Motivated Mislearning: The Case of Correlation Neglect

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Abstract

We design an experiment to study the role of motivated reasoning in correlation neglect. In our main treatment, participants receive potentially redundant signals about an ego-relevant state, their IQ test performance. We then ask them how likely the signals are from the same source (and thus contain redundant information). Participants generally underappreciate the extent to which identical signals are more likely to come from the same source, but the bias is stronger for identical ego-favorable signals than for identical ego-unfavorable signals. We do not detect an asymmetric effect in a control treatment where the state is ego-irrelevant. Our results suggest that individuals may neglect the correlation between desirable signals to sustain motivated beliefs.

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1 Introduction

Correlated or redundant information is prevalent in the modern information economy. Different media outlets often repeat the same news generated from the same underlying sources. Individuals self-select into clusters of social networks with similar information and beliefs. Existing research suggests that complexity and inherent cognitive limitations may lead individuals to mislearn from correlated information structures (Fedyk and Hodson, 2019; Enke and Zimmermann, 2019).

In this paper, we propose a different perspective and study whether *motivated reasoning* could magnify or exacerbate mislearning from correlated information. A large literature has documented that individuals could be motivated to hold certain beliefs across various domains, as such beliefs may provide various hedonic and instrumental benefits (Bénabou, 2015; Zimmermann et al., 2019): For example, favorable beliefs about one's own ability may provide ego utility (Köszegi, 2006), incentivize individuals to overcome self-control issues (Bénabou and Tirole, 2002), or help them to better persuade others (Schwardmann and Van der Weele, 2019). We hypothesize that correlated information potentially provide individuals with the flexibility to reach motivated beliefs without conscious self-deception.

To test our hypothesis, we design an experiment where individuals receive potentially redundant ego-relevant signals and revise their beliefs about both information redundancy and own performance. In our *Main* treatment, participants first complete a short IQ test. We then elicit their belief about the probability that they scored in the top half of all our test takers (a binary "state"). To study individuals' learning from correlated information, participants receive information from the following information structure. We first generate two independent binary signals about the state for each participant. The participant is then matched with two information sources, each showing her one signal; in particular, they show her either the same underlying signal or the two independent signals, each with 50% probability. Given the realization of the observed signal(s), we ask the participant to guess whether the two sources show her the same underlying signal and indicate how likely she thinks they show the same underlying signal. Finally, we elicit her posterior belief about the binary state again.

If the two sources show two signals of different values, then these are clearly the two original independent signals. Thus, our main interest lies in how participants update about signal redundancy if the two sources show them two signals of identical values. In this case, it is uncertain whether the two sources show the two original independent signals or the same underlying signal. However, in principle, observing two signals with the same values increases the likelihood of the latter.

We find that most participants update their beliefs about signal redundancy in the correct direction, but they update insufficiently relative to the Bayesian benchmark. Importantly, participants who see two identical ego-favorable signals update significantly less about signal redundancy than those who see two identical ego-unfavorable signals. In other words, those who see two identical ego-favorable signals believe that they are more likely to be two independent signals, in a way that cannot be accounted for by Bayesian updating. This is consistent with motivated reasoning driving participants' inferences about signal redundancy. Nonetheless, the effect is not quantitatively large enough to generate significant asymmetric updating about own performance in the IQ test.

To further establish that our results are not driven by confounding factors, we design a *Control* treatment where the binary state is ego-irrelevant and present participants with signals generated from the same information structure as above. We confirm that the asymmetric updating about signal redundancy completely disappears in the *Control* treatment. This strengthens our interpretation of the effect in the *Main* treatment as driven by motivated reasoning.

This paper contributes to a nascent literature in behavioral and experimental economics that has documented systematic patterns of mislearning from complex information structures, such as redundancy neglect in social learning settings (Kübler and Weizsäcker, 2004; Eyster et al., 2015), correlation neglect in private settings (Enke and Zimmermann, 2019; Hossain and Okui, 2020), selection neglect (Esponda and Vespa, 2018; Barron et al., 2019; Enke, 2020), and feature neglect (Graeber, 2020). We document the role of motivated reasoning in mislearning, beyond the traditional explanations for the mislearning phenomena such as cognitive limitations and complexity.

The literature of motivated reasoning and motivated beliefs in psychology and economics

(Kunda, 1990; Bénabou and Tirole, 2016; Epley and Gilovich, 2016) has found applications in overconfidence (Bénabou and Tirole, 2002), moral behavior (Babcock et al., 1995), and belief polarization (Kahan, 2012). On the "supply" side of motivated beliefs, there is now evidence for motivated information demand or avoidance (Oster et al., 2013; Ganguly and Tasoff, 2016; Golman et al., 2017), asymmetric updating to noisy signals (Eil and Rao, 2011; Sharot et al., 2011; Mobius et al., 2011), motivated memory management (Chew et al., 2018; Zimmermann et al., 2019), and motivated recognition (Engelmann et al., 2019). We document an asymmetric inference effect from correlated information, a novel mechanism that could contribute to motivated beliefs and overconfidence.

The rest of the paper proceeds as follows. Section 2 outlines our experimental design. Section 3 and Section 4 present the results from our main treatment and control treatment, respectively. Section 5 discusses the implications of our results and concludes.

2 Experimental Design

2.1 Environment

In order to study the role of motivated reasoning in correlation neglect, we design an experiment where participants receive ego-relevant information that are potentially correlated. In the main treatment (henceforth referred to as *Main*), participants first take an IQ test which defines an ego-relevant state (*IQ Test stage*) and then receive possibly correlated (redundant) information about the state (*Information stage*). Our main interest lies in how participants assess the redundancy of the information depending on whether it is ego-favorable or ego-unfavorable. In order to more convincingly attribute any effect we find to motivated reasoning, we run a control treatment (referred to as *Control*) where the state is ego-irrelevant.

We next describe the different stages of the experiment in greater detail.

2.1.1 IQ Test stage

In both treatments, participants first complete an abridged IQ test. Participants are told about the relevance of the IQ test in measuring reasoning ability and fluid intelligence. The test consists of 20 Raven's Progressive Matrices problems that participants have 5 minutes to complete.[1] The final score of a participant is the number of correct answers minus the number of incorrect answers. At the end of the experiment, we randomly choose either the *IQ Test stage* or the *Information stage* to determine a participant's bonus payment; if the *IQ Test stage* is chosen, the participant receives 10 cents for each point she scores, but she will not lose any money if her score is negative. After participants complete the IQ test, they answer the following question: "*How important is it to you to be able to perform well in the IQ test?*" on a scale from 0 to 10. This measure is intended to proxy the ego-relevance of the test at the participant level.

In *Main*, we use the IQ test score to define a binary ego-relevant state for each participant. Specifically, we denote a participant's state as *TOP* if she scores in the top half of all participants and *BOTTOM* otherwise. We use a binary state so that the beliefs over the state could be summarized by a scalar probability, making them straightforward to elicit and analyze.

We then elicit participants' beliefs of the probability that they scored in the top half prior to receiving any information.[2] In *Main*, this corresponds to prior beliefs over the ego-relevant state. In *Control*, we now define an analogous binary *ego-irrelevant* state that is participant-specific based on their prior beliefs. To make the priors (roughly) comparable across the two treatments, we use the following procedure to define the priors over the ego-irrelevant state. For a particular participant in *Control*, let μ denote their prior belief of having scored in the top half in the IQ test. For this participant, we define the ego-irrelevant state as a binary variable that takes the value of *TOP* with probability μ and *BOTTOM* with probability $(1-\mu)$, rounded to the nearest 5%.[3]

[1] Each of the 20 Raven's Progressive Matrices consists of a visual pattern of eight symbols and a missing piece. Participants are given eight options to complete the pattern. An example problem can be found in the experimental instructions given in Section A.1 of the online appendix.

