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From preference shifts to information leaks: Examining Individuals' sensitivity to information leakage in the framing effect

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ABSTRACT

The framing effect is a highly robust phenomenon, wherein logically equivalent options (e.g., 90 % chance of winning vs. 10 % chance of losing) trigger different preferences. The Information Leakage account provides a rational interpretation of this effect by suggesting that choice of frame 'leaks' information to decision-makers, making the frames informationally non-equivalent. For example, decision-makers might interpret a positive frame (e.g., 90 % chance of winning) as an implicit recommendation to take a risk. In a series of six preregistered experiments (total $N = 1211$), we manipulated the informativeness of frames by 1) reducing the perceived freedom of a speaker to choose a frame (the Choice Limitation manipulation), and 2) varying the communication context between the speaker and the listener from collaborative to competitive (the Interest Alignment manipulation). We expected a diminished framing effect in scenarios where the leaked information conveys no useful or trustworthy cues. While the Choice Limitation manipulation occasionally attenuated the framing effect, particularly in within-subject designs, the Interest Alignment manipulation consistently led to a reduction in the framing effect in both within-subject and between-subject designs. These findings show that individuals can be adaptable and sensitive to the informational value of frames and suggest that competition prompts inferences more readily than a speaker's agency over the choice of frame. The implications of these results for rational accounts of framing effects are discussed.

1. Introduction

Options can frequently be presented in different frames, and research has consistently demonstrated that these frames, even if logically equivalent, can lead to shifts in preferences. For instance, when a meat product is framed as "90 % lean," it is perceived as tastier compared to the same product framed as "10 % fat" (Levin & Gaeth, 1988; see also, Sanford et al., 2002). Similarly, a medical treatment presented with a "95% survival rate" is preferred over the same treatment framed with a "5 % death rate" (Levin et al., 1988; McNeil et al., 1982). This phenomenon, where logically equivalent frames lead to different preferences for an option, is referred to as a *valence-consistent shift,* or the *attribute framing effect* (Levin et al., 1998; Tversky & Kahneman, 1981).

The attribute framing effect (hereafter, 'framing effect') is typically considered a cognitive bias that challenges the principle of description invariance (Tversky & Kahneman, 1981, 1988). This principle states that different, but logically equivalent, descriptions of options should result in the same evaluations. However, people are reliably influenced by these different frames, leading to varying preferences for the same choice.

A number of explanations of the framing effect support the idea that the effect is irrational. For instance, the Association-Valence account suggests that positive associations of an option are evoked when it is described positively (Levin, 1987; Levin et al., 1998; see also Teigen, 2015, who likens this effect to a priming effect). Kreiner and Gamliel's (2018) attention-based account is also consistent with a categorization of attribute framing as a cognitive bias. Such an account holds that framing serves to shift attention to one element of an option (e.g., positive framing leads to a focus on positive attributes). The neglect (or down-weighting) of the complementary element(s) renders such a process irrational. Such a process may not, however, be irrational if the frame itself implies a lower-bound interpretation of provided information (e.g., the meat is *at least* 90 % lean; see Mandel, 2014 – we return to this account in the General Discussion) and/or which element of the

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choice *should* be accorded greater weight. This second insight is at the heart of the Information Leakage account of framing which is the focus of the current paper (e.g., McKenzie et al., 2018; McKenzie & Nelson, 2003; Sher et al., 2022; Sher & McKenzie, 2006).

The Information Leakage account makes two primary assumptions: 1) the way in which a speaker frames an option may imply a preference, or the objective superiority of that option; 2) listeners are attuned to these cues and use them to shape their own preferences for the options (McKenzie et al., 2018; Sher et al., 2022). On this account, even though frames may be logically equivalent, they are not *informationally* equivalent because the selection of frames by a speaker (i.e., the person responsible for framing an option) conveys choice-relevant information to listeners (i.e., the persons who receive the frames). This account argues that individuals tend to frame options positively when they have a positive attitude toward the option. Moreover, an option is described using a frame that appears to be increased in relation to a reference point (McKenzie et al., 2018; Sher et al., 2022; Sher & McKenzie, 2006).

To illustrate these basic tenets of the Information Leakage account, consider an experiment by Sher and McKenzie (2006) who asked participants to evaluate a research-and-development team. The team was described either as highly successful or poorly performing, with participants receiving varying descriptions of the team's educational background and work history. Despite the team's actual track record being the same across conditions (e.g., 25 failures and 25 successes), participants were more likely to frame the team in terms of "failures" when the team was described as clearly 'bad' (e.g., trivial successes) versus 'good' (e.g., highly ambitious projects). Speakers' framing of the teams in terms of success or failure rates, influenced by their attitudes toward the teams, indicates that these frames convey choice-relevant information to listeners. Therefore, being affected by such framing should not be viewed as a violation of the principle of description invariance, nor as an irrational phenomenon or cognitive bias (McKenzie et al., 2018; Sher & McKenzie, 2022). Rather, the framing effect might be viewed as a rational response to informative cues in the communicative context (Ghasemi, 2024; McKenzie, 2004).

In the current paper, we aim to test the limits of the rationality of framing effects. Specifically, we are interested in the adaptability of listeners' use of frame information in their decision making. A fully rational and adaptable decision-maker would be expected not to use frame information where the first assumption above (speakers frame options to convey information) is not met. Where speakers do not have agency over the framing of options, it is not clear what information a frame can convey. Do listeners persist in using frame information, even where it does not reflect the preferences or knowledge of the speaker? Or are framing effects eliminated under such conditions? Similarly, we consider the case where the listener and speaker are in competition. In this situation, a speaker's choice of frame may not be relied upon to convey accurate information to a listener because the speaker's and listener's interests may not be aligned.

As indicated, by addressing the aforementioned questions we intend to provide an understanding of the limits of the rationality of people's sensitivity to information frames. The persistence of framing effects in situations where the frames are (objectively) informationally uninformative would suggest that sensitivity to information frames is (at least) not fully rational. Some previous research has attempted to address our focal question, with results suggesting different levels of sensitivity to the informational content of frames. Harris et al. (2021) observed somewhat underwhelming evidence for sensitivity to a speaker's agency in the choice of communication frame, whilst Leong (2020) found that framing effects were eliminated when speakers and listeners were in direct competition against one another.

Our studies build on Harris et al. (2021) and Leong (2020) in order to develop a more nuanced understanding of the broader rationality of framing effects as well the contexts in which we might expect them to occur. The work of Harris et al. (2021) already points to the suggestion that the leakage of information from informative frames is in itself 'leaky'. 'Leaky information leakage' suggests that, because inferring information from a speaker's choice of frame is typically a useful or adaptive strategy, people over-generalize and continue to do so even in situations when the speaker's agency is removed. In contrast, Leong's (2020) findings that competition reduces or even eliminates framing suggest that when attention is drawn to the potential of being manipulated by a speaker who does not have your interests at heart, the importance of selected frames is highlighted.

The different findings relating to the impact of manipulating frame choice and competition come from separate experiments, in completely different contexts: Harris et al. (2021) used a task in which risk communicators had (or did not have) flexibility to convey information about the potential harms of food; Leong (2020) used a variation of Sher and McKenzie's (2006) glass of water task in which participants had to infer the state of a hidden glass as a function of whether a target glass was described as half-empty or half-full. These differences in the set-up, along with some other issues with the strength of the manipulations (which we discuss in the presentation of our results) make it very difficult to determine the absolute and relative impact of choice limitation and competition on the observation of framing effects. By designing a task that can accommodate both of these manipulations, we have the potential with our experiments to permit stronger, and more general inferences about the (ir)rationality and adaptability of listeners than previously.

2. The current study

We designed a choice environment where we manipulate the communicated information from the speaker, either by removing agency (using the Choice Limitation manipulation) or by conveying information that is not easily trusted (using the Interest Alignment manipulation). If individuals are sensitive to the informational relevance of leaked information from frames, an attenuated framing effect is expected in these situations.

In all of our experiments, participants were presented with a game scenario that involved two players, with participants assuming the role of the Selector, and an imaginary player acting as the Informant. As the Selector, a participants' task was to make decisions by choosing between two options: accepting a guaranteed offer of $10 or taking the opportunity to draw a ball from a jar containing 100 green and red balls. If the drawn ball was green, they would win an *unknown* amount of money, while drawing a red ball resulted in no winnings.

Participants were told that the Informant possessed knowledge about the amount of money they would win if they drew a green ball. Additionally, they were told that in each round of the game, the Informant is provided with two pieces of paper—one indicating the probability of drawing a winning green ball and the other stating the probability of drawing a losing red ball. The Informant had to hand one of these pieces of paper to the Selector. Based on the piece of paper received from the Informant, the Selector then had to indicate their likelihood of accepting the gamble instead of opting for the sure offer.

Fig. 1 illustrates the Choice Limitation manipulation. The left column of the figure presents a scenario where the Informant is given the freedom to select the winning or losing frames by providing the Selector with either piece of paper (high-choice condition). On the Information Leakage account of framing, the Informant, who is aware of the gamble's expected value and the sure offer, is expected to strategically select either a positive winning frame or a negative losing frame to signal the Selector. Specifically, the Informant is expected to select the positive winning frame when they perceive the gamble as more advantageous than the sure offer, and the negative losing frame when the opposite is true. The Selector, being unaware of the amount of the gamble and sensitive to the choice of frames, is expected to be influenced by the framing manipulation such that they are more likely to choose the gamble when presented with a positive winning frame, than when presented with a negative losing frame. Therefore, in the high-choice

