Misjudging the Time of First Occurrence of an Uncertain Event

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Introduction

People often need to consider how long it will be before an uncertain event will eventually happen, or equivalently, when the event will *first* happen. Consider the following situation.

> *Imagine that your parking permit for work just expired. You have a 10% chance of being ticketed on any given day if you park your car with the expired permit. Once you are ticketed, you will be forced to renew the permit to expunge the ticket. If you continue to park with the expired permit, on which day are you most likely to receive your first ticket?*

We investigate intuitions for the time of first occurrence of an uncertain event in a sequence of independent and identical trials. We find that people are notably biased when estimating the time of first occurrence in such a sequence.

The Normative Model

Consider the parking-permit example above. Being first ticketed on Day X implies that you were not ticketed on previous days. Then,

- *Pr*(Ticketed on Day 1) = .10
- *Pr*(Ticketed on Day 2) = .9 x .10 = .09
- *Pr*(Ticketed on Day 3) = .9 x .9 x .10 = .08

The probability of being ticketed for the **first** time goes down each day. Thus, you are most likely to be **first** ticketed on **day 1**, **regardless of the probability on a single day.**

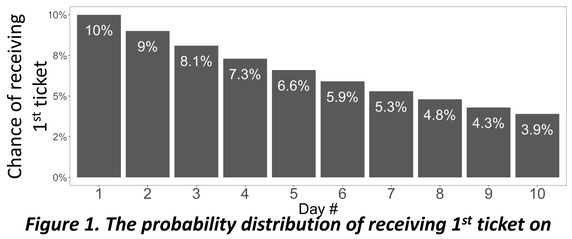

Figure 1. The probability distribution of receiving 1st ticket on each day

Experiment 1. Biased Predictions

Do people recognize that the first occurrence of an uncertain event is more likely to occur on the first trial than on any other trial?

Design:

We invited 775 participants to play a game.

- They each rolled a virtual 6-sided die 20 times.
- They predicted on which roll they would **first** roll a six.
- We incentivized half of them with a 50-cent bonus for correct predictions.

Results:

Ps were clearly biased against the optimal prediction (1st roll). See ***Figure 2***.

- Very few Ps (2% or 3%) predicted the 1st roll.
- As a result, Ps earned significantly less than an optimal forecaster.
- There was no reliable effect of incentives.

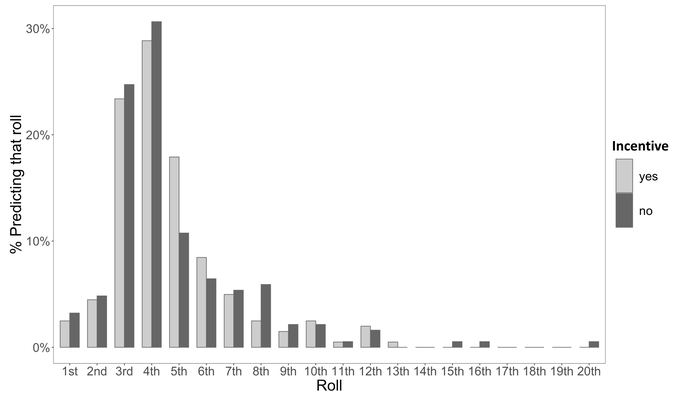

Figure 2. Participants in Study 1 do not recognize that the first 6 is most likely to emerge on the first roll.

Experiment 2. Biased Beliefs

- **Experiment 1 measured Ps' predictions to infer their beliefs about the most likely time of first occurrence.**
- ***Experiment 2 directly examined these beliefs.***

Design:

- Ps imagined that many people each rolled a 6-sided die until they first rolled a six and then they stopped rolling.
- Ps imagined that the die-rollers were divided into groups based on when they rolled a six, such as
  - Group 1: People who first rolled a six on the first roll.
  - Group 2: People who first rolled a six on the second roll.
- Ps indicated which group they thought would be the largest.

Results:

The normative model predicts that the group who rolled a six on the first roll is the largest, but Ps did not generally select this group. See ***Figure 3***.