[2] In our experiment, we elicit all beliefs over binary states (events) using the crossover mechanism (Karni, 2009).

[3] To avoid a degenerate distribution, We round very low priors to 5% instead of 0% and very high priors to 95% instead of 100%.

We then draw the actual realization of the ego-irrelevant state based on these probabilities. The participant knows the prior probabilities but not the realization of the state.[4]

2.1.2 Information stage

We next provide each participant with some information about the state (which is ego-relevant in *Main* and ego-irrelevant in *Control*). To study correlation neglect, we design an information structure with correlated and potentially redundant information, which is used in both *Main* and *Control*. We then measure both participants' beliefs about the redundancy of the information and their belief updating about the state.

Figure 1 visualizes the information structure we use, which is the simplest one that features correlation or redundancy. We first generate two independent "reports" (framed as "the blue report" and "the green report") which are binary noisy signals about the state, each matching the state with probability $\theta = \frac{2}{3}$. In other words, if the true state is *TOP*, then each report says *TOP* with probability $\frac{2}{3}$ and says *BOTTOM* with probability $\frac{1}{3}$, and vice versa. Thus, θ indicates the informativeness or diagnosticity of the reports. The participant does *not* directly observe the reports but receives two signals from computer players Ann and Bob. The participant knows that Ann's signal (henceforth the "first signal") is the blue report. Bob's signal (henceforth the "second signal") is either the blue report or the green report with equal probabilities, but Bob does not disclose which report it is. Thus, the second signal possibly contains redundant information.

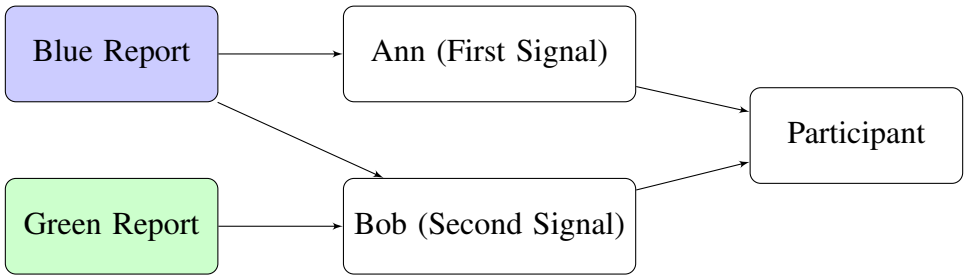

Figure 1: Information Structure with Correlation

[4]The ego-irrelevant state is framed to the participants as a random draw from 20 balls consisting of $\left[\frac{\mu}{5}\right]$ TOP balls (balls with the word "TOP" written on them) and $(20 - \left[\frac{\mu}{5}\right])$ BOTTOM balls (balls with the word "BOTTOM" written on them). See Section A.1.2 of the online appendix for detailed instructions.

We choose this simple information structure based on the following considerations. (i) By construction, correlation already adds to the complexity of the environment, so additional complexity risks confusing participants and adding noise to the data. (ii) A simple structure makes the environment easier to describe and analyze, so it serves as a natural starting point for our investigation.

After participants confirm the two signals they observed, we elicit three beliefs from them, which will be the major outcomes we analyze. (i) We first ask them to make a binary guess about whether the second signal is the blue report (and hence redundant) or the green report (and hence informative). They get a $2 bonus payment if their guess is correct and this question is randomly selected to determine their bonus. (ii) We further ask them to provide their belief of the probability that the second signal is the blue (green) report, i.e., the probability that the second signal is redundant (or not). (iii) Finally, we elicit their posterior beliefs about the state after receiving the information.

2.2 Theoretical Benchmarks and Hypotheses

Broadly speaking, we hypothesize that ego-relevance of the state may affect how participants interpret possibly redundant information in the following way. When the state is ego-relevant, as in *Main*, individuals may be motivated to underestimate redundancy when the information is "good," relative to the case in which the information is "bad," so as to update positively about the state. If motivated reasoning drives such an asymmetric effect, it should disappear in *Control* where the state is ego-irrelevant. In the rest of this paper, we will refer to this hypothesis as the *Motivated Mislearning Hypothesis.*

For the participants who see two different signals, i.e., one *TOP* signal and one *BOTTOM* signal, they should clearly conclude that these are the two underlying reports. In the online appendix, we show that most of these participants indeed do so. In the rest of the main exposition, we will focus on the other participants who see two identical signals: either two *TOP* signals or two *BOTTOM* signals. In such cases, the identity of the second signal cannot be inferred with certainty: Either it is a repetition of the first signal, or it is a different report and turns out to agree with the

first signal.

We first derive the Bayesian inference about the redundancy of the second signal. Recall that, unconditionally, the second signal is a repetition of the first signal with $\frac{1}{2}$ probability. When a participant sees two identical signals such as two *TOP* signals, the probability that the second signal is new (NOT redundant) decreases:

$$\begin{aligned}
&\Pr(\text{Second Signal New}|\text{Two } \textit{TOP} \text{ Signals}) \\
=&\frac{\Pr(\text{Second Signal New}, \text{Two } \textit{TOP} \text{ Signals})}{\Pr(\text{Second Signal Redundant}, \text{Two } \textit{TOP} \text{ Signals}) + \Pr(\text{Second Signal New}, \text{Two } \textit{TOP} \text{ Signals})} \\
=&\frac{\frac{1}{2}[\mu\theta^2 + (1-\mu)(1-\theta)^2]}{\frac{1}{2}[\mu\theta + (1-\mu)(1-\theta)] + \frac{1}{2}[\mu\theta^2 + (1-\mu)(1-\theta)^2]} = \frac{3\mu+1}{6\mu+4} \in [25\%, 40\%]
\end{aligned}$$

where μ denotes the agent's prior belief of the probability of the *TOP* state and $\theta = \frac{2}{3}$ indicates the diagnosticity of the signals. Analogously,

$$\Pr(\text{Second Signal New}|\text{Two } \textit{BOTTOM} \text{ Signals}) = \frac{3(1-\mu)+1}{6(1-\mu)+4} \in [25\%, 40\%]$$

Thus, a Bayesian agent who sees two identical signals, regardless of their prior beliefs over the state, should infer that it is more likely that the second signal is redundant (and guess that the second signal is the blue report).

However, the Motivated Mislearning Hypothesis predicts that participants in *Main* who observe two ego-favorable signals may be motivated to assign a relatively high probability of the second signal being new compared to participants who observe two ego-unfavorable signals. Similarly, to the extent that it is a "mistake" to guess that the second signal is new (the green report), the Motivated Mislearning Hypothesis predicts that in *Main* the incidence of mistakes is higher after receiving two ego-favorable signals than after receiving two ego-unfavorable signals. Since the motivated reasoning mechanism should be shut down in *Control*, the hypothesis predicts that these effects disappear in that treatment.

Finally, consider participants' posterior beliefs about the state after receiving the information.