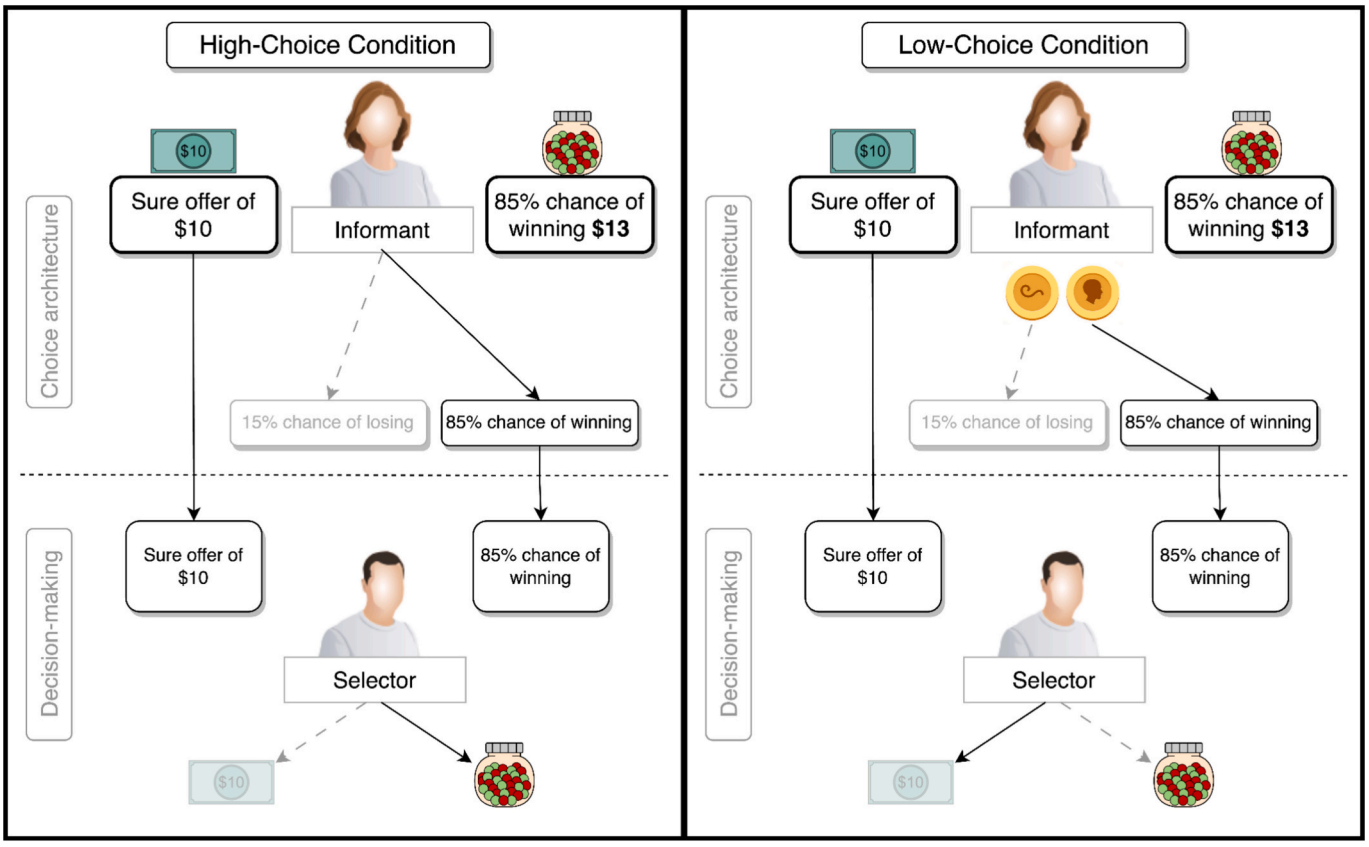

Fig. 1. The theoretical framework of the current study in the context of a decision-making game. In this game, the participant assumes the role of the Selector, while an imaginary player acts as the Informant. The objective is for the Selector to indicate their likelihood of drawing a ball from a jar to potentially win an unknown sum of money, rather than accepting a guaranteed offer of $10. The decision is influenced by the hint provided by the informed Informant. The Informant's role is to provide either a piece of paper stating the probability of winning or a piece stating the probability of losing to the Selector. In the high-choice condition, the Informant is free to choose either piece to give to the Selector. In the low-choice condition, the Informant must give a piece based on the outcome of a coin toss.

condition, we expect to observe a framing effect. On the other hand, in the low-choice condition (the right column of Fig. 1), instead of choosing the frames freely, the Informant must rely on the outcome of a coin toss to determine which frame to present. As a result, the selection of frame is random and thus conveys no information about the Informant's preference. If Selectors are adaptable in their use of frame information, the framing manipulation should have a diminished impact on the Selector's preference in this condition.

Turning to our second main manipulation: Interest Alignment adjusts the degree of alignment between the interests of the Informant and the Selector (not shown in Fig. 1). Under the collaborative, aligned, condition, participants were informed that the Informant is their teammate, and all winnings would be shared equally. In the competitive condition, participants were informed that the Informant is their opponent rather than a teammate, and the win of one player would result in the other player's loss. The misaligned interests between the players may lead participants to perceive the Informant's frame selection as an attempt to deceive them or, at the very least, to view the information as untrustworthy and therefore, disregard it. Consequently, in this condition, the attenuation of the framing effect (or even a reversed framing effect) is expected. We will return to these predictions in Experiment 3 (Experiments 1 & 2 focus on the Choice Limitation manipulation).

3. Experiment 1A

Participants were presented with a game scenario in which they had to indicate their willingness to accept a gamble instead of a guaranteed offer of $10. They were randomly assigned to either the high-choice group, where the Informant is free to pick the frames, or the low-choice group, where a coin toss 'picks' the frames. Adaptable reliance on frames would manifest as a significant framing effect in the high-choice condition and an attenuated framing effect in the low-choice condition. All experiments outlined in this study were pre-registered, and all corresponding pre-registrations, data, analysis codes, and materials are available at (https://osf.io/xfrqj/).

4. Method

4.1. Ethics statement

All experiments conducted in this study received approval from the UNSW Human Research Ethics Committee (Reference No. 3704). Informed consent was obtained from all participants prior to the commencement of each experiment, and they were debriefed at the conclusion of the experiments.

4.2. Participants

Sample size was determined by a Bayesian power analysis conducted prior to the experiment (see the Supplementary Materials for details). A total of 203 participants (*Mean* age = 29.1, *SD* = 10.5) were recruited from Prolific (www.prolific.co). The participants included 135 males, 65 females, 2 non-binary individuals, and 1 participant who preferred not to answer. Each participant was compensated with £1.80 for completing this 12-min experiment. In Experiment 1A, we did not preregister the exclusion of participants based on their responses to one of our manipulation checks (details provided later), so we retained all participants. An exploratory analysis of the data from Experiment 1A, as well as other

experiments, revealed a similar pattern of results with and without excluding inattentive participants. Figs. S1 to S6 in the Supplementary Materials show the raw data for the full sample and the attentive samples for each experiment.

4.3. Design

We employed a 2 (frame: positive vs. negative) by 2 (choice: high vs. low) design. The frame variable was manipulated within-subjects and the choice variable was manipulated between-subjects. The dependent variable was a likelihood rating for choosing the gamble option over the sure option.

4.4. Materials and procedure

Upon consenting to participate, participants were provided with the game scenario, which is summarized in Fig. 2. They were then randomly assigned to one of two choice groups. In the high-choice group, they were informed that the Informant could freely choose each piece of paper to give them. In the low-choice group, participants were told that the Informant had to toss a coin first and, depending on the outcome of the coin toss, the Informant would provide them with the corresponding piece of paper.

Following the successful completion of a comprehension check quiz, participants in both groups were presented with a sequence of 10 trials in a random order. On 5 trials, the piece of paper from the [imaginary] Informant stated the probability of winning the gamble (i.e., the positive frame), and on the remaining 5 the piece of the paper stated the probability of losing the gamble (i.e., the negative frame). Equivalent probability levels were assigned to positive (i.e., 75 %, 80 %, 85 %, 90 %, and 95 %) and negative (i.e., 25 %, 20 %, 15 %, 10 %, 5 %) frames across the 10 trials. In each trial, participants indicated their likelihood of extracting a ball from the jar instead of accepting the $10 offer on a scale from 1 (not likely at all) to 7 (extremely likely).

Upon completion of the experimental phase, participants were presented with two manipulation check questions assessing the extent to which they had understood the choice-limitation manipulation. The first question assessed the extent to which participants perceived their partner to be free in choosing which piece of paper to give them in each round (i.e., "*How much your partner was free to choose which piece of paper to give you in each round?* 1-Not free at all; 7-Completely free"). The second question asked participants to identify the factor responsible for

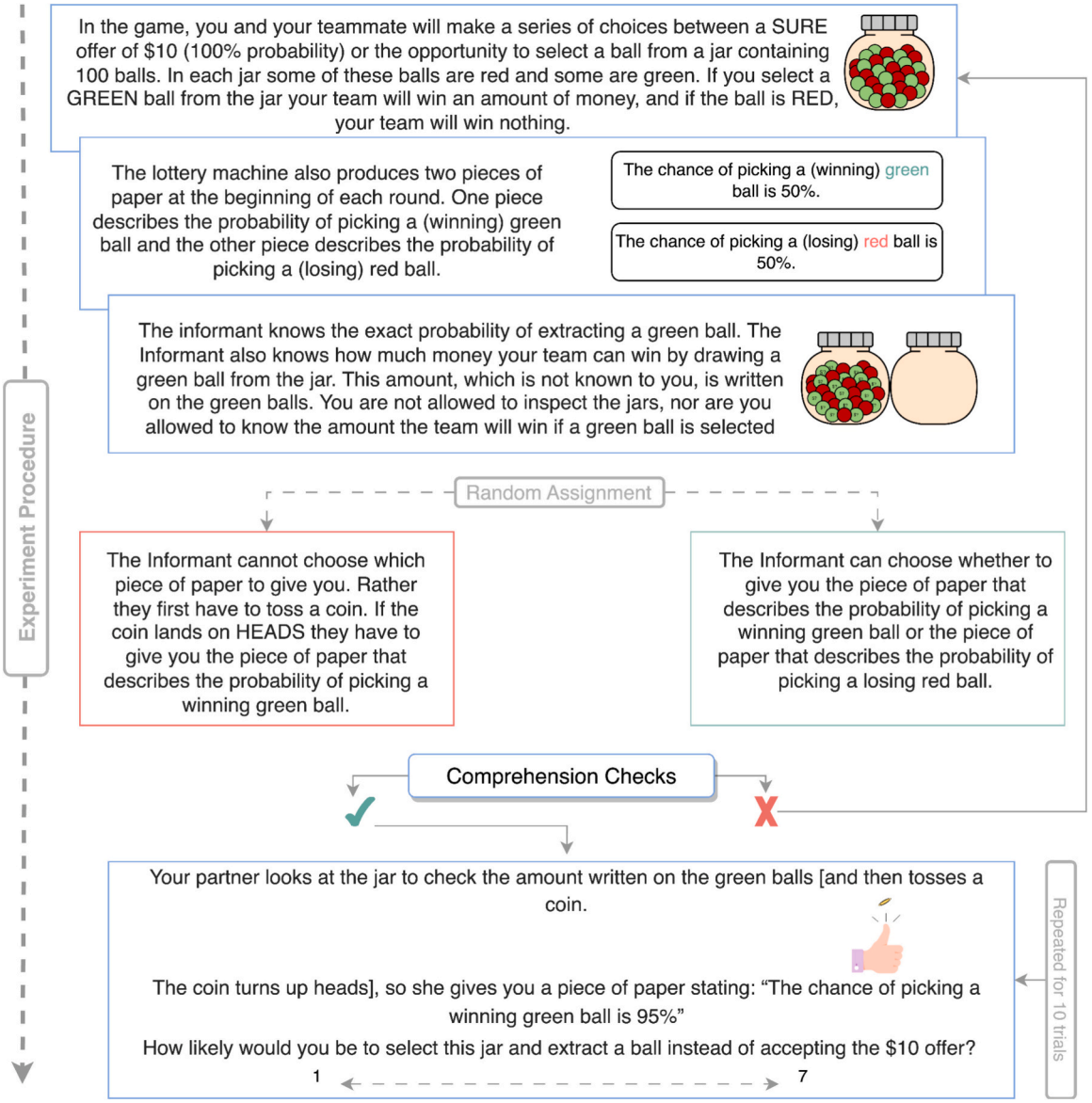

Fig. 2. Summary of procedure and game design for Experiment 1A.

them receiving a specific piece of paper (i.e., "*In one round of the game, you received a piece of paper stating that the chance of picking a winning green ball is 85%. What or who was responsible for you to receive that piece of paper rather than the one that describes the probability of drawing a (losing) red ball? Your partner/The outcome of a coin toss*"). The instructions, comprehension and manipulation check questions, as well as the trials for all experiments in the current study, are available on OSF (https://osf.io/xfrqj/).