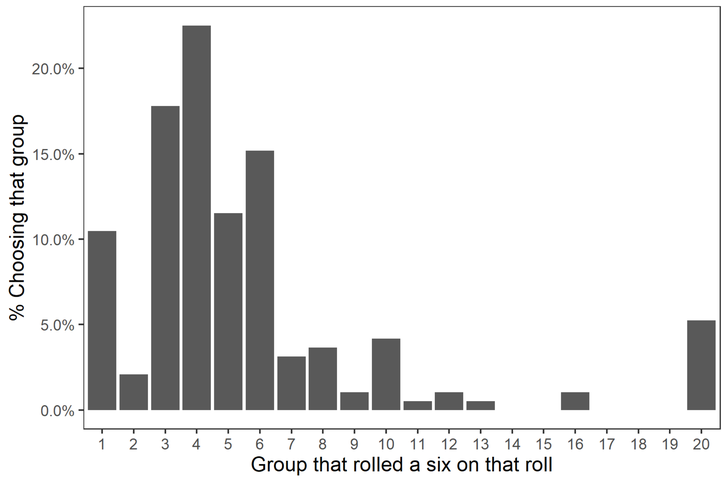

Figure 3. Participants in Study 2 did not recognize that the group who rolled a six on the first roll would be the largest.

Experiment 3. Sensitivity to Event Probability

We propose that people are biased against the optimal prediction because

- **they erroneously focus on the probability of a single trial; and**
- **they believe that a low (high) probability implies late (early) occurrence (Keren and Teigen, 2001).**

Hypothesis: changing the event's single-trial probability will shift people's predictions of its first occurrence.

Design:

We invited 940 participants to play a game.

- They each rolled a virtual 6-sided die 20 times and predicted when they would ***first*** roll a
  - 1; or
  - 1 or 2; or
  - 1, 2, or 3; or
  - 1, 2, 3, or 4; or
  - 1, 2, 3, 4, or 5.

The probability of rolling the specified number thus varied from 1/6 to 5/6. However, note that, mathematically speaking, Ps were always most likely to **first** roll the specified number on the ***first*** roll, regardless of event probability.

Results:

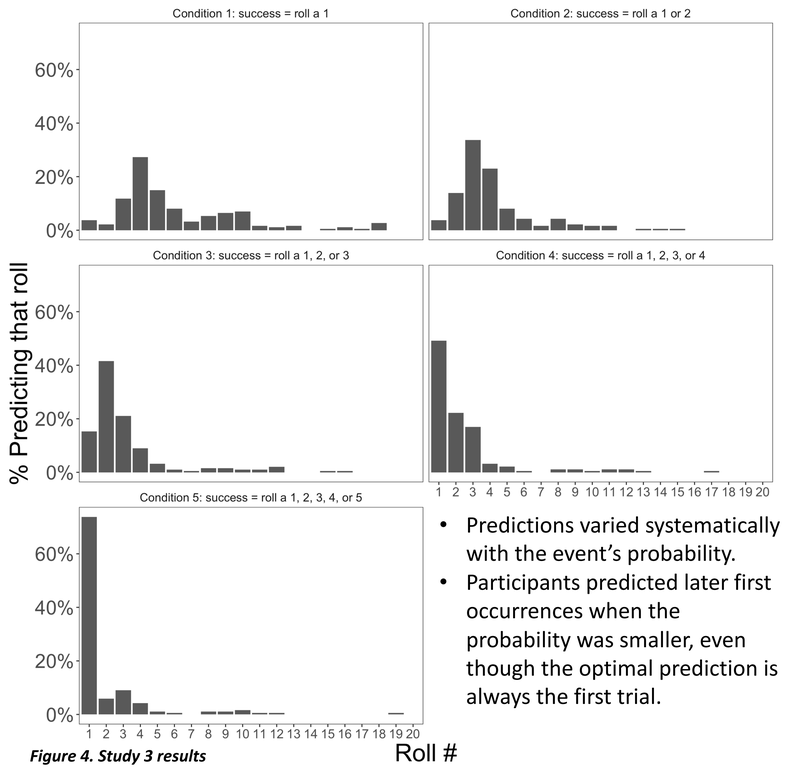

Figure 4. Study 3 results

- Predictions varied systematically with the event's probability.
- Participants predicted later first occurrences when the probability was smaller, even though the optimal prediction is always the first trial.

Discussion

This project uncovers a novel bias in perceptions of probabilistic events. When people consider a probabilistic event that can happen in a sequence of identical and independent trials, they fail to realize that the event is always most likely to happen for the first time on the first trial. Instead, they are sensitive to the event's probability when they should not be, resulting in a systematic bias in forecasting.

Selected References

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. Heuristics and biases: The psychology of intuitive judgment, 49, 81.

Keren, G., & Teigen, K. H. (2001). Why isp=. 90 better thanp=. 70? Preference for definitive predictions by lay consumers of probability judgments. Psychonomic Bulletin & Review, 8(2), 191-202.