Let $\text{logit}(x) = \log(\frac{x}{1-x})$ be the logit or log odds function. Suppose a Bayesian agent observes two *TOP* signals, the logit of the Bayesian posterior can be written as the sum of the logit of the prior and the log likelihood ratio of the signals:

$$\text{logit}(\eta) = \text{logit}(\mu) + \log\Big(\frac{\Pr(\textit{TOP} \text{ state}, \text{Two } \textit{TOP} \text{ Signals})}{\Pr(\textit{BOTTOM} \text{ state}, \text{Two } \textit{TOP} \text{ Signals})}\Big)$$

where μ denotes the prior belief for the *TOP* state and η denotes the posterior belief. With a signal diagnosticity of $\theta = \frac{2}{3}$, the likelihood ratio of two *TOP* signals is 2.5. The symmetry of the signal structure implies that the likelihood ratio of two *BOTTOM* signals is given by $\frac{1}{2.5}$ or 0.4. Along the same lines, if someone receives one *TOP* signal and one *BOTTOM* signal, then they should cancel out each other exactly, and the Bayesian posterior exactly equals the prior. Thus, the general expression for the Bayesian posterior belief for the *TOP* state is:

$$\text{logit}(\eta) = \text{logit}(\mu) + \log(2.5) \cdot \mathbb{1}_{\text{Two Good Signals}} - \log(2.5) \cdot \mathbb{1}_{\text{Two Bad Signals}} + 0 \cdot \mathbb{1}_{\text{Mixed Signals}}$$

The Motivated Mislearning Hypothesis predicts that participants may deviate from the Bayesian posterior derived above. In particular, participants may react more to ego-favorable than to ego-unfavorable signals through the channel of motivated mislearning from correlated signals.

2.3 Procedures

We programmed our experiment using oTree (Chen et al., 2016) and recruited our participants through Prolific, an online platform designed for social science research.[5] 601 participants participated in our main treatment, among whom 444 got two identical signals. Another 601 participants participated in our control treatment, among whom 454 got two identical signals.

Participants spent on average about 20 minutes on the experiment and earned an average payment of \$3.9 including a \$3 base payment.

[5]See Palan and Schitter (2018) and Gupta et al. (2021) for using Prolific as a participant pool. We only recruited US participants who have completed more than 100 tasks on Prolific and have an approval rate of at least 95%.

3 Results from the Main Treatment

In this section, we use the data from our *Main* treatment to test our Motivated Mislearning Hypothesis—participants' inferences about information redundancy may be different depending on whether the information is ego-favorable. We carry out our analysis using the two main belief outcomes of information redundancy: the binary guess and the probabilistic belief about the identity of the second signal. We also look at how participants update their beliefs about their IQ test performance after receiving the signals.

As discussed above, if one's prior belief of scoring in the top half is μ, then the Bayesian inference about signal redundancy after seeing two identical signals should be

$$\Pr(\text{Second Signal is NOT Redundant}|\text{Both Signals are } \textit{TOP}) = \frac{3\mu + 1}{6\mu + 4} \in [25\%, 40\%]$$

and

$$\Pr(\text{Second Signal is NOT Redundant}|\text{Both Signals are } \textit{BOTTOM}) = \frac{4 - 3\mu}{10 - 6\mu} \in [25\%, 40\%]$$

Therefore, the correct binary guess after seeing two identical signals is always that the second signal is redundant.

Figure 2 shows the percentages of participants who make the *wrong* guess (i.e., guess that the second signal is new or different from the first signal) after seeing two identical signals. Although our main interest lies in comparing participants' reactions after seeing two *TOP* signals or two *BOTTOM* signals, we also break down the sample by participants' IQ test performance (top half vs. bottom half): Since the signals are informative about test performance, participants who see two *TOP* signals are more likely to have scored in the top half than those who see two *BOTTOM* signals, and thus may have higher cognitive ability or may be more attentive. Making the comparison *within* each performance group eliminates this confounding factor and exploits only the exogenous variation from signal randomness built into our design.

Indeed, we find that participants scoring in the top half are in general less likely to make the wrong guess than those in the bottom half (24% vs. 43%, $p < 0.01$), which necessitates our within-performance-group comparison. However, we fail to reject the null hypothesis that participants seeing two *TOP* signals are more likely to make the wrong guess than participants seeing two *BOTTOM* signals within each performance group. We thus find no evidence for our Motivated Mislearning Hypothesis in the binary guess outcome.

The binary guess is only a coarse proxy for the inference about signal redundancy, so we next look at participants' (probabilistic) posterior belief that the second signal is new (non-redundant) after seeing two identical signals. Given our design, it is important to keep in mind that the rational benchmark for this belief depends on the participant's prior belief about their test performance, and is generally different between people who see two *TOP* signals and people who see two *BOTTOM* signals. For example, if a participant's prior belief of their chance of scoring in the top half is higher than 50% (i.e., they are relatively confident about their performance to begin with), then they should think that the second signal is relatively more likely to be new (non-redundant) after seeing two *TOP* signals; by contrast, if they see two *BOTTOM* signals, they should think that there is a high chance that the second signal is redundant. It is thus important that we control for the rational benchmark when we compare the inferences made by the two *TOP* group and the two *BOTTOM* group about signal redundancy.

Figure 3 shows both the average elicited posteriors and the average rational posteriors that the second signal is new after seeing two identical signals, separately by IQ test performance group and signal valence. Focusing first on participants who scored in the top half, we notice that the average rational posterior of the second signal being new is a little ($\sim 3\%$) higher after seeing two *TOP* signals than after seeing two *BOTTOM* signals, consistent with this subgroup of participants being relatively confident about their performances to begin with. Their actual posteriors are much higher than the rational posteriors on average, suggesting that they infer too little about signal redundancy from two identical signals. Importantly, the average elicited posterior that the second signal is new is around 5% higher for the two *TOP* group than the two *BOTTOM* group, a gap that

is 2% wider than the corresponding gap for the rational posteriors. This is directionally consistent with our Motivated Mislearning Hypothesis: Individuals who see repeated ego-favorable signals may be motivated to exaggerate the chance that they contain independent information.

Analysis of the beliefs of participants who scored in the bottom half yields the same pattern. As these participants' prior beliefs about their performance are less confident, the average rational posterior of the second signal being new is actually 1% lower with two *TOP* signals than with *BOTTOM* signals. However, the elicited posteriors from the participants show the opposite: Participants seeing two *TOP* signals on average decide that it is 49% likely that the second signal is new, which is 3% higher than participants seeing two *BOTTOM* signals. This provides even stronger evidence for the Motivated Mislearning Hypothesis that cannot be explained by Bayesian inference.

In Table 1, we put these results into regression form by estimating the following specification:

$$\text{Posterior Belief} = \beta_1 \mathbb{1}_{\text{Two Good Signals}} + \beta_2 \mathbb{1}_{\text{Top Half in Test}} + \beta_3 \text{Bayesian Belief} + \gamma X + \epsilon \qquad (1)$$

where the dependent variable is the posterior belief of the probability that the second signal is new, and X may be empty or include a set of demographic controls.

Columns (1) and (2) in Table 1 present the regression results using the full sample of 444 participants who see two identical signals. Consistent with the Motivated Mislearning Hypothesis, we find that participants who see two good signals believe that the second signal is 4% more likely to be new compared with those who see two bad signals, controlling for test performance and the Bayesian posterior. The effect becomes slightly larger when we additionally control for personal characteristics including gender, race, age, education, and the precise score in the IQ test. In columns (3) and (4), we drop participants who report a higher than 50% posterior that the second signal is new after seeing two identical signals, which indicates that they make a directionally wrong inference about signal redundancy. The effect becomes even stronger in the restricted sample.

Why do we find an asymmetric effect in the probabilistic beliefs but no effect in the binary guess? In Appendix Table A1, we present a two-way tabulation of the probabilistic beliefs and the binary guess. The results suggest that receiving two good signals (instead of two bad signals) shift around 10% of participants from providing a posterior belief of less than 50% to providing a posterior belief of exactly 50%. This is consistent with the Motivated Mislearning Hypothesis. However, since only around a fourth to a half of those answering exactly 50% guess that the second signal is new in the binary guess, the effect size on the binary guess would be only a fourth to a half of 10%. There are also a small fraction of participants who indicate beliefs different from 50% but provide guesses inconsistent with their own beliefs, which further diminishes the effect on the binary guess. We conclude that the binary guess as a crude measure may not be able to pick up the subtle effects on beliefs that we document.

