The impact of sampling bias on preferences for skewed distributions in decisions from experience

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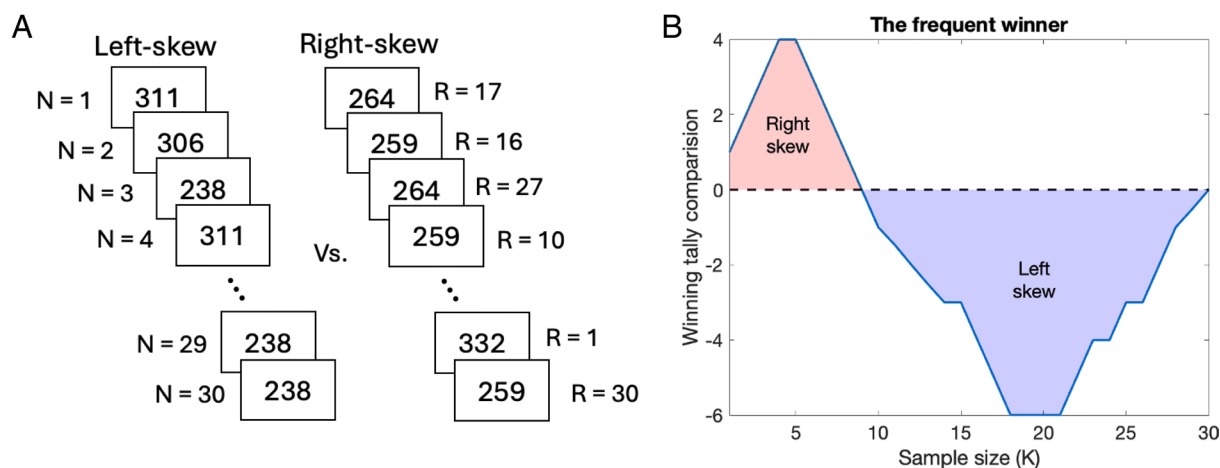
Fig. 1. (*A*) Example display from the "broker game" in Study 3 (ref. 1), where participants viewed a sequence of 30 pairs of dividends from two stocks—one with a left-skew distribution and the other with a right-skew distribution—and were asked to choose from which stock they wished to obtain a dividend. Importantly, each stock had higher values in exactly half of the observations, ensuring the frequent winner across the sequence was balanced. R represents the value difference rank, ranging from 1 (the largest difference) to 30 (the smallest difference). Identical differences were ranked consecutively. N represents the temporal position in the sequence. (*B*) A simulation of the frequent winner comparison as a function of sample size K. If K = 1, the subsample contains the winner from the largest rank (R = 1), and as K increases, winners from the following ranks are included in the subsample until reaching the full sample at K = 30. A positive winning tally value in the figure (red area) indicates a preference for right-skew distributions over left-skew distributions, while a negative winning tally value (blue area) indicates the opposite.

A recent PNAS article proposes a tallying mechanism to reconcile the discrepancy between a preference for right-skewed reward distributions in economic theories and left-skewed distributions in empirical studies on decisions-from-experience (1). The authors suggest that choice is determined by how often one option displays a larger reward than the other—*the frequent winner effect*. However, they claim that there is a choice bias toward right-skewed distributions when neither option is the frequent winner.

These findings highlight a novel tallying mechanism that diverges from traditional learning models in decisions-from-experience. However, a choice bias for right-skewed distributions contradicts recent findings showing a robust preference for left-skewed distributions, even when the "frequent winner" is controlled for (2). In that study, participants were presented with an array of rewards and tasked with choosing between taking a gamble with equal probability of winning one of the rewards or a known certain payoff, with a balanced number of rewards above and below the certain payoff. The preference for left-skewed distributions was explained by an incomplete sampling process based on a subset of the largest rewards in the display. Notably, the two studies differ in demands on cognitive capacity: The former (1) displays 60 rewards per trial, while the latter (2) presents 8.

A choice mechanism based on a subset of outcomes is common in decisions-from-experience. Research has shown that the experience–description gap (3, 4) can be explained by a process relying on small memory samples, where rare outcomes are often underrepresented (5–8), but extreme outcomes are likely included due to their memorability (9–10). Therefore, a preference for right-skewed distributions may stem from the subset of rewards recalled from memory, influenced by sequence length.

To illustrate this notion, we simulated variations in the frequent winner as a function of sample size K when the frequent winner across the sequence was balanced (study 3 in ref. 1). We ranked the rewards in the sequences by the absolute difference between them (Fig. 1*A*), assuming that larger differences are more memorable. We then computed the frequent winner considering a subsample of the largest value differences, where K = 1 included the winner of the largest value difference, and as K increased, winners from the following ranks were included until reaching the full sample at K = 30. Findings show the right-skew distribution was the frequent winner if fewer than 10 winners from the largest ranks were

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included, while the left-skew distribution was the frequent winner if more than 10 were included (Fig. 1*B*).

We conclude that when capacity is challenged by sequence length, a preference for right-skewed distributions may emerge due to reliance on small samples containing the most memorable outcomes. However, with fewer outcomes to remember, more comprehensive sampling may favor left-skewed distributions. Thus, a preference for right-skewed distributions might be driven by a sampling bias. Future experiments could determine the specific impact of sequence length on skewness preferences, while controlling for other procedural differences between (1) and (2) (e.g., presence of a safe option).

1. S. Olschewski, M. S. Spektor, G. Le Mens, Frequent winners explain apparent skewness preferences in experience-based decisions. *Proc. Natl. Acad. Sci. U.S.A.* **121**, e2317751121 (2024).
2. Y. Vananu, J. M. Hotaling, M. E. Le Pelley, B. R. Newell, How top-down and bottom-up attention modulate risky choice. *Proc. Natl. Acad. Sci. U.S.A.* **118**, e2025646118 (2021).
3. R. Hertwig, G. Barron, E. U. Weber, I. Erev, Decisions from experience and the effect of rare events in risky choice. *Psychol. Sci.* **15**, 534–539 (2004).
4. R. Hertwig, I. Erev, The description–experience gap in risky choice. *Trends Cogn. Sci.* **13**, 517–523 (2009).
5. I. Erev *et al.*, A choice prediction competition: Choices from experience and from description. *J. Behav. Decis. Mak.* **23**, 15–47 (2010).
6. C. R. Fox, L. Hadar, "Decisions from experience" = sampling error + prospect theory: Reconsidering Hertwig, Barron, Weber & Erev (2004). *Judg. Decis. Mak.* **1**, 159–161 (2006).
7. R. Hau, T. J. Pleskac, R. Hertwig, Decisions from experience and statistical probabilities: Why they trigger different choices than a priori probabilities. *J. Behav. Decis. Mak.* **23**, 48–68 (2010).
8. O. Plonsky, K. Teodorescu, I. Erev, Reliance on small samples, the wavy recency effect, and similarity-based learning. *Psychol. Rev.* **122**, 621–647 (2015).
9. C. R. Madan, E. A. Ludvig, M. L. Spetch, Remembering the best and worst of times: Memories for extreme outcomes bias risky decisions. *Psychon. Bull. Rev.* **21**, 629–636 (2014).
10. A. Mason, E. A. Ludvig, M. L. Spetch, C. R. Madan, Rare and extreme outcomes in risky choice. *Psychon. Bull. Rev.* **31**, 1301–1308 (2024).