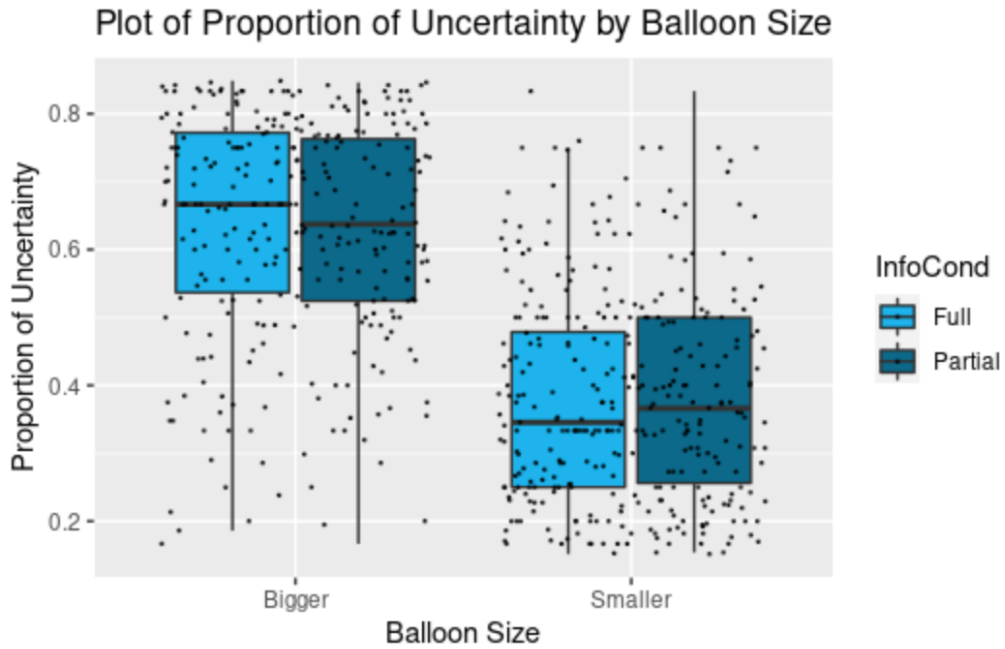


Fig. 3. Plot of proportion of uncertainty vs. the relative size of the previous balloon, grouped by full and partial feedback conditions.

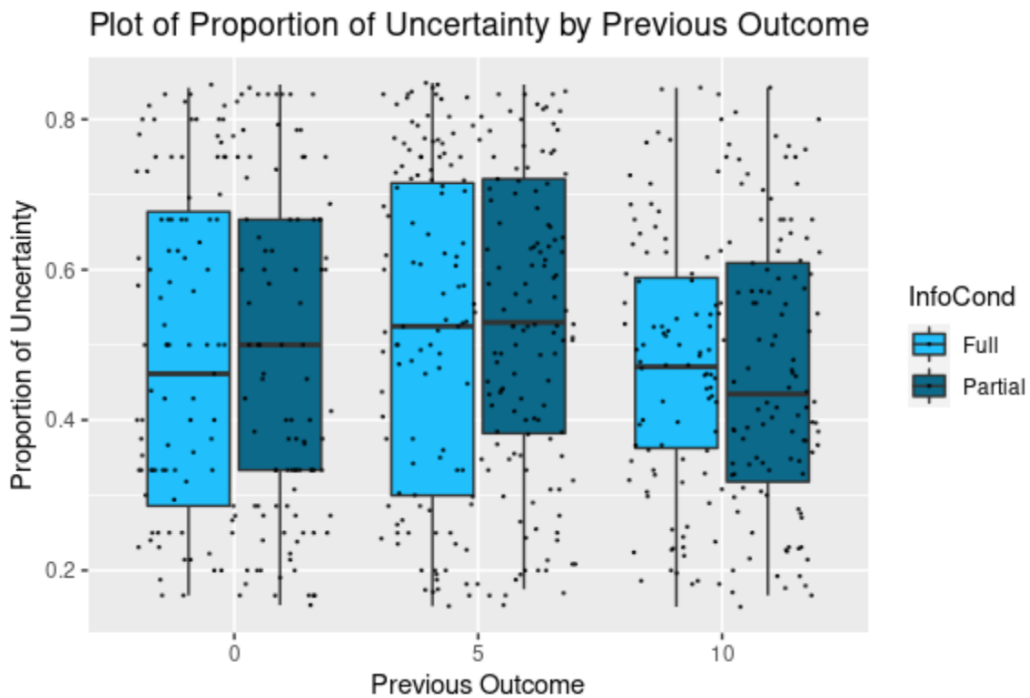


Fig. 4 Plot of proportion of uncertainty vs. the outcome of the previous trial; that is, whether the participant inflated the balloon and it popped, whether the participant chose not to inflate the balloon, and whether the participant inflated the balloon and it did not pop, grouped by full and partial feedback conditions.