Finally, we examine whether the asymmetric inference about signal redundancy we document could contribute to significant asymmetric updating about participants' own IQ test performance. Recall that the Bayesian posterior about own test performance is as follows:

$$\text{logit}(\eta) = \text{logit}(\mu) + \log(2.5) \cdot \mathbb{1}_{\text{Two Good Signals}} - \log(2.5) \cdot \mathbb{1}_{\text{Two Bad Signals}} + 0 \cdot \mathbb{1}_{\text{Mixed Signals}} \quad (2)$$

where μ is the prior belief of the probability of scoring in the top half, η is the posterior belief of the probability of scoring in the top half. Equation (2) says that the log likelihood ratio of beliefs should go up by $\log(2.5)$ if one receives two (possibly redundant) good signals, should go down by $\log(2.5)$ if one receives two (possibly redundant) bad signals, and should not change if one receives one good signal and one bad signal.

In light of Equation (2), and focusing on the subsample of participants who receive two identical signals, we estimate the following specification:

$$\text{logit}(\eta) = \delta \, \text{logit}(\mu) + \alpha_G \log(2.5) \cdot \mathbb{1}_{\text{Two Good Signals}} - \alpha_B \log(2.5) \cdot \mathbb{1}_{\text{Two Bad Signals}} + \epsilon \quad (3)$$

We report the results in Table 2. We estimate $\alpha_G = 0.641$ and $\alpha_B = 0.621$, without a statistically

significant difference between the two coefficients ($p = 0.802$). In short, even in our setting of potentially redundant signals, the asymmetric inference about signal redundancy is not quantitatively large enough to generate significant asymmetric updating about participants' own IQ test performance. This stands in contrast to some existing evidence in the literature such as Mobius et al. (2014) which finds significant asymmetric updating with mutually independent signals.[6]

Why do we find an asymmetric updating effect on signal redundancy but in the end no significant asymmetric updating for test performance? Power issues arise because: (i) the effect on the inference about signal redundancy is moderate in magnitude to begin with; and (ii) all in all participants still underreact to the signals by a factor of 0.6 relative to the Bayesian benchmark, even as they do not fully appreciate the potential redundancy of the second signal. For example, back-of-the-envelope calculations suggest that a 5% effect on the posterior probability that the second signal is redundant can generate no more than an effect of 0.03 on the α_G coefficient in (3). Our remarkably simple information structure, intended as the most transparent way to introduce correlation, may not be sufficient to ultimately generate a statistically detectable asymmetric effect on inference about the state. Nonetheless, the mechanism it illustrates may lead to larger effects in richer environments with a larger number of correlated signals, which we leave for future work.

4 Results from the Control Treatment

Although evidence from the belief data in the *Main* treatment is consistent with the Motivated Mislearning Hypothesis, the need to control for the rational posterior may lead some to worry that our results are sensitive to the chosen specification. To alleviate this concern, we conduct a "placebo" exercise by testing for a similar asymmetric effect in the *Control* treatment where participants receive potentially redundant signals about an *ego-irrelevant* state and the priors over the states are matched with participants' prior beliefs about their test performance.

For the sake of brevity, we present the regression results directly using the following specifica-

[6]The evidence in the motivated beliefs literature on asymmetric updating has been mixed, with some papers finding significant asymmetric updating but others finding no effects. See Benjamin (2019) for a detailed discussion.

tion where we pool the data from the *Main* treatment and the *Control* treatment:

$$\begin{aligned}\text{Posterior Belief} \quad &= \beta_1 \mathbb{1}_{\textit{Main}\text{ Treatment}} \times \mathbb{1}_{\text{Two Good Signals}} + \beta_2 \mathbb{1}_{\textit{Control}\text{ Treatment}} \times \mathbb{1}_{\text{Two Good Signals}} \\ &+ \beta_3 \mathbb{1}_{\textit{Main}\text{ Treatment}} \times \mathbb{1}_{\text{Top Half in Test}} + \beta_4 \mathbb{1}_{\textit{Control}\text{ Treatment}} \times \mathbb{1}_{\text{Top Half in Test}} \\ &+ \beta_5 \mathbb{1}_{\textit{Main}\text{ Treatment}} + \beta_6 \text{Bayesian Belief} + \gamma X + \epsilon \end{aligned} \tag{4}$$

where the dependent variable is the posterior belief of the probability that the second signal is new.[7]

Table 3 present the regression results. In column (1), the interaction term between the *Main* treatment and the "Two Good Signals" dummy replicates the result that in the *Main* treatment participants' beliefs that the second signal is new is 4% higher if they see two good signals. Importantly, the interaction term between the *Control* treatment and the "Two Good Signals" dummy is estimated to be extremely close to zero, indicating that the effect disappears in the *Control* treatment. A t-test of equal coefficients yields a p-value of 0.071, which suggests that we can reject that the effect is the same in the two treatments at the 10% level. In column (2), we drop participants who report a higher than 50% posterior that the second signal is new, and obtain very similar results.

Overall, results from the *Control* treatment suggests that the asymmetric effect we document in the *Main* treatment is specific to the ego-relevant state of own test performance. This bolsters our interpretation of the effect as a manifestation of the Motivated Mislearning Hypothesis we propose.

[7] In the *Control* treatment, participants who see two *TOP* signals have higher prior beliefs about their test performance and thus may have higher cognitive ability. To control for this, we add dummies for each possible level of the prior probability of the *TOP* state. To maintain symmetry in the specification, we define these dummies for participants in the *Main* treatment as well, rounding their prior beliefs about own test performance to the nearest 5%, moving very low priors to 5% insteadof 0% and very high priors to 95% instead of 100%. We then include all these dummies interacted with the treatment in the regressions.

5 Conclusion

In this paper, we design an experiment to study whether motivated reasoning could affect individual learning from correlated information. Participants who receive identical ego-favorable signals indicate that the signals are less likely to be redundant compared with participants who receive identical ego-unfavorable signals. As a proof of concept, this finding demonstrates the degree of flexibility in interpreting correlated information in settings potentially with motivated beliefs. Although such asymmetric inference about signal redundancy does not lead to significant asymmetric updating about own performance in our experiment, we note that this may result from the remarkable simplicity of our design. In richer settings with a larger number of correlated signals, the asymmetric effect we document may well build up to generate more significant effects on the beliefs of interest.

There are at least two avenues for future research. First, one could explore the effect of motivated reasoning on other types of learning biases. For example, motivated reasoning may lead individuals to learn narrowly from selected information without accounting for the information that is filtered out but can in principle be deduced from observed information (Enke, 2020). Second, one could apply our findings to other settings where motivated reasoning may play a role, such as political beliefs.