5. Results

5.1. Analysis approach

We conducted hierarchical Bayesian ordinal regression analyses with a cumulative family and probit link function, employing weakly-informative priors for all experiments. This approach is recommended for analyzing rating scale data, as it provides several advantages such as

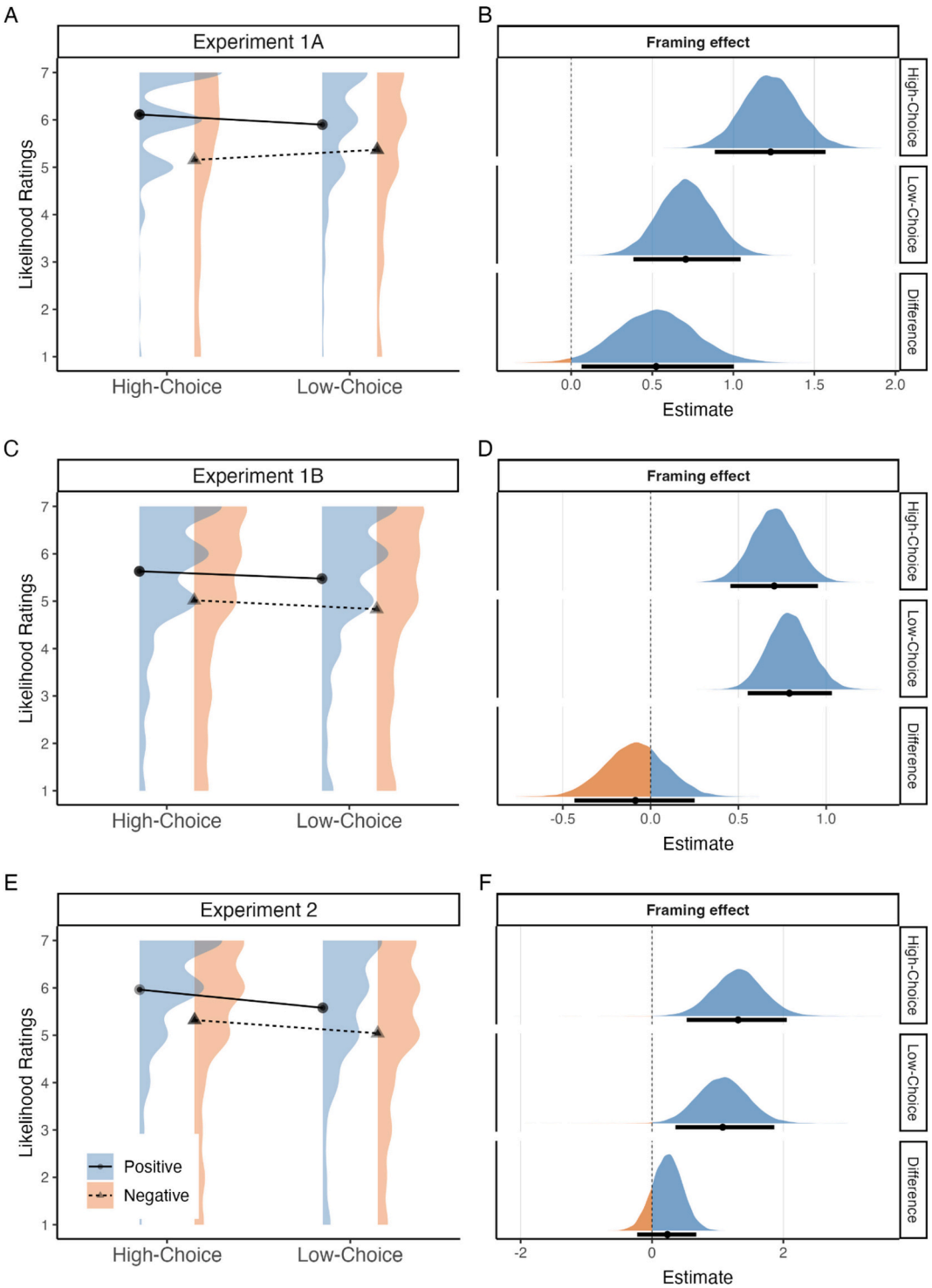

Fig. 3. The plots of the raw data (left column) and posterior draws of the main predictors (right column). Panels A and B display the plots for Experiment 1A, Panels C and D showcase the plots for Experiment 1B, and Panels E and F depict the plots for Experiment 2. The credible intervals shown in the posterior plots represent the 95 % highest density intervals, which provide a measure of uncertainty.

protecting against Type-1 errors and yielding more accurate effect sizes over traditional methods like ANOVA and *t*-test (Bürkner & Vuorre, 2019). By sampling from a joint distribution of prior and likelihood, Bayesian analyses allow us to compute the posterior distribution of parameters. To interpret the results, we used the parameter estimation approach (Kruschke, 2014) by extracting the posterior draws to calculate the estimated marginal means, hereafter referred to as "Estimates," for our predictors (e.g., frame) and the interaction terms (e.g., frame in high vs. low-choice conditions).

To quantify the uncertainty surrounding our estimates, we calculate the 95 % highest density interval (HDI) as the measure of Bayesian credible interval (CI). The HDI represents an interval that captures the most credible values for the parameter, providing a range within which the true value is likely to fall with a certain degree of confidence. The width of the HDI indicates the precision of the effect estimation, with narrower intervals reflecting greater precision. Furthermore, the positioning of the HDI relative to the null value (i.e., zero) provides insight into the credibility of the effect. If the HDI excludes the null value, it indicates a credible effect. Conversely, if the HDI includes the null value, it suggests a non-credible effect. The distance between the lower and upper bounds of the HDI from the null value allows us to move beyond a binary credible-noncredible decision and provides a measure of the relative effect size, with a larger distance indicating greater credibility.

Our Bayesian analyses utilized a hierarchical structure with zero-sum coded fixed-effects, random-effect structures including random intercepts, random slopes, and correlation parameters, which were justified by the design of the study (Barr et al., 2013). In addition to the preregistered Bayesian analyses, we conducted frequentist mixed model analyses. The results revealed similar patterns across both types of analyses. The output of the mixed models, as well as detailed information about the formula specification, prior choices, model outputs, diagnostics, and predictive checks for each Bayesian model can be found in the Supplementary Materials. Throughout this article, confirmatory analyses are those that were pre-registered, whilst non-preregistered analyses are reported in the exploratory analysis section.

5.2. Confirmatory analysis

In panel A of Fig. 3, we present the participants' likelihood ratings for positive and negative frames across the choice conditions. This figure demonstrates the presence of a framing effect, as participants displayed a higher likelihood of taking the gamble when presented with the positive (winning) frame compared to the negative frame. Notably, the framing effect appears to be more pronounced in the high-choice condition than in the low-choice condition.

To ascertain the statistical credibility of the pattern of results described above, we conducted a hierarchical Bayesian ordinal regression with the likelihood rating of selecting the gamble as the dependent variable. The results revealed a credible framing effect. Participants displayed higher likelihood ratings in positive trials ($M_{pos} = 6.00$) compared to negative trials ($M_{neg} = 5.26$), Estimate = 0.97, CI [0.73, 1.21]. There was no credible difference in likelihood ratings between the high-choice ($M_{high} = 5.63$) and low-choice ($M_{low} = 5.63$) conditions, Estimate = 0.09, CI [−0.30, 0.48].

More importantly, as Panel B of Fig. 3 shows, the framing effect is more pronounced in the high-choice condition (Estimate = 1.23, CI [0.89, 1.57]) compared to the low-choice condition (Estimate = 0.71, CI [0.38, 1.04]). The attenuation of the framing effect in the low-choice condition is supported by the credible intervals of the difference distribution, which exclude the null value as a credible value, Estimate = 0.52, CI [0.64, 1.01]. In fact, 98.6 % of the posterior draws of the difference distribution are above the null value. This indicates that the observed difference between the high and low-choice conditions is credible and provides evidence that the framing effect is indeed attenuated in the low-choice condition.

5.3. Exploratory analysis

We examined the responses to the manipulation check questions. The results of the first manipulation check question indicated that participants in the high-choice condition rated the Informant as having a greater degree of freedom in selecting frames (i.e., pieces of paper) compared to those in the low-choice condition, $M_{high} = 6.85$, $M_{low} = 2.08$, $t\,(116.25) = 26.71$, $p < .001$. Notably, the difference in perceived freedom was considerably larger in this experiment compared to Harris et al. (2021, Study 2), where a similar question and a 7-point response scale were used ($M_{high} = 4.93$, $M_{low} = 3.47$).

The second manipulation check question aimed to assess participants' understanding of the factor responsible for giving them a specific piece of paper. In the high-choice condition, 96 out of 100 participants (96 %) correctly identified their partner as the factor responsible for their paper selection. In the low-choice condition, 96 out of 103 participants (93 %) correctly identified the outcome of a coin toss as the factor responsible for their paper selection. These high percentages indicate that participants understood the Choice Limitation manipulation.

6. Discussion

The findings from Experiment 1A showed a consistent framing effect. Individuals were more inclined to endorse the gamble when it was presented in a positive frame compared to a negative frame. Crucially, the results showed an attenuation of the framing effect in the low-choice condition. This suggests that individuals adaptively respond to the informational relevance of frame choice, within a Choice Limitation manipulation. These findings contrast with the results of Harris et al. (2021), who did not find reliable evidence for the attenuation of the framing effect in their four experiments. One possible explanation for the inconsistent results is the apparently improved Choice Limitation manipulation (illustrated by the manipulation check), achieved by assigning the frame selection to a random process rather than a mandate from a higher-order organization (as in Harris et al., 2021).

7. Experiment 1B

Experiment 1B was a replication of Experiment 1A with two modifications. First, we preregistered the exclusion of inattentive participants who failed to correctly answer the second manipulation check question regarding the factor responsible for receiving a specific piece of paper. Secondly, we increased the number of trials from 10 to 20.

8. Method

8.1. Participants

A total of 215 participants were recruited from Prolific. As per our preregistered plan, 15 participants who incorrectly answered the second manipulation check question were excluded from the analysis (12 from the low-choice group and 3 from the high-choice group). Therefore, the final sample consisted of 200 participants (*Mean* age = 31.1, *SD* = 11.4), including 132 males, 60 females, 5 non-binary individuals, and 3 participants who either did not provide a response or preferred not to disclose their gender. Each participant received £1.20 as compensation for completing this 8-min experiment.

8.2. Design, materials and procedure

The method was identical to Experiment 1A, apart from increasing the number of trials per participant to 20. The trials consisted of equivalent probability levels for positive (e.g., 69 %, 72 %, 75 %, 78 %, 81 %, 84 %, 87 %, 90 %, 93 %, 96 %) and negative (e.g., 31 %, 28 %, 25 %, 22 %, 19 %, 16 %, 13 %, 10 %, 7 %, 4 %) outcomes.