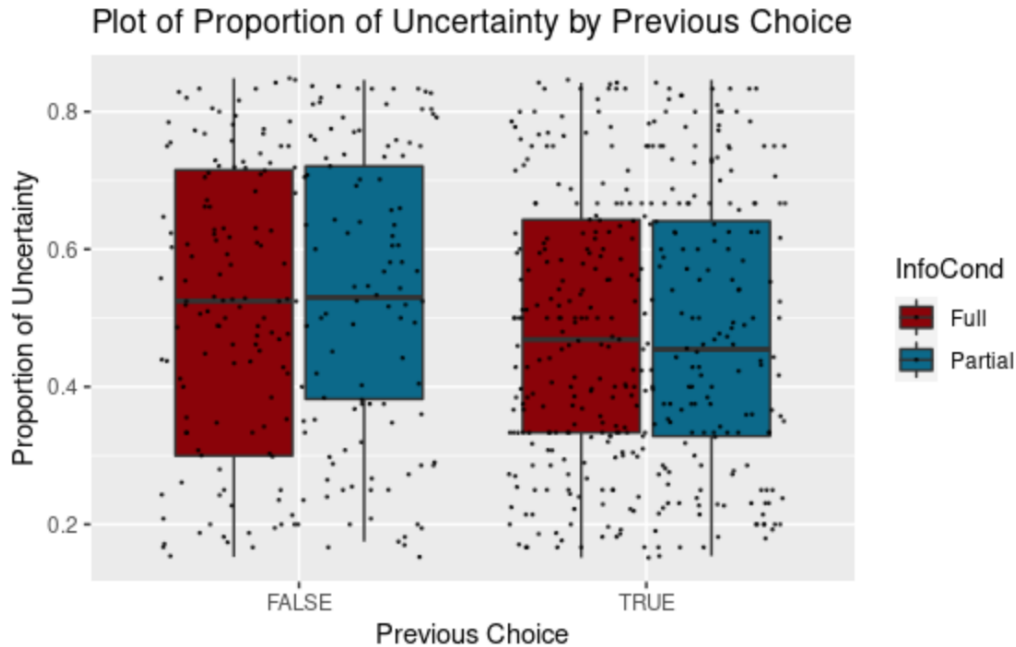


Fig. 5. Plot of proportion of uncertainty vs. the choice of the participant in the previous trial to inflate or not inflate the balloon, grouped by full and partial feedback conditions.

I calculated a one-way analysis of variance (ANOVA) on these three relationships to determine the significance of the results. The analysis for the proportion of uncertainty by balloon size showed that there was not a statistically significant difference ($F(1, 1) = 2.983, p = 0.0846$). Likewise, the proportion of uncertainty against outcome ($F(1, 1) = 0.357, p = 0.551$) and proportion of uncertainty vs. participant choice ($F(1, 1) = 0.686, p = 0.408$) were not statistically significant.

Discussion

Since the sample size was sufficiently large, these results indicate that participants may not be as influenced by feedback when making future choices as we anticipated, showing that exploratory and exploitative behavior are not significantly affected. A possible reason for this is that participants might be more greatly motivated by fear of the balloon popping than they are by the information they gain from watching the feedback videos.

This potentially corroborates the findings of previous research investigating avoidance behavior in the BART, including a study which showed that participants avoided risky scenarios when they were associated with fear-relevant stimuli, even if it incurred a financial cost ([Hengen, KM, and Alpers, GW, 2021](#)). As participants' aversion to the sound of the balloon popping is well-documented ([MacLean et al., 2017](#)), it is possible that this phenomenon is a result of avoidance behavior. Future steps could include directly investigating the link between avoidance of the balloon popping and behavior in the BART.

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