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Figures and Tables

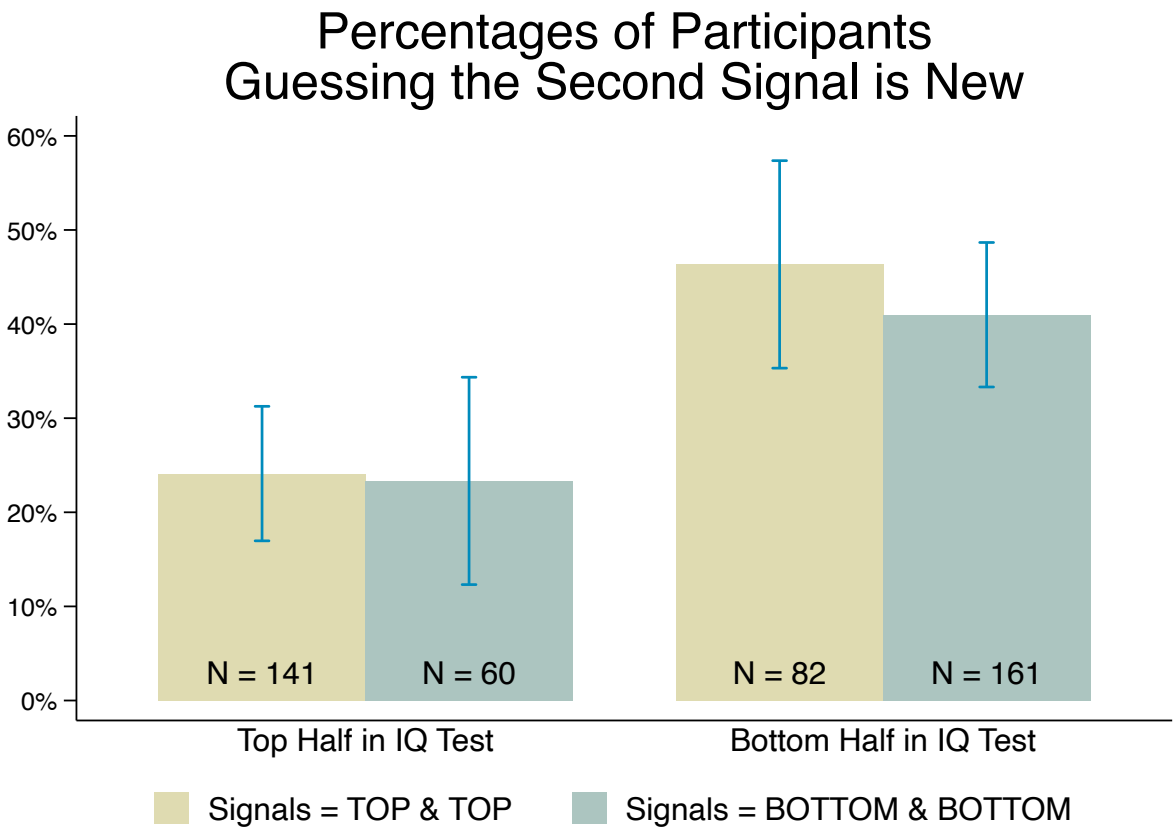


Figure 2: The percentages of participants guessing the second signal is a different signal, by IQ test performance and signal valence.

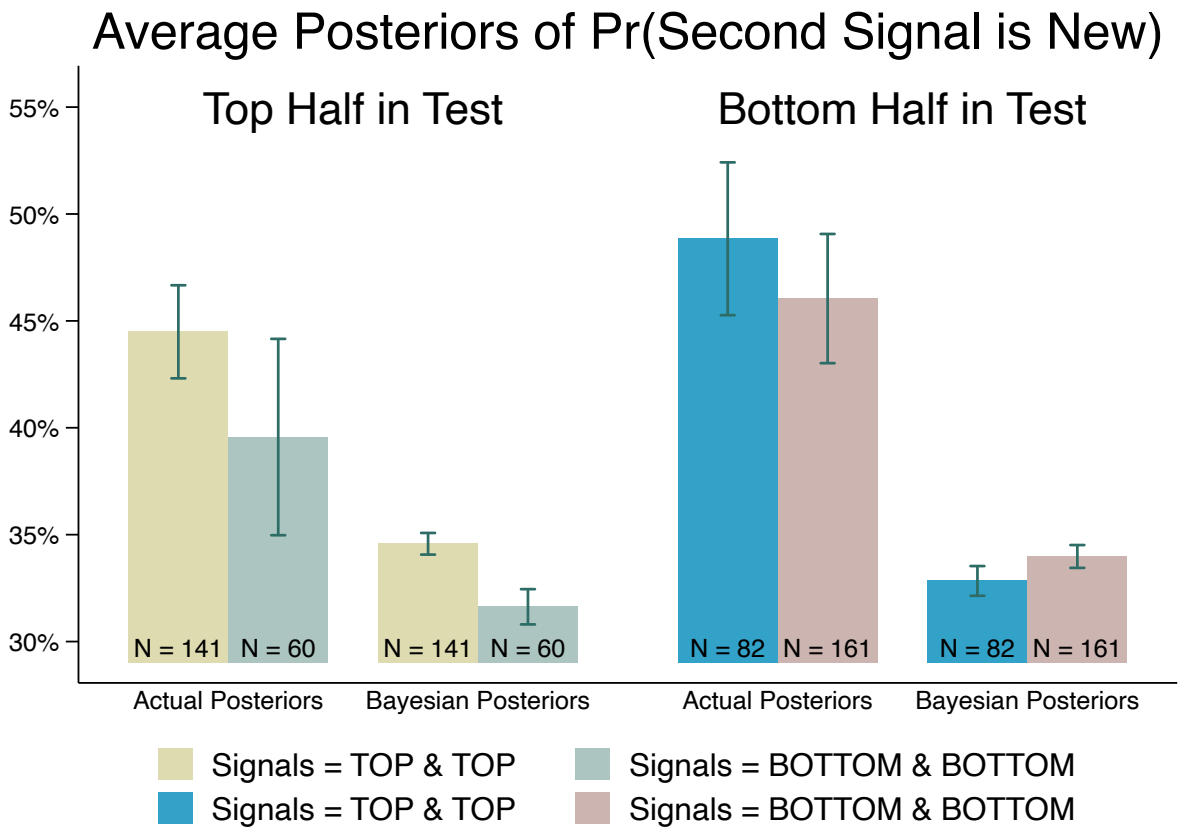


Figure 3: Average elicited and Bayesian posteriors of the probability that the second signal is a different signal, by IQ test performance and signal valence.

Table 1: Inference about signal redundancy after seeing two good signal or two bad signals, the *Main* treatment.

	Dependent Variable: Pr(Second Signal is New), Actual Posterior (in %)			
	Full Sample		Drop Wrong Direction	
	(1)	(2)	(3)	(4)
Two Good Signals	3.625**	3.775**	4.637***	5.237***
	(1.722)	(1.693)	(1.414)	(1.399)
Top Half in Test	-5.303***	2.031	-2.055	-0.993
	(1.694)	(2.525)	(1.424)	(2.052)
Bayesian Posterior (in %)	0.157	0.102	-0.030	-0.050
	(0.284)	(0.290)	(0.223)	(0.220)
Demographic Controls	No	Yes	No	Yes
Observations	444	444	369	369
R^2	0.025	0.065	0.029	0.061

Notes: Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. "Demographic Controls" include dummy variables for Male, White, Age $\leq$ 35, College Degree, and the raw score in our IQ test.

Table 2: Inference about own IQ test performance after seeing two good signal or two bad signals, the *Main* treatment.

	Dep Var: Posterior logit(Pr(Top Half))
δ	0.798***
	(0.051)
α_G	0.641***
	(0.052)
α_B	0.621***
	(0.061)
p-value: $\alpha_G = \alpha_B$	0.802
Observations	420
R^2	0.696

Notes: Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. We restrict the sample to the 420 participants who receive two identical signals and whose prior and posterior beliefs are not 0% or 100%. The outcome in the regression is the log likelihood ratio of the posterior belief. δ is the coefficient on the log likelihood ratio of the prior belief; α_G and α_B are the estimated effects of the log likelihood ratio for two good signals and two bad signals, respectively. Bayesian updating corresponds to $\delta = \alpha_G = \alpha_B = 1$.

Table 3: Inference about signal redundancy, pooling data from the *Main* treatment and the *Control* treatment.