9. Results

9.1. Confirmatory analyses

Panel C of Fig. 3 reveals an overall framing effect, indicating that participants were more inclined to accept the gamble when presented with a positive frame compared to a negative frame. In contrast to Experiment 1A, the size of the framing effect appears to be similar in both the high and low-choice groups.

The results of a hierarchical Bayesian ordinal regression revealed a credible framing effect, indicating that participants provided higher likelihood ratings for positive frames ($M_{pos} = 5.55$) compared to negative frames ($M_{neg} = 4.92$), Estimate = 0.75, CI [0.57, 0.92]. Importantly, as depicted in Panel D of Fig. 3, the framing effect appears to be of similar magnitude in both the high-choice condition (Estimate = 0.27, CI [0.18, 0.37]) and the low-choice condition (Estimate = 0.30, CI [0.22, 0.39]). This suggests that there is no reliable attenuation of the framing effect in the low-choice condition, as supported by the credible interval of the difference distribution, which includes zero as a credible value, Estimate = −0.09, CI [−0.43, 0.25]. Moreover, only 31 % of the credible values are above the null value of zero. This finding contradicts the results of Experiment 1A and questions individuals' ability to rely adaptably on the communicated frames. Finally, the main effect of choice was not found to be statistically credible, as participants provided similar ratings in both the high-choice ($M_{high} = 5.33$) and low-choice ($M_{low} = 5.15$) conditions, Estimate = 0.23, CI [−0.18, 0.64].

9.2. Exploratory analysis

The results of the first manipulation check question supported the effectiveness of the choice manipulation. Participants in the high-choice condition rated the Informant as having a significantly greater degree of freedom in selecting frames compared to those in the low-choice condition, $M_{high} = 6.7$, $M_{low} = 1.73$, $t(154.79) = 26.45$, $p < .001$. As already mentioned, 3 out of 102 participants in the high-choice group and 12 out of 113 participants in the low-choice group provided incorrect responses to the second manipulation check question and were subsequently excluded from all analyses. However, a comparison between the responses in the full dataset and the excluded dataset for this experiment, as well as all the following ones, demonstrated a similar response pattern (see Supplementary Materials for details).

10. Discussion

A consistent framing effect, whereby positive frames elicited higher likelihood ratings of taking the gamble compared to negative frames, was observed, which was not attenuated in the low-choice condition. The results consequently do not replicate those of Experiment 1A, but are rather in line with those reported in Harris et al. (2021). Overall, the findings of this experiment suggest that individuals are not sensitive to manipulations that remove the informativeness of leaked information from frame selections. Could the increase in trial numbers be causing the inconsistency between Experiments 1A and 1B? If adaptable frame sensitivity needs mental effort, boredom or fatigue from more trials might explain the difference. However, this explanation seems less likely because the length of Experiment 1B was not significantly different from 1A. Also, the experiments that follow in this paper failed to replicate the results of Experiment 1A even with the same trial numbers.

11. Experiment 2

Thus far, we have conducted two experiments, and we have observed the predicted attenuation effect in one of them. Experiment 1B replicated the 'headline' result in Harris et al. (2021) - a failure of the Choice Limitation condition to attenuate framing effects. Harris et al. did report one experiment (of six) in which the framing effect was reduced in the low-choice condition. In that experiment – and in contrast to all other experiments in Harris et al. (2021) – Choice Limitation was manipulated within-subjects. A within-subjects manipulation might render an influence more likely by increasing the salience of such a manipulation. In line with our goal to fully understand participants' sensitivity to manipulations designed to reduce the informational value of frames, Experiment 2 tests a within-subjects manipulation of Choice Limitation. However, in contrast to Harris et al. (2021), the frame variable was manipulated between subjects. As in Experiments 1A and 1B, we predicted that the framing effect would be less pronounced in the low-choice block.

12. Method

12.1. Participants

We recruited 217 participants from Prolific. As per our preregistered plan, 17 participants who failed the attention checks were excluded from the analysis. Consequently, the final sample comprised 200 participants (*Mean* age = 30.8, *SD* = 11.6), consisting of 126 males, 66 females, 7 non-binary individuals, and 1 participant who chose not to disclose their gender. Each participant received £1.20 as compensation for completing this 8-min experiment.

12.2. Design and materials

We employed a 2 (frame: positive vs. negative) by 2 (choice: high vs. low) design for this study. The choice variable was treated as a within-subjects factor and the frame variable was treated as a between-subjects factor. To ensure consistency with Experiment 1A, participants in the positive frame group received trials with probability levels of 75 %, 80 %, 85 %, 90 %, and 95 %, while participants in the negative frame group received trials with probability levels of 25 %, 20 %, 15 %, 10 %, and 5 %.

12.3. Procedure

Participants began the experiment by completing a high-choice block similar to the one in Experiments 1A and 1B. After this block, they were introduced to the low-choice block and informed of a change in the game's rules, in which a coin toss determined which pieces of paper they would receive. After each block, participants were given a 4-question quiz, similar to the one in the previous experiment, to assess their comprehension of the game rules. They were required to answer all of these questions correctly to proceed further in the experiment. Additionally, the two manipulation check questions were presented twice, once at the end of each block. Participants completed a total of 10 trials, with 5 trials in the high-choice block and 5 trials in the low-choice block and were asked to indicate their likelihood of extracting a ball from the jar using a 7-point Likert scale.

13. Results

13.1. Confirmatory analysis

Panel E of Fig. 3 demonstrates the presence of a framing effect, as participants displayed higher likelihood ratings to accept the gamble when presented with positive frames compared to negative frames. This effect appears to be of similar magnitude in both the high and low-choice conditions. The findings from the hierarchical Bayesian ordinal regression analysis further support these interpretations. The analysis revealed a credible framing effect, as participants rated positive frames ($M_{pos} = 5.77$) higher in likelihood compared to negative frames ($M_{neg} = 5.18$), Estimate = 1.19, CI [0.45, 1.89]. Notably, the magnitude of the framing effect was quite similar across both the high-choice condition (Estimate = 1.31, CI [0.53, 2.05]) and the low-choice condition

(Estimate = 1.08, CI [0.36, 1.86]), as shown in Panel F of Fig. 3. This suggests that there is no substantial attenuation in the framing effect in the low-choice condition, which is supported by the credible interval of the difference distribution including zero as a credible value (Estimate = 0.23, CI [−0.23, 0.67]). Moreover, 84.7 % of the credible values are above zero. These findings replicate the results of Experiment 1B and contradict the findings of Experiment 1A. Finally, in contrast to the previous experiments, we observed a credible main effect of choice, Estimate = 0.67, CI [0.44, 0.90]. Participants provided higher likelihood ratings in the high-choice condition ($M_{high} = 5.64$) compared to the low-choice condition ($M_{low} = 5.31$).

13.2. Exploratory analysis

The results of the first manipulation check question revealed a large difference in participants' ratings of the Informant's freedom in selecting frames between the high-choice condition and the low-choice condition, $M_{high} = 6.7$, $M_{low} = 1.4$, t (199) = 49.12, $p < .001$.

14. Discussion

Experiment 2 did not replicate the attenuated framing effect observed in Experiment 1A. Participants exhibited a similarly large framing effect in both the low-choice and high-choice blocks, despite the communicated cues by the Informant being determined by a coin toss rather than the Informants themselves. While this finding contradicts the results of Harris et al.'s (2021) study, where an attenuation of the framing effect was observed in a within-subject design, it is important to note that our experiment differed from Harris et al.'s as we manipulated the frame between subjects (we return to this issue in Experiment 5). In the next experiment, we introduced the Interest Alignment manipulation (cf. Leong, 2020). Additionally, we included a direct replication of Experiment 1A, the only experiment thus far in which we observed an attenuated framing effect using a Choice Limitation manipulation.

14.1. Experiment 3

The Interest Alignment manipulation involved informing participants that the Informant would either be their teammate, with winnings to be split equally between them (the collaborative scenario), or their opponent, with only one of them able to win (the competitive scenario). According to the Information Leakage account, participants engage in social sense-making to interpret the intentions and preferences of the speaker (Leong et al., 2017, 2020; McKenzie et al., 2021), and the misaligned interests may lead them to perceive the Informant's frame selection as either entirely uninformative or as attempts to deceive them through bluffs or double-bluffs. Consequently, participants may be less inclined to rely on the Informant's frames, thus making them less likely to accept the gamble when presented with positive frames compared to negative frames. This could arise for several reasons. Firstly, participants might view the Informant as a competitor, perceiving them as untrustworthy. Consequently, they may disregard the communicated frames, relying instead on their own limited knowledge or assumptions. Alternatively, they might attempt to make use of the untrustworthy information provided by the Informant while attempting to unpick the Informant's intentions. In other words, receiving a positively framed piece of paper from the Informant may lead participants to believe that the gamble has a lower expected value than the sure offer, but the Informant used a positive frame to persuade them to choose it. In any of these cases, sensitivity to the informational value of communication from a competitor would necessitate a non-positive framing effect in the competitive scenario, leading to an attenuated framing effect relative to a collaborative scenario.

If participants are sensitive to the Interest Alignment manipulation, it is expected to affect the framing effect in the high-choice condition but not in the low-choice condition. The social sense-making process, including the interpretation of the communicated information and the Informant's preferences and intentions, becomes relevant when the Informant has the freedom to choose the frames (Harris et al., 2021; Krijnen et al., 2017; McKenzie et al., 2018). However, when the frames are determined by the outcome of a coin toss, the alignment of interests between the players becomes irrelevant. Thus, whether the Informant is a teammate or an opponent does not impact the framing effect in the low-choice condition.

The main goal of this experiment is to investigate the effects of both the Choice Limitation and Interest Alignment manipulations on the framing effect within the same experimental paradigm. In addition, the collaborative block of this experiment precisely replicated Experiment 1A. Given the lack of replication in the subsequent experiments with slight variations from Experiment 1A, this experiment determines if the attenuation effect could be replicated under identical conditions.

15. Method

15.1. Participants

We initially recruited 212 participants from Prolific for this experiment. However, following our preregistration, we excluded 11 participants who failed to correctly answer the second manipulation check question (9 from the low-choice group and 2 from the high-choice group). As a result, the final sample included 201 participants (mean age = 34.9, SD = 11.8), consisting of 131 males, 64 females, 4 non-binary individuals, and 2 participants who preferred not to disclose their gender. Each participant received £1.80 as compensation for completing this 12-min experiment.

15.2. Design and materials

We used a 2 (frame: positive vs. negative) by 2 (choice: high vs. low) by 2 (scenario: collaborative vs. competitive) design. Both frame and scenario were manipulated within subjects, with the collaborative scenario always preceding the competitive scenario. The choice variable was treated as a between-subjects factor.

15.3. Procedure

Participants were randomly assigned to either the high-choice or low-choice group at the beginning of the experiment. As in the previous experiments, participants were informed that the Informant had the freedom to choose a piece of paper in the high-choice condition or had to toss a coin to determine which piece of paper to select in the low-choice condition (see Fig. 1).