	Dep Var: Pr(Second Signal is New), Actual Posterior (in %)	
	Full Sample	Drop Wrong Direction
	(1)	(2)
Main $\times$ Two Good Signals	4.181**	4.825***
	(1.661)	(1.392)
Control $\times$ Two Good Signals	-0.000	1.290
	(1.598)	(1.280)
Main $\times$ Top Half in Test	-0.685	-1.978
	(2.023)	(1.674)
Control $\times$ Top Half in Test	1.778	-0.340
	(1.721)	(1.446)
Main Treatment	-1.985	1.193
	(7.354)	(6.911)
Bayesian Posterior (in $\%$)	-0.098	-0.009
	(0.204)	(0.160)
Controls	Yes	Yes
p-value (Equal Effects)	0.071	0.063
Observations	898	771
R^2	0.091	0.114

Notes: Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. "Controls" include: a dummy for each possible level of the prior probability of the Top state, interacted with the treatment; dummies for Male, White, Age $\leq$ 35, College Degree; and the raw score in our IQ test.

A Online Appendix

Table A1: Detailed two-way tabulation of beliefs and guesses in the *Main* treatment.

Group	Posterior Belief Pr(Second Signal is New)	Number of Participants	Binary Guess Second = First	Binary Guess Second ≠ First
Top Half in IQ Test, Two Good Signals (N = 141)	Belief < 50%	63 (44.7%)	61 (43.3%)	2 (1.4%)
	Belief = 50%	62 (44.0%)	46 (32.6%)	16 (11.3%)
	Belief > 50%	16 (11.3%)	0 (0%)	16 (11.3%)
Top Half in IQ Test, Two Bad Signals (N = 60)	Belief < 50%	32 (53.3%)	30 (50%)	2 (3.3%)
	Belief = 50%	22 (36.7%)	16 (26.7%)	6 (10%)
	Belief > 50%	6 (10%)	0 (0%)	6 (10%)
Bottom Half in IQ Test, Two Good Signals (N = 82)	Belief < 50%	24 (29.3%)	20 (24.4%)	4 (4.9%)
	Belief = 50%	40 (48.8%)	18 (22.0%)	22 (26.8%)
	Belief > 50%	18 (22.0%)	6 (7.3%)	12 (14.6%)
Bottom Half in IQ Test, Two Bad Signals (N = 161)	Belief < 50%	63 (39.1%)	52 (32.3%)	11 (6.8%)
	Belief = 50%	63 (39.1%)	35 (21.7%)	28 (17.4%)
	Belief > 50%	35 (21.7%)	8 (5.0%)	27 (16.8%)

Notes: In this table, we first divide all participants in the *Main* treatment who see two identical signals into four groups depending on their performance in the IQ test (top half vs. bottom half) and whether their signals are good (ego-favorable). Within each group, we divide participants into subgroups according to whether their posterior belief of the probability that the second signal is new is lower than, equal to, or higher than 50%. In the third column, we provide the numbers and percentages of participants who fall into each subgroup. In the fourth and fifth columns, we provide the numbers of participants who provide each possible guess within the corresponding subgroup; the percentages are still calculated relative to the four broad groups.

A.1 Experimental Instructions

A.1.1 Main Treatment

WELCOME

You are invited to participate in a research study run by the Department of Economics at Stanford University. If you successfully complete the study, you will receive a $3 fixed payment. You may also receive an additional bonus payment (up to $2) in the study. Therefore, the total payment for completion will be $3-5.

On the next page, you will see a consent form. Please review it carefully before deciding whether you want to take part in this study.

When you are ready, click "Next" to read the consent form.

Next

CONSENT FORM

- You are being asked to take part in a research study.
- If you choose to be in the study, you will complete a series of online tasks. This study will help us learn more about how people make decisions. Most participants complete this study in 15 to 25 minutes.
- All payments and procedures will be implemented in exactly the manner they are described in the study instructions and on the Prolific platform. If you complete the study, you will receive a $3 base payment. You may also receive a bonus payment up to $2.
- You may stop the study at any time, but you will only get paid the full amount if you complete the study.
- The study is anonymous, and no one will be able to link your answers back to you. Please do not include your name or other information that could be used to identify you in the study responses.
- This is a minimal risk study. We cannot and do not promise or guarantee that you will receive any benefits from participating.
- Questions, Concerns, or Complaints: If you have any questions, concerns or complaints about this research study - its procedures, risks and benefits - contact Tony Fan, tonyqfan@stanford.edu.
- If you have questions about your rights as a research participant or are not satisfied with how this research is being conducted, you may contact the Stanford University IRB at irb2-manager@lists.stanford.edu to speak to someone independent of the research team.

Being in this study is voluntary. Please exit the webpage if you do not want to participate.

If you agree to participate in this study, please click "Yes, I agree" and "Next." After you click "Next," we will ask you a few questions to determine if you qualify for this study.

Yes, I Agree

Next

Please read carefully

Please make sure that you read the entire paragraph on this page and follow the instructions.

Many professional athletes have become prominent public figures. The following is adapted from Wikipedia:

Some historians – most notably Bernard Lewis – claim that team sports as we know them today are primarily an invention of Western culture. British Prime Minister John Major was more explicit in 1995: "We invented the majority of the world's great sports.... 19th century Britain was the cradle of a leisure revolution every bit as significant as the agricultural and industrial revolutions we launched in the century before." It is critical that the data we collect in this experiment be accurate, and we therefore need to screen out bots and participants who are speeding through the survey without reading the questions. We have included the question below for this purpose. Select only the bottom option, regardless of which athletes you have heard about recently. If you do not select only the bottom option, then you will not be compensated for this survey. The Industrial Revolution and mass production brought increased leisure which allowed more time to engage in playing or observing (and gambling upon) spectator sports, as well as less elitism in and greater accessibility of sports of many kinds. With the advent of mass media and global communication, professionalism became prevalent in sports, and this furthered sports popularity in general.

Based on the text you read above, which of the following athletes have you been asked to enter?

Answer	Select
Lionel Messi	☐
Serena Williams	☐
LeBron James	☐
Tom Brady	☐
Roger Federer	☐
None of the Above	☐

Next

WELCOME

You are now invited to participate in a research study run by the Department of Economics at Stanford University on decision-making. All the responses you will give as part of this study will be strictly anonymous: We will not connect your Prolific ID to any of the answers you give in this study. Your anonymity is thus guaranteed.

Please read and follow all the instructions we give in the study carefully; they contain everything you need to know. Please always scroll down to make sure that you read the entire page.

Most participants complete this study in 15 to 25 minutes. Please start this study only if you have that much time in a single session, and are able to take it on a full screen laptop or computer, NOT a tablet or smartphone. If you do not complete the study, or if the study times out on you, we will not be able to pay you.

You will earn a fixed payment of $3 just for completing this study.

This study consists of three parts. At the end of the study, we will randomly choose one of the three parts. This part will determine your bonus payment (up to $2). The amount of the bonus payment will depend both on the decisions you make in the chosen part and on luck. Your total payment will be the sum of the fixed payment $3 and the bonus payment.

When you are ready, click "Next" to start the first part of the study.

Next

Part 1 begins when you click "Next."

Next

Part 1: IQ Test

In Part 1 of this study, you will take a short IQ test. The test is designed to measure the test taker's reasoning ability. Its result is regarded as an estimate of fluid intelligence. The test was developed and used for academic research on IQ, and was routinely administered to entrants to military services throughout the world. Several high IQ societies accept it as a qualification for admission.

The IQ test has 20 multiple choice questions and you have 5 minutes to answer as many questions as you can. In each question, you are asked to identify the missing element that completes a pattern. Please focus on the shape of the element; the size may be different from those in the pattern.

Your final score is the number of correct answers minus the number of incorrect answers. Questions unanswered will not count towards the score. If your final score is positive, you will get 10 bonus cents for each point you score. If your final score is 0 or less, you won't get any bonus payment, but you also won't lose any money.

When you are ready, click "Next."

Next

Part 1: IQ Test

The test will start soon...

When you click "Start IQ Test," the IQ test will start.

Note:

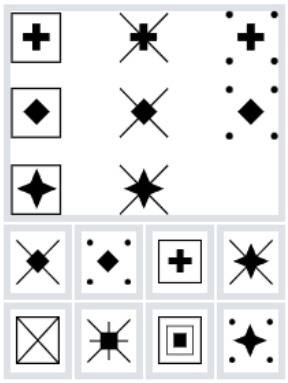
- There are 20 multiple choice questions in total, and your score is the number of correct answers minus the number of incorrect answers. Questions unanswered will not count towards the score.
- You will have 5 minutes to answer as many questions as you can. There will be a clock at the top of the page that tells you the remaining time.
- To answer each question, simply click the option that you think completes the pattern. Please focus on the shape of the options; the size may be different from those in the pattern. You may click the option again to delete your answer. You may click another option to change your answer.
- The test has 20 pages, one for each question. To move on to a different question, click its question number at the bottom of the page. You can always go back to previous questions within the time limit.
- When the time is up, the page will automatically skip to the next part of the study.

Good luck!

Start IQ Test

Part 1: IQ Test

Time left to complete IQ test: **4:51**



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Part 1: IQ Test

The IQ test has ended.

Please answer the following question:
How important is it to you to be able to perform well in the IQ test?
(0 = Not important at all, 10 = Extremely important)

Your answer to this question will NOT affect your payment in this study.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Next

You have completed Part 1. Part 2 begins when you click "Next."

Next

Part 2: Feedback about Performance

Please read the following instructions carefully. Please always scroll down to make sure that you read the entire page. We will test your understanding of the instructions. You can only proceed once you answer all questions about the instructions correctly.

In Part 2, we will give you some feedback on your performance on the IQ test, and also ask you several questions, including questions about your test performance. In each question, you can earn a possible bonus of $2, and you make the most money by giving your best guess. In the end, if Part 2 is chosen to count for your bonus, we will randomly choose one question in Part 2 to count for your bonus. So you should give your best guess in every question as if it is the question that counts - because it can be!

For example, we will ask you what you think is the chance that you scored in the top half of all our test participants on the platform. If you want to see details about how the bonus payment will be determined for this question, click "Payment Details" below. The bonus payment for the other questions will be determined similarly.

Payment Details

When you are ready, click "Next" to answer some questions about the instructions.

Next

Understanding Questions

Your answers to the following questions will not affect your payment. However, you can only proceed once you answer all these questions correctly.

Q1: Which of the following is a question you will be asked in Part 2?

- ○ The chance that I scored among the top 25% of all participants in the IQ test
- ○ The chance that I scored among the top half of all participants in the IQ test
- ○ The chance that I scored among the top 75% of all participants in the IQ test
- ○ The amount of payment in this study

Q2: How can you maximize your bonus payment in the questions in Part 2?

- ○ By giving answers that are as high as possible
- ○ By giving my best guess
- ○ By giving answers that are as low as possible
- ○ By randomly giving answers

Q3: In the end, if Part 2 is randomly chosen to determine your bonus payment for this study, what will your bonus payment be?

- ○ The bonus payment from one randomly chosen question in Part 2
- ○ The sum of bonus payments from two randomly chosen questions in Part 2
- ○ The sum of bonus payments from all the questions in Part 2
- ○ It will always be $2

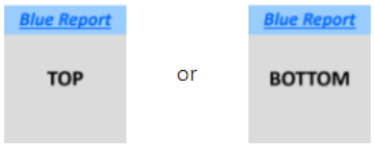
After you finish all the questions, click "Next." If any of your answers are incorrect, you will get an error message below each of your incorrect answers. Once you correct all your answers, you can proceed to the rest of the study by clicking "Next" again.

Next

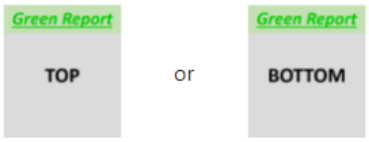
Reports

To give you some feedback on your IQ test performance, we will generate two reports for you: **Blue Report** and **Green Report**. Each report says either TOP or BOTTOM, which indicates whether your IQ test performance was in the top half or bottom half.

Blue Report



Green Report



However, the reports are not always correct because of how they are generated:

- We have a regular die with six faces. We will roll the die twice.
- The first roll determines your **Blue Report**. If the first roll turns up 1, 2, 3, or 4, your **Blue Report** will be correct; if it turns up 5 or 6, your **Blue Report** will be incorrect.
- The second roll determines your **Green Report**. If the second roll turns up 1, 2, 3, or 4, your **Green Report** will be correct; if it turns up 5 or 6, your **Green Report** will be incorrect.
- Thus, if you actually scored in the top half, each report has a two-thirds chance to be TOP; if you actually scored in the bottom half, each report has a two-thirds chance to be BOTTOM.
- So, if your **Blue Report** says TOP, it is good news about your IQ test performance, but it does not mean you are in the top half for sure. Similarly, if your **Blue Report** says BOTTOM, it is bad news about your IQ test performance, but it does not mean you are in the bottom half for sure. The same goes for your **Green Report**.

When you are ready, click "Next" below to answer some questions about the reports.

Next

Understanding Questions

Your answers to the following questions will not affect your payment. However, you can only proceed once you answer all these questions correctly.

Q1: How many reports will we generate for you in total?

- ○ One
- ○ Two
- ○ Three
- ○ Four

Q2: Suppose you actually scored in the top half in the IQ test. For each report about you, what is the chance that the report will say TOP?

- ○ One third
- ○ One half
- ○ Two thirds

Q3: Suppose your Blue Report says TOP. Should this report make you more or less confident that you scored in the top half in the IQ test?

- ○ More confident
- ○ Less confident
- ○ As confident as before

Q4: Suppose your Blue Report says BOTTOM. Should this report make you more or less confident that you scored in the top half in the IQ test?

- ○ More confident
- ○ Less confident
- ○ As confident as before

Q5: Suppose your Blue Report says TOP. Does this mean that you scored in the top half in the IQ test for sure?

- ○ Yes
- ○ No

Q6: Suppose your Blue Report says BOTTOM. Does this mean that you scored in the bottom half in the IQ test for sure?

- ○ Yes
- ○ No

Q7: Which of the following statements about your two reports is correct?

- ○ If my Blue Report says TOP, then my Green Report must also say TOP
- ○ Even if my Blue Report says TOP, my Green Report may still say BOTTOM

After you finish all the questions, click "Next." If any of your answers are incorrect, you will get an error message below each of your incorrect answers. Once you correct all your answers, you can proceed to the rest of the study by clicking "Next" again.

Next

Part 2: Feedback about Performance

Before you see any feedback, please first answer how likely you think you scored in the top half among all our IQ test participants on the platform.

This question may be chosen to determine your bonus payment. You make the most money by reporting your best guess.

What do you think is the chance that you scored in the top half? Please enter your answer (between 0 and 100) below.

I think there is a _____ % chance that I scored in the top half.

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

Part 2: Feedback about Performance

Feedback starts now...

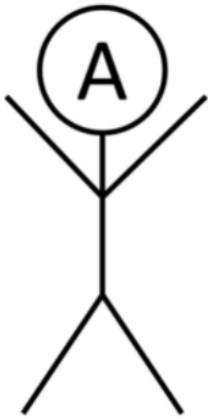
We have generated your **Blue Report** and **Green Report** as we described to you.