After completing the collaborative block, participants proceeded to the competitive scenario. In this block, they were informed that they would play the game for an additional 10 rounds, but with a key change to the game rules. Participants were explicitly told that in these rounds, either they or the Informant (now referred to as the opponent) would win the earnings, but not both. After correctly solving 4 new comprehension check questions specific to the competitive scenario, participants were presented with the same 10 trials as in the collaborative block, but with the phrase “The Informant” replaced with “Your opponent.” No manipulation check questions were presented at the end of this block.

16. Results

16.1. Confirmatory analyses

Panel A of Fig. 4 reveals a clear framing effect, indicating that participants were more inclined to take the gamble when presented with positive frames compared to negative frames. Additionally, participants demonstrated a reduced willingness to take the gamble in the

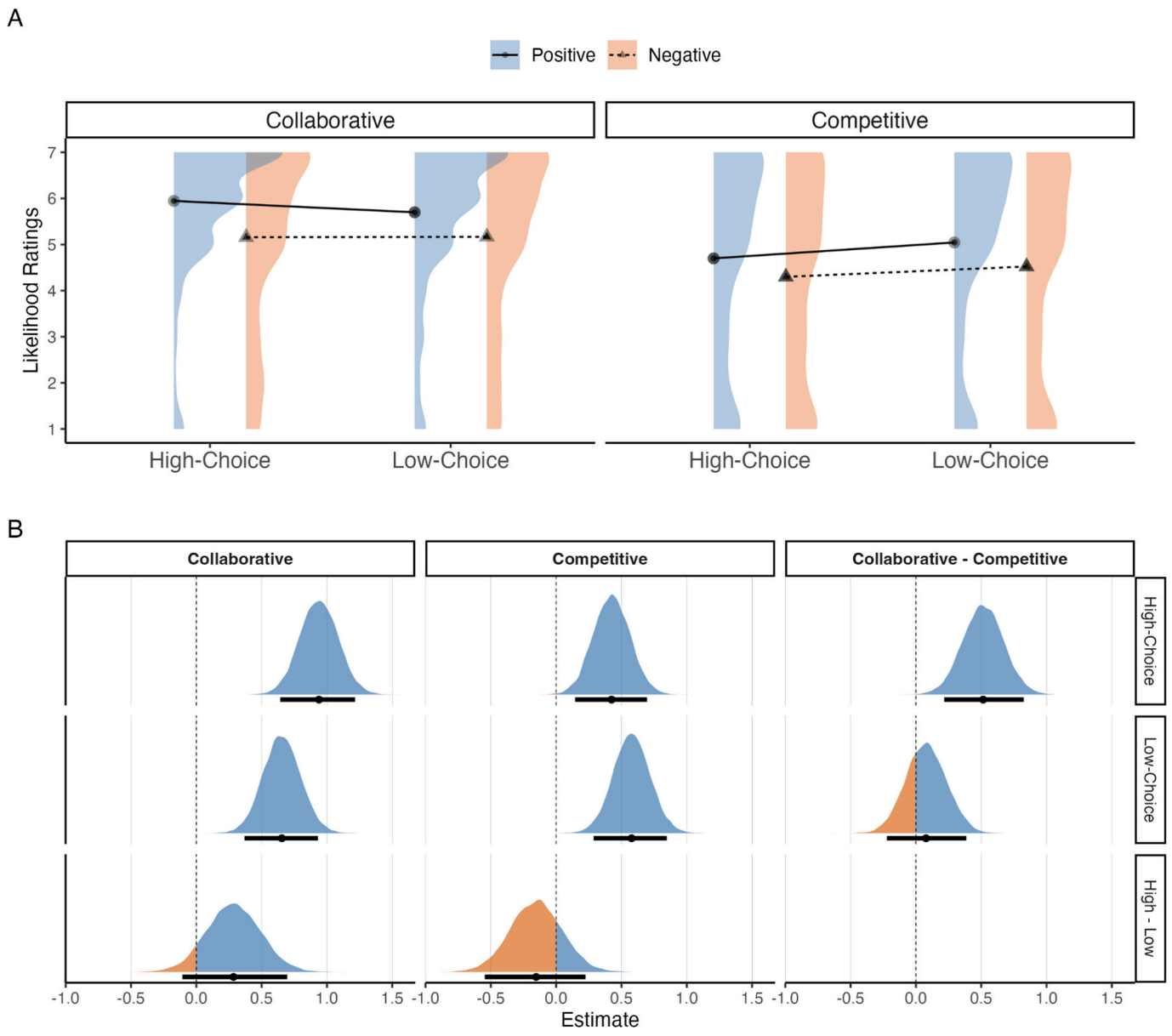

Fig. 4. The plots of the raw data (Panel A) and posterior draws of the framing effects across conditions (Panel B) of Experiment 3. The credible intervals shown in the posterior plots represent the 95 % highest density intervals, which provide a measure of uncertainty.

competitive scenario compared to the collaborative scenario. In the collaborative scenario, which replicates Experiment 1A, a slight reduction in the framing effect was observed in the low-choice condition. However, as we will demonstrate later, this attenuation was not found to be credible. Consequently, it appears that the Choice Limitation manipulation was ineffective in diminishing the framing effect within the low-choice group. Conversely, the Interest Alignment manipulation appeared to be effective. The framing effect was notably reduced in the high-choice condition of the competitive scenario. The attenuation of the framing effect in this condition, compared to the high-choice condition of the collaborative scenario, suggests that when Informants have the autonomy to select the frames and possess interests that are misaligned with the participants, individuals are less influenced by the simple framing of choices. This finding contrasts with situations where participants share a common interest with the Informant, highlighting the role of interest alignment in shaping the impact of framing on decision-making.

The results of a hierarchical Bayesian ordinal regression analysis supported these observations. The findings showed a credible framing effect, Estimate = 0.65, CI [0.48, 0.82]. Participants were more likely to accept the gamble when they were presented with positive frames (M_{pos} = 5.35) compared to negative ones (M_{neg} = 4.79).

To investigate the impact of the Choice Limitation manipulation, we focused on the collaborative scenario. As depicted in Panel B in Fig. 4 (the leftmost column), the observed attenuation in the framing effect in the low-choice group (Estimate = 0.66, CI [0.37, 0.93]) compared to the high-choice group (Estimate = 0.94, CI [0.64, 1.22]) is not statistically credible, Estimate = 0.28, CI [−0.11, 0.70]. The 95 % credible interval of the difference distribution (i.e., High - Low) includes zero as a credible value, and only 91.9 % of these credible values are above zero. These findings suggest that limiting the choice of frames did not effectively reduce the framing effect, once again failing to replicate the effect observed in Experiment 1A.

Next, we examined the impact of interest alignment by comparing the competitive and collaborative scenarios. This comparison is specifically applied to the high-choice cases, where the Informant has the freedom to choose the frames, and the [mis]aligned interests between the players becomes relevant. As illustrated in Panel B of Fig. 4 (the

topmost row), the framing effect is attenuated in the competitive scenario (Estimate = 0.42, CI [0.15, 0.70]) compared to the collaborative scenario (Estimate = 0.94, CI [0.64, 1.21]), and this attenuation is statistically credible (Estimate = 0.52, CI [0.22, 0.83]). The 95 % credible interval of the difference distribution (i.e., Collaborative - Competitive) includes zero as a credible value, with 99.9 % of the credible values being above zero. These findings indicate that manipulating the interests between the players is effective in reducing the magnitude of the framing effect. In contrast, in the low-choice condition, where the frame is determined by the outcome of a coin toss, the [mis]aligned interests of the players do not have a significant impact. The second row of the figure demonstrates that the framing effect in the low-choice group had similar magnitudes in both the competitive scenario (Estimate = 0.58, CI [0.29, 0.85]) and the collaborative scenario (Estimate = 0.66, CI [0.37, 0.93]), Estimate = 0.08, CI [−0.22, 0.39], with only 68.6 % of the credible values being above zero.

Finally, participants overall displayed a higher likelihood of accepting the gamble in the collaborative scenario (M_{collab} = 5.49) compared to the competitive scenario (M_{compt} = 4.64), Estimate = 1.11, CI [0.82, 1.38]. However, the preference for the gamble was found to be similar between the high-choice group (M_{high} = 5.03) and the low-choice group (M_{low} = 5.11), Estimate = −0.04, CI [−0.68, 0.60].

16.2. Exploratory analysis

Participants in the high-choice condition rated the Informant's freedom in selecting frames much higher than those in the low-choice condition, $M_{high} = 6.7$, $M_{low} = 1.6$, t (156.17) = 30.93, $p < .001$.

17. Discussion

The results of Experiment 3 revealed that the Choice Limitation manipulation, where the selection of frames was assigned to a random process, did not result in an attenuation of the framing effect. This failure to replicate the findings of Experiment 1A is consistent with the results of Experiments 1B and 2, as well as the Harris et al.'s (2021) study (leading us to suspect that the result of Experiment 1A to be a false positive). In contrast, the Interest Alignment manipulation yielded a reduction in the framing effect. When the frame selection is controlled by a speaker in competition with the listener, the diagnostic value of the leaked information is diminished. In our experiment, this led to a smaller framing effect in participants' preferences. This finding aligns with the results of Leong (2020), indicating that decision-makers exhibit sensitivity to different levels of informational value conveyed in frame selections by speakers with aligned and misaligned interests.

A limitation of Experiment 3 is that participants could simply indicate a low willingness to take the gamble and opt for the guaranteed offer in every trial. In this case, they would win $10 while the Informant would receive nothing. This undermines the necessity to interpret the intention behind the communicated information. To address this limitation, and directly improve on the design of Experiment 3, Experiment 4 replicated the basic structure of Experiment 3 but implemented a more effective Interest Alignment manipulation.

18. Experiment 4

In Experiment 4, participants were informed that the Informant would get to play the option the participant did not choose. We expect that such modification will increase the competitive nature of the game and, hence, further attenuate the framing effect due to the misaligned interests between the players. In all other aspects, this experiment closely resembled Experiment 3.

19. Method

19.1. Participants

A total of 221 participants were recruited from Prolific. However, following our preregistration, 14 participants who failed our attention checks were excluded from the analysis (9 from the low-choice group and 5 from the high-choice group). Consequently, the final sample included 207 participants (*Mean* age = 32.4, *SD* = 11.1), comprising 116 males, 87 females, and 4 non-binary individuals. Each participant received £1.50 as compensation for completing this 10-min experiment.

19.2. Design, materials, and procedure

This experiment had the same design, and a similar procedure, to Experiment 3. The only difference was that the Misaligned interests scenario was made more competitive. Specifically, after the Aligned interests, participants were presented with the following instructions: "… *in the following rounds, the Informant is your opponent rather than your partner. The Informant gets to play whatever option you do not choose. For example, if you decide to take the sure offer of $10, the Informant will be given the opportunity to draw a ball from the jar. Conversely, if you decide to draw a ball from the jar, the Informant will be given the sure offer of $10. The goal of the Informant is to maximize their winnings while playing against you.*"

20. Results

20.1. Confirmatory analysis

Similar to Experiment 3, the data, shown in Panel A of Fig. 5, indicate higher likelihood ratings for the positive frames compared to the negative frames, suggesting an overall framing effect. Participants also exhibited lower likelihood ratings in the competitive scenario compared to the collaborative scenario. Importantly, the framing effect appears to be attenuated in the high-choice condition of the competitive scenario compared to the high-choice condition of the collaborative scenario, indicating the effectiveness of the Interest Alignment manipulation. However, the Choice Limitation manipulation did not appear to attenuate the framing effect in the low-choice conditions compared to the high-choice conditions.

The results of a hierarchical Bayesian ordinal regression analysis revealed a credible framing effect. Participants exhibited higher likelihood ratings for positive frames (M_{high} = 5.45) compared to negative frames (M_{low} = 4.95), Estimate = 0.63, CI: [0.47, 0.75].

Next, we examined the impact of the Interest Alignment manipulation by comparing the size of the framing effect across the collaborative and competitive scenarios, as depicted in Panel B of Fig. 5. In the high-choice group (topmost row of the figure), where alignment of interests is relevant, a credible attenuation of the framing effect is observed in the competitive scenario (Estimate = 0.10, CI [−0.16, 0.33]), compared to the collaborative scenario (Estimate = 0.72, CI [0.51, 0.92]). In fact, the framing effect in the competitive scenario is not merely reduced, but completely eliminated. The 95 % credible interval of the difference distribution (i.e., Collaborative - Competitive) excludes zero as a credible value, providing evidence for a credible difference in the framing effect between the two scenarios, Estimate = 0.62, CI [0.38, 0.87], with 100 % of the credible values being above zero. In contrast, for the low-choice group (middle row), the size of the framing effect does not appear to differ credibly between the collaborative scenario (Estimate = 0.87, CI [0.65, 1.09]) and the competitive scenario (Estimate = 0.76, CI [0.51, 1.01]), Estimate = 0.12, CI [−0.15, 0.37]. In the low-choice group, where the frame selection is determined by a coin toss, the alignment of interests between the players does not have a credible impact on the framing effect. Overall, the results provided support for the Information Leakage hypothesis, as the Interest Alignment manipulation effectively

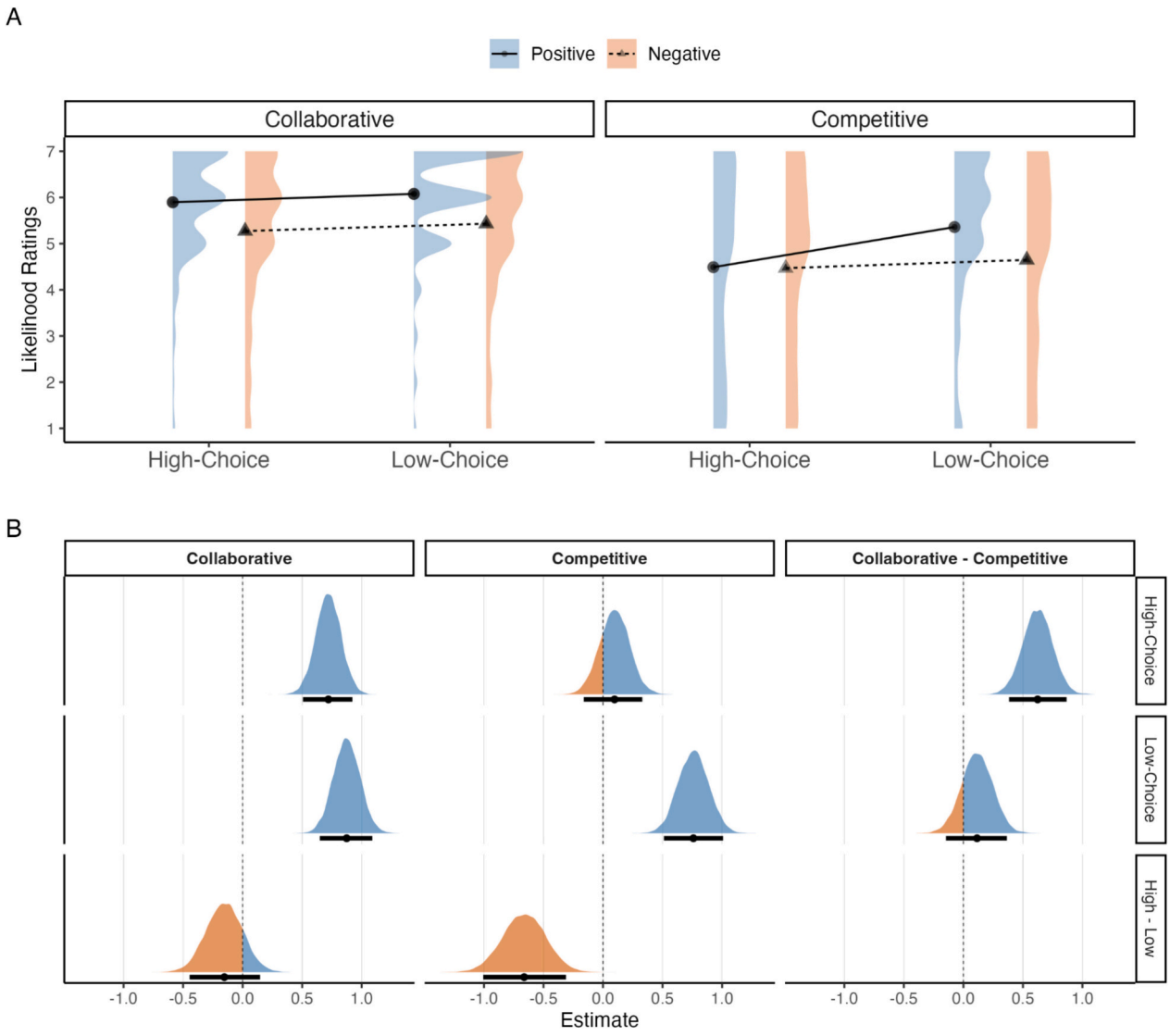

Fig. 5. The plots of the raw data (Panel A) and posterior draws of the framing effects across conditions (Panel B) of Experiment 4. The credible intervals shown in the posterior plots represent the 95 % highest density intervals, which provide a measure of uncertainty.

attenuated the framing effect.

To investigate the impact of choice limitation on the framing effect, we examined the responses in the collaborative scenario. Panel B of Fig. 5 (the leftmost column) reveals that the framing effect is not credibly different between the high-choice group (Estimate = 0.72, CI [0.51, 0.92]) and the low-choice group (Estimate = 0.87, CI [0.65, 1.09]). The credible interval of the difference distribution includes zero as a credible value (Estimate = −0.15, CI [0.45, 0.15]), with only 16 % of the credible values being above zero. These findings suggest that the Choice Limitation manipulation did not have a substantial impact on the magnitude of the framing effect in the collaborative scenario.

Finally, participants displayed a higher likelihood of accepting the gamble in the collaborative scenario (M_{collab} = 5.67) compared to the competitive scenario (M_{compt} = 4.73), Estimate = 1.01, CI [0.77, 1.25]. However, their likelihood ratings in the low-choice group (M_{low} = 5.38) and the high-choice group (M_{high} = 5.03) were not credibly different, Estimate = −0.40, CI [−0.89, 0.04].

20.2. Exploratory analysis

Participants reported a higher perception of freedom for the Informant to select the frames in the high-choice group compared to the low-choice group, M_{high} = 6.6, M_{low} = 1.9, t (145.33) = 24.91, $p < .001$.

21. Discussion

The findings of this experiment align with those of Experiment 3. The Choice Limitation manipulation, which aimed to remove the usefulness of the communicated information, failed to attenuate the framing effect. Participants in the low-choice conditions were still influenced by the framing of the options, showing a greater willingness to accept the gamble when presented with a positive frame compared to a negative frame. This finding aligns with the results of previous experiments in this study, all but one of which employed a between-subject design, as well as with the between-subject experiments conducted by Harris et al. (2021).

In contrast, the Interest Alignment manipulation had a substantial impact on the framing effect in the competitive scenario, where the Informant had a misaligned interest with the Selector and had the freedom to select the frames (i.e., the high-choice condition). In this scenario, the framing effect was not only reduced but completely eliminated. This attenuation of the framing effect was even more pronounced than in Experiment 3. It suggests that the alignment of interests between the players is crucial for determining the influence of framing.

22. Experiment 5

Thus far, we have found evidence supporting individuals' adaptability in relying on the frames through the Interest Alignment manipulation. However, such supportive evidence was exclusively observed when the interest manipulation was implemented within-subject with a collaborative scenario followed by a competitive scenario (including in Leong, 2020). A question remains whether the Interest Alignment manipulation is robust enough to remain effective in a between-subject design. In this experiment, we manipulate scenarios between subjects by assigning participants to either a collaborative or a competitive scenario to address this question.

The Choice Limitation manipulation, on the other hand, has mostly failed to provide support for such an adaptability. The lack of an impact of choice limitation on the framing effect was observed even in Experiment 2, which employed a within-subject choice manipulation. This finding contradicts the results of Harris et al.'s (2021) fourth experiment, where an attenuation of the framing effect was observed in a within-subject design. However, it is noteworthy that Experiment 2 deviated from Harris et al.'s (2021) experiment by manipulating frame between subjects. In Experiment 5, we manipulated both choice and frame within-subjects, to increase the saliency of the choice even further and to test the replicability of Harris et al.'s (2021) results using a more similar design (See the supplementary for details of a further aim of Experiment 5 for which we failed to find a conclusive answer).

23. Method

23.1. Participants

We recruited 215 participants from Prolific. However, in accordance with our preregistration, we excluded 15 participants who did not pass our attention checks. As a result, the final sample consisted of 200 participants (Mean age = 35.7, SD = 13.6), including 113 males, 80 females, and 5 individuals who identified as non-binary. Each participant received £1.65 as compensation for completing this 10-min experiment.

23.2. Design, materials, and procedure

In this experiment, the scenario was manipulated between-subjects, while choice and frame were manipulated within-subjects. Participants were randomly assigned to either a collaborative scenario or a competitive scenario. Irrespective of their scenario group, participants were presented with the high-choice block followed by the low-choice block.

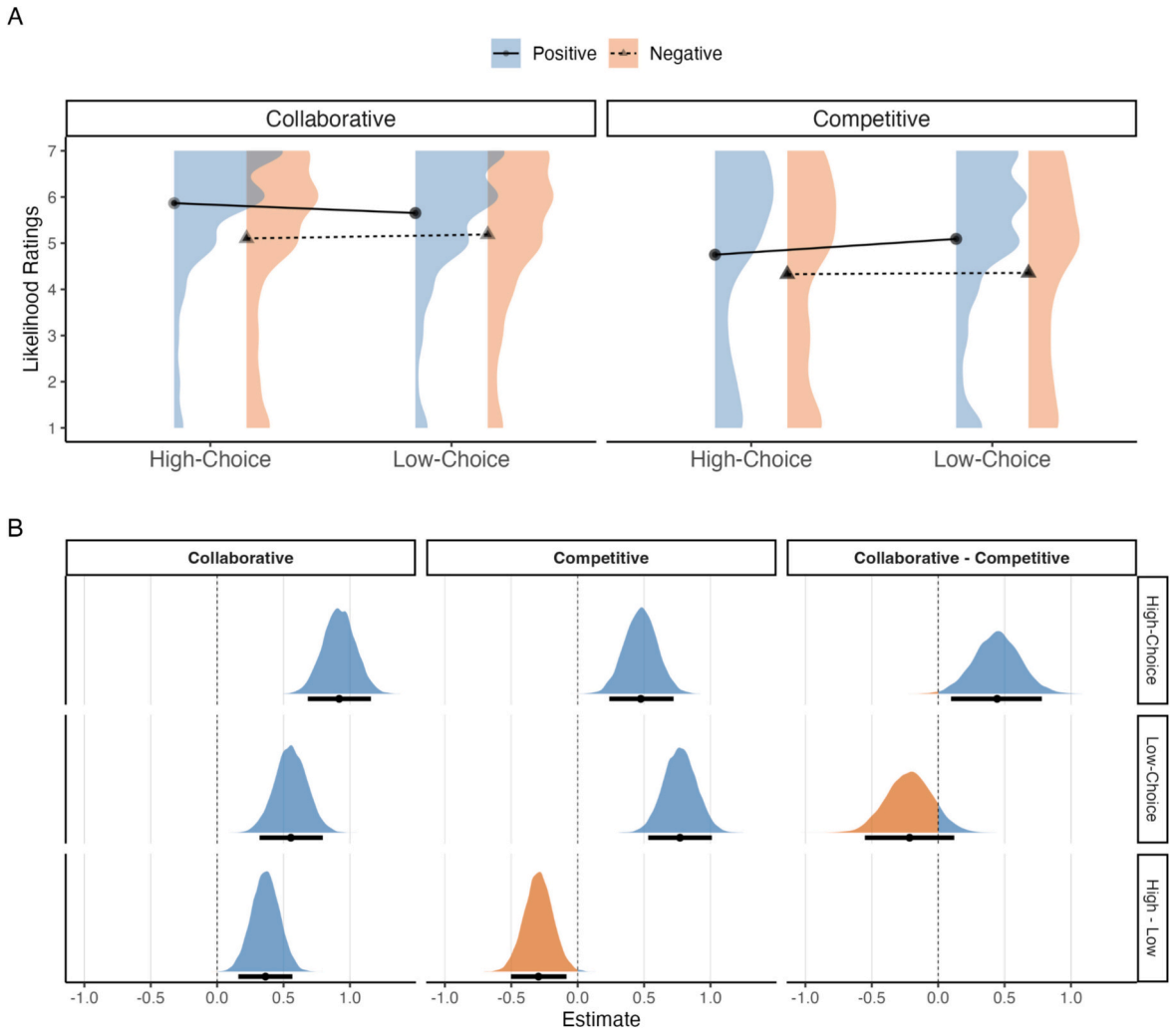

Fig. 6. The plots of the raw data (Panel A) and posterior draws of the framing effects across conditions (Panel B) of Experiment 5. The credible intervals shown in the posterior plots represent the 95 % highest density intervals, which provide a measure of uncertainty.

24. Results

24.1. Confirmatory analyses

Panel A of Fig. 6 shows an overall framing effect; however, this effect is attenuated in the high-choice condition of the competitive scenario compared to the collaborative scenario, indicating the effectiveness of the Interest Alignment manipulation. Furthermore, the attenuation in the framing effect in the low-choice condition compared to the high-choice condition of the collaborative scenario suggests the effectiveness of the Choice Limitation manipulation.

The results of a hierarchical Bayesian ordinal regression analysis revealed a credible framing effect. Participants had higher likelihood ratings for positive frames ($M_{high} = 5.36$) than negative frames ($M_{low} = 4.76$), Estimate = 0.68, CI: [0.53, 0.84]. Moreover, a greater likelihood of accepting the gamble in the collaborative scenario ($M_{collab} = 5.45$) compared to the competitive scenario ($M_{compt} = 4.63$) was found, Estimate = 0.95, CI [0.49, 1.42]. The likelihood ratings in the low-choice group ($M_{low} = 5.09$) and the high-choice group ($M_{high} = 5.03$) were not credibly different, Estimate = 0.006, CI [−0.31, 0.36].

The comparison of the magnitude of the framing effect in the high-choice conditions of the collaborative and competitive scenarios provides a test for the Interest Alignment manipulation (refer to Panel B of Fig. 5, the top row). The results revealed a smaller framing effect in the competitive scenario (Estimate = 0.48, CI [0.24, 0.72]) compared to the collaborative scenario (Estimate = 0.92, CI [0.68, 1.16]). The 95 % credible interval of the difference distribution (i.e., Collaborative - Competitive) excludes zero as a credible value, demonstrating a significant difference in the framing effect between the two scenarios (Estimate = 0.44, CI [0.10, 0.78]), with 99 % of the credible values being above zero. In contrast, in the low-choice condition, the alignment of interests between the players does not seem to have an impact on the framing effect, as the size of the framing effect does not credibly differ between the collaborative scenario (Estimate = 0.56, CI [0.32, 0.80]) and the competitive scenario (Estimate = 0.77, CI [0.53, 1.01]), Estimate = 0.22, CI [−0.55, 0.12]. Overall, the results demonstrated the effective attenuation of the framing effect through the Interest Alignment manipulation.

To investigate the impact of choice limitation, we compared the magnitude of the framing effect within the collaborative scenario. Panel B of Fig. 5 (the leftmost column) illustrates a credible difference in the framing effect between the high-choice group (Estimate = 0.92, CI [0.68, 1.16]) and the low-choice group (Estimate = 0.56, CI [0.32, 0.80]). The credible interval of the difference distribution excludes zero as a credible value (Estimate = 0.36, CI [0.16, 0.57]), with 100 % of the credible values being above zero. These results indicate that the Choice Limitation manipulation had a substantial impact on the magnitude of the framing effect within the collaborative scenario.

24.2. Exploratory analysis

In line with all the experiments conducted in the current study, participants consistently reported a substantially higher perception of freedom for the Informant in the high-choice group compared to the low-choice group, $M_{high} = 6.4$, $M_{low} = 1.6$, $t\,(199) = 32.68$, $p < .001$.

24.3. Comparing manipulations

Fig. 7 summarizes the results across all experiments regarding the framing effect and the attenuation effects resulting from the Choice Limitation and Interest Alignment manipulations, as extracted from each study's model. Across all experiments, credible framing effects were observed. The Choice Limitation manipulation was found to be credible in Experiments 5, where we manipulated choice within subjects, and Experiment 1A, indicating a smaller framing effect in the low-choice condition compared to the high-choice condition. Conversely, the Interest Alignment manipulation showed credibility in all experiments where it was applied, signifying a credible attenuation of the framing effect in competitive scenarios compared to collaborative ones. Although the estimated parameters for the interest alignment effect appeared larger in Experiment 4, they considerably overlapped with the Choice Limitation effect in Experiments 3 and 5. Hence, the key question is whether these two manipulations are notably distinct in their ability to attenuate the framing effect?

To answer this question, we compare the Choice Limitation and Interest Alignment manipulations in the last three experiments. Specifically, we compared the high vs. low conditions in the collaborative scenario for the Choice Limitation manipulation and the collaborative vs. competitive conditions in the high-choice scenario for the Interest Alignment manipulation.

Fig. 8 demonstrates that the Interest Alignment manipulations tend to be more effective, as indicated by their distributions being consistently farther away from the null value, compared to the distributions associated with Choice Limitation manipulations. However, it is worth noting that the attenuation effects resulting from these manipulations are credibly different only in Experiment 4. Additionally, in Experiment 5, the within-subject manipulation of choice increased the effectiveness of the Choice Limitation manipulation, while the between-subject manipulation of scenario reduced the effectiveness of the Interest Alignment manipulation. As a result, the attenuation distributions from these manipulations overlapped considerably. It is important to note that the relative magnitudes of the effect sizes for these manipulations in this experiment are specific to this context, and future experiments with stronger or weaker Choice Limitation and Interest Alignment

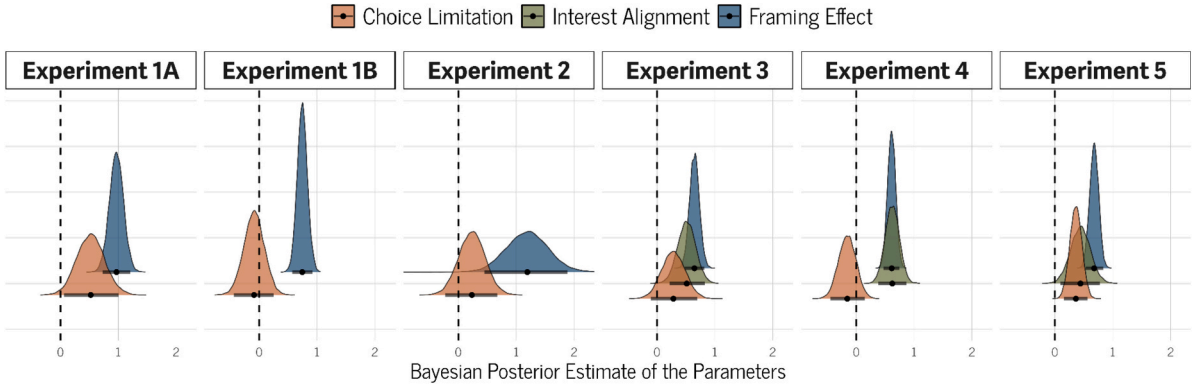

Fig. 7. The Bayesian posterior estimate of the framing, choice limitation, and interest alignment effects across all experiments. The framing effect is the main effect, while the choice limitation and interest alignment effects are interaction effects (manipulation of choice limitation or interest alignment by framing interaction) across all experiments. The credible intervals displayed in the posterior plots represent the 95 % highest density intervals.

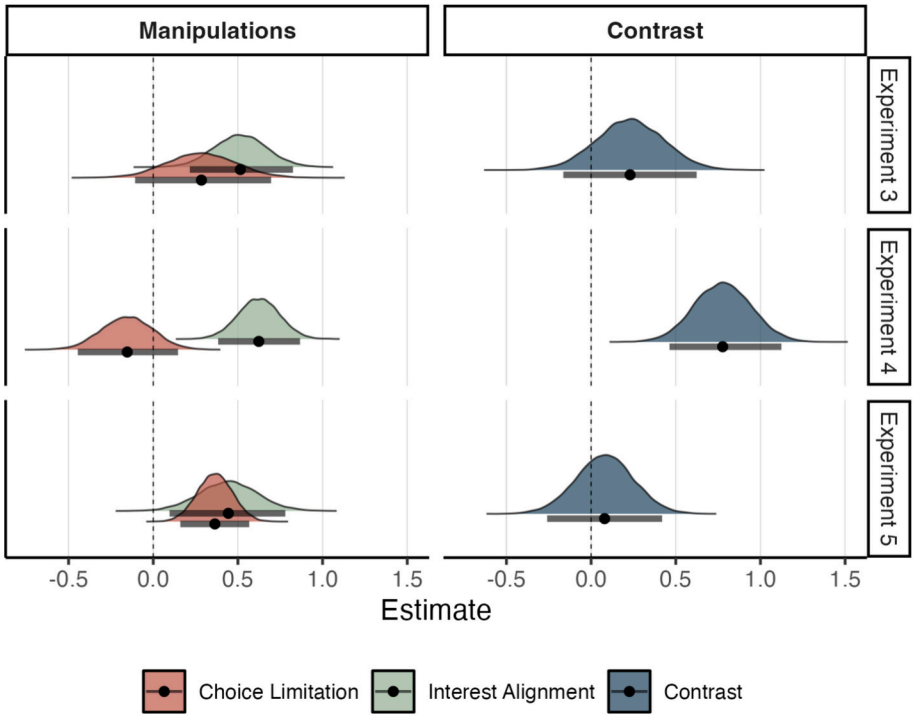

Fig. 8. The magnitude of the attenuation effect (i.e., the difference in distributions) resulting from each manipulation and their contrasts for Experiments 3, 4, and 5. The credible intervals displayed in the posterior plots represent the 95 % highest density intervals.

manipulations might yield a different pattern of results.

25. Discussion

The results of Experiment 5 demonstrated an overall framing effect, and this effect was effectively attenuated through the Interest Alignment manipulation. However, the magnitude of the attenuation effect was smaller compared to the previous experiments, potentially related to the reduced transparency and saliency of the between-subject manipulation (Greenwald, 1976; Kahneman & Frederick, 2005).

Interestingly, the framing effect was also effectively attenuated by the Choice Limitation manipulation in this experiment. While the previous within-subject manipulation of choice in Experiment 2 did not produce a similar attenuation effect, in Experiment 5 both choice *and* frame were manipulated within-subjects. These are the same conditions under which Harris et al. (2021) observed an attenuation of framing with a Choice Limitation manipulation (notably, the only two times - to our knowledge - that both Choice and Frame have been manipulated within-subjects, the framing effect has been attenuated by the Choice Limitation manipulation).

Finally, the results indicated that, in the competitive scenario, individuals may have dismissed information provided by the untrustworthy Informant, leading to a reduction in the framing effect. This aligns with studies demonstrating a diminished impact of frames on judgment when conveyed by a less trustworthy speaker (Druckman, 2001a, 2001b; Juanchich et al., 2023; Keren, 2007). However, it is plausible that participants interpreted the Informant's frames as part of a double-bluff strategy and made choices accordingly. Our findings do not conclusively support either explanation, suggesting a need for further exploration into participants' perceptions of untrustworthy frames in future studies.

26. General discussion

Debates about the rationality of framing effects endure in the literature (Bermúdez, 2022; Chater, 2022; Ghasemi, 2024; Krijnen et al., 2017; Mandel, 2014; McKenzie, 2004; Sher & McKenzie, 2006, 2022; Tversky & Kahneman, 1981, 1988). Here we examined implications of one account of framing: Information Leakage – the idea that people rationally derive inferences from the choice of framing (McKenzie et al., 2018; Sher & McKenzie, 2006). Across our six experiments, we examined the degree of this rationality and found that framing effects could be attenuated where attenuation was rationally appropriate, but the conditions under which this occurred were rather specific.

The key patterns in our data were that: 1) framing effects were reliably – and appropriately - affected when the alignment of interests between parties was manipulated, and 2) framing effects were not consistently attenuated by the removal of agency from the speaker. These findings echo those of Leong (2020) and Harris et al. (2021), and build on those studies by detailing the operation of these effects within a single experimental task that provides a more robust manipulation of choice limitation.

Why does interest-alignment more reliably attenuate the difference between positively and negatively framed information than choice limitation? One possibility is that the competitive vs. collaborative nature of everyday interactions is something to which we are highly-attuned, whereas the nature of choice-limitation is less intuitive. Several aspects of our data speak to this possibility. First, the Choice Limitation manipulation only reliably (assuming a false-positive in Experiment 10A) attenuated the framing effect when participants saw both versions (high- and low-choice) alongside both versions of the attribute frame (positive and negative) – that is, in a within-subjects design (Experiment 5). This finding, along with the similar pattern seen in Harris et al. (2021) strongly suggests that sensitivity to agency only arises when its manipulation is prominent (for a discussion of the expectations for observing 'biases' in within vs. between subject designs see Greenwald, 1976, and Tversky & Kahneman, 1988; for an interpretation of this pattern in terms of a 'causal field' explanation see Hogarth, 2014, and Newell & Shanks, 2023). Second, we find a positive correlation between the ratings of the perceived freedom to choose held by the Informant and the magnitude of the framing effect (Pearson's $r = 0.25$, $p < .001$, 95 % CI [0.16, 0.33]). The less freedom participants

perceived the Informant to have, the smaller their framing effect (see Fig. S13 and Table S13 in the supplementary materials for further details). In other words, participants who inferred the experimenter-intended impact of choice limitation on frame were more likely to show a reduced framing effect.

With regard to the impact (and potential familiarity) of competitiveness, our findings are consistent with findings indicating attenuated framing effects from less trustworthy sources. For instance, Druckman (2001a) demonstrated that individuals were more affected by the framing effect when the source was credible (e.g., New York Times) than non-credible (e.g., National Enquirer). Similarly, Keren (2007) found an attenuated framing effect in situations where one or both speakers were untrustworthy compared to conditions where both were trustworthy. We can also readily come up with everyday instances where framing is used to make messages more palatable when interests maybe non-aligned, such as the politician who frames their party's policy (e.g., a 2 % reduction in unemployment when the target was 4 %) in terms of success (e.g., achieving a 2 % reduction) rather than failure (e.g., failing to reach the target by 2 %), and vice versa for an unfavorable policy.

Simple examples of choice limitation are perhaps harder to come by. We, along with Leong (2020), employed a random device (coin flip) to remove agency from the speaker. Harris et al. (2021) used an arguably more naturalistic method in which participants were informed that speakers (risk communicators) were mandated by an organization to convey information using either a positive or negative frame. Although our manipulation appeared to be more transparent (see data on manipulation checks in all experiments), the overall impact of the choice limitation manipulation was similarly underwhelming in all of these studies. This consistent insensitivity suggests an account in line with the "leaky" information leakage proposed by Harris et al. (2021). The basic proposition being that individuals tend to over-rely on leaked information regardless of its informativeness because it is usually adaptive to do so. In our experiments, it was only when attention was piqued by the presence of nefarious other actors that this leaky leakage abated. In many ways this account echoes long standing views of individuals as boundedly-rational decision-makers (Simon, 1956) who show sensitivity to the informativeness of frames, but only when disruptions to that informativeness are made particularly salient.

We chose to focus on the informational non-equivalence of frames as an explanation for why framing effects might occur. But, as befits a robust and enduring phenomenon like framing, there are other accounts that do not rely on the notion of informational leakage across frames. As noted in the introduction, some accounts maintain that framing effects are non-rational, attributing them to the evocation of positive associations through positive frames (Levin, 1987; Levin et al., 1998), or directing attention to a specific attribute of an option simply by highlighting it and consequently down-weighting its complement even when there is no perceived intentionality behind the direction (e.g., the chance of winning a gamble; Kreiner & Gamliel, 2018). We cannot rule out that these additional mechanisms may have played a role in the persistence of framing effects across our experiments.

Turning to other rational treatments, Mandel (2001, 2014, for a review see Fisher & Mandel, 2021) has shown that many framing manipulations are not even *logically* equivalent. These studies have shown that seemingly equivalent frames like "200 out of 600 people will be saved" vs. "400 out of 600 people will die" are often interpreted as implying at least 200 people will be saved and at least 400 people will die. Such a lower-bound interpretation might also apply to probabilities ("at least an 85% chance of winning"), in which case the loss ('at least 15% chance of losing') and gain ('at least 85% chance of winning') frames are no longer mathematically equivalent (Mandel & Kelly, 2024). This account clearly offers another route by which framing effects might be observed which neither undermines participant rationality, nor makes additional assumptions about the transmission of information from a speaker to a listener. However, we think it is unlikely that this account could explain the framing effect or its attenuation and persistence in the present study. Recall that in all our experiments, at the start of each round the lottery machine produces two pieces of paper stating the probabilities of winning and losing, separately. The Informant then chooses which to give to the Selector (or flips a coin to decide). As such it is unclear to us why participants would infer that the lottery machine could infuse a lower-bound interpretation into the probabilities stated on the pieces of paper.

We hope that the game task we introduce here provides flexibility for future researchers to tailor designs for testing predictions stemming from the Information Leakage account, the logical non-equivalence account and others. Future studies testing information leakage could explore alternative designs that make the Choice Limitation manipulation even more salient (e.g., by having the listeners, rather than the speaker, toss a coin and select a frame accordingly) and thus potentially render the communicated frames truly uninformative. Researchers might also manipulate the speaker's expertise and trustworthiness to gauge their influence on listener preferences and, consequently, the magnitude of the framing effect (Keren, 2007; Koch & Peter, 2017; Leong et al., 2017).

27. Conclusion

Participants tend to be more inclined to accept an option when it is framed positively (e.g., a gamble with the chance of winning) rather than negatively. This phenomenon, known as the framing effect, is explained by the Information Leakage account as an implicit social interaction; the speaker's selection of frames leaks information about their preferences or intentions to the listeners, who then integrate and use this leaked information in their judgments. The results of the current study indicate that experimentally interrupting this social interaction can lead to an attenuation of the framing effect, suggesting sensitivity and adaptability to the informational value of frames. Competition, however, more readily demonstrates such adaptability than does a speaker's agency over the choice of frame.

Divergence from the Preregistration

1. In the preregistration for Experiments 1A, 1B, and 2, we indicated that the estimates of the Bayesian model would be converted to a probability scale. However, in the reporting of the results, we presented the estimates on the probit scale without applying any conversions. This decision was made to facilitate easier interpretation for readers and to directly compare the estimates with the model output. It is important to note that applying the conversion would only change the scale of the estimates and would not alter the pattern of the findings.
2. In the preregistration for Experiment 3, we originally planned to conduct two separate Bayesian models, one for the collaborative block and one for the competitive block. However, in order to fully test our hypotheses, we realized that we needed a model that contains both scenarios. Therefore, we reported the output of this combined model in Experiment 3. The results of the separate models, which are similar to the reported model in the key findings, can be found in the supplementary materials.
3. For all experiments, we preregistered a sample size of 200 participants based on a Bayesian power analysis. However, in some experiments (such as Experiment 4 with $N = 207$), we ended up collecting a slightly larger number of participants due to the challenges of controlling the number of participants in an online setting, especially when applying exclusion criteria. We decided to keep the extra participants for the experiments, as excluding them did not alter the key findings of the study.

Open Science Practice

All experiments outlined in this study were pre-registered, and all

corresponding pre-registrations, data, analysis codes, and materials are available at (https://osf.io/xfrqj/).

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CRediT authorship contribution statement

Omid Ghasemi: Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Adam J.L. Harris:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Conceptualization. **Ben R. Newell:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2025.106087.

Data availability

The data is publicly available at OSF.

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