We have matched you with two computer players: Ann and Bob. They will be responsible for delivering the feedback to you.

Ann:

Bob:

Ann will show you your **Blue Report**. You will see a message like below. The grey cloud will be replaced by TOP if the **Blue Report** actually says TOP and replaced by BOTTOM if the **Blue Report** actually says BOTTOM.



Bob will randomly choose one of your **Blue Report** and **Green Report** to show you. Specifically, Bob will flip a coin; Bob will choose **Blue Report** if the coin comes up heads, and choose **Green Report** if the coin comes up tails. You will see a message like below. The grey cloud will be replaced by TOP if the chosen report actually says TOP and replaced by BOTTOM if the chosen report actually says BOTTOM. You won't know whether the chosen report is the **Blue Report** or the **Green Report** because the identity of the report is covered by a blue and green cloud that will not be removed.

When you are ready, click "Next" below to answer some questions about the instructions.

Next

Understanding Questions

Your answers to the following questions will not affect your payment. However, you can only proceed once you answer all these questions correctly.

Q1: Which report will Ann show you?

- ○ Blue Report
- ○ Green Report
- ○ Either Blue Report or Green Report

Q2: Which report will Bob show you?

- ○ Blue Report
- ○ Green Report
- ○ Either Blue Report or Green Report

After you finish all the questions, click "Next." If any of your answers are incorrect, you will get an error message below each of your incorrect answers. Once you correct all your answers, you can proceed to the rest of the study by clicking "Next" again.

Next

Part 2: Feedback about Performance

When you are ready, click "Next" to see Ann and Bob.

Next

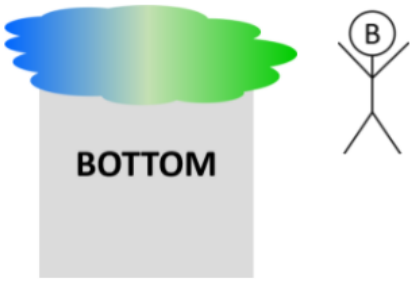
If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Part 2: Feedback about Performance

Ann's Report (the Blue Report)

Bob's Report (the Blue Report or the Green Report)



To confirm, choose what Ann shows you:

- ○ TOP
- ○ BOTTOM

To confirm, choose what Bob shows you:

- ○ TOP
- ○ BOTTOM

When you are ready, click "Next."

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Guess about the Identity of Bob's Report

Now that you have seen both Ann's Report and Bob's Report, we will now ask you to guess the identity of Bob's Report (in other words, whether it is the **Blue Report** or the **Green Report**).

If this question is chosen to determine your bonus payment, you will get a bonus payment of $2 if your guess is correct. Otherwise, you will not get the bonus. Thus, you make the most money by giving your best guess.

Please indicate your guess of the identity of Bob's Report:

- ○ Blue Report
- ○ Green Report

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Confidence in Your Guess

Your guess was that Bob's report is the **Blue Report**. Now we want to get a sense of how confident you are about your guess. Specifically, we will ask you what you think is the chance that Bob's Report is the **Blue Report**.

This question may be chosen to determine your bonus payment. You make the most money by giving your best guess.

What do you think is the chance that Bob's Report is the **Blue Report**? Please enter your answer (between 0 and 100) in the first blank below.

I think there is a _____ % chance that Bob's Report is the **Blue Report**.

(In other words, I think there is a _____ % chance that Bob's Report is the **Green Report**.)

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Belief about Performance

Your guess was that Bob's report is the **Blue Report**. You also answered that you think there is a **65%** chance that Bob's Report is the **Blue Report**.

We will now ask you again how likely you scored in the top half among all our IQ test participants on the platform.

This question may be chosen to determine your bonus payment. You make the most money by giving your best guess.

Before you saw Ann and Bob, you answered that there is a **45%** chance that you scored in the top half.

Having now seen Ann and Bob, what do you think is the chance that you scored in the top half? Please enter your answer (between 0 and 100) below.

I think there is a [ ] % chance that I scored in the top half.

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Both Part 1 and Part 2 of the study are now finished.

Thank you! What do you think?

We would be grateful for any comments on Part 1 (IQ Test) and Part 2 (Feedback about Performance) of the study. Did you feel comfortable with the instructions? Were you confused? If you can tell us which aspects are confusing and what we can do better, we would be very grateful! Thanks in advance!

Feedback on Part 1 [IQ Test]:

Feedback on Part 2 [Feedback about Performance]:

After you answer the questions, click "Next."

Next

Demographic questions

Please answer some questions about yourself to complete this study.

Gender: Which gender identity do you most identify with?

- ○ Female
- ○ Male
- ○ Transgender female
- ○ Transgender male
- ○ Gender variant/Non-conforming
- ○ Not listed
- ○ Prefer not to answer

Race: Which race do you most identify with?

- ○ White or Caucasian
- ○ Black or African American
- ○ Hispanic or Latino
- ○ Asian or Asian American
- ○ American Indian or Alaska Native
- ○ Native Hawaiian or Pacific Islander
- ○ Other
- ○ Prefer not to answer

Age: What is your age?

- ○ 18-25 years old
- ○ 26-35 years old
- ○ 36-45 years old
- ○ 46-55 years old
- ○ 56-65 years old
- ○ Above 65 years old
- ○ Prefer not to answer

Education: What is the highest level of school you have completed or the highest degree you have received?

- ○ Some high school
- ○ High school diploma (or equivalent, including GED)
- ○ Some college
- ○ Associate's degree in 2-year college
- ○ Bachelor's degree in 4-year college
- ○ Master's degree
- ○ Doctoral degree (PhD)
- ○ Professional doctorate (JD, MD)
- ○ Prefer not to answer

What is your marital status?

- ○ Single, never married
- ○ Married or domestic partnership
- ○ Widowed
- ○ Divorced
- ○ Separated
- ○ Prefer not to answer

What is the annual income of your household? This includes money from jobs, net income from business, farm or rent, pensions, dividends, interest, social security payments and any other monetary income.

- ○ Less than $10,000
- ○ $10,000 to $29,999
- ○ $30,000 to $49,999
- ○ $50,000 to $69,999
- ○ $70,000 to $99,999
- ○ $100,000 to $149,999
- ○ $150,000 to $199,999
- ○ More than $200,000
- ○ Prefer not to answer

The study is now finished.

Part 2 has been chosen to determine your final bonus payment.

Your bonus payment from Part 2 is $2.00.

Your total payment (the sum of your fixed payment $3 and final bonus payment $2.00) is $5.00.

Thank you for participating. Your total payment $5.00 will soon be transferred to your account.

Your completion code is 17087F09. Please enter this code on the Prolific site.

Thank you for participating. You may close this browser now.

Have a nice day!

A.1.2 Control Treatment

WELCOME

You are invited to participate in a research study run by the Department of Economics at Stanford University. If you successfully complete the study, you will receive a $3 fixed payment. You may also receive an additional bonus payment (up to $2) in the study. Therefore, the total payment for completion will be $3-5.

On the next page, you will see a consent form. Please review it carefully before deciding whether you want to take part in this study.

When you are ready, click "Next" to read the consent form.

Next

CONSENT FORM

- You are being asked to take part in a research study.
- If you choose to be in the study, you will complete a series of online tasks. This study will help us learn more about how people make decisions. Most participants complete this study in 15 to 25 minutes.
- All payments and procedures will be implemented in exactly the manner they are described in the study instructions and on the Prolific platform. If you complete the study, you will receive a $3 base payment. You may also receive a bonus payment up to $2.
- You may stop the study at any time, but you will only get paid the full amount if you complete the study.
- The study is anonymous, and no one will be able to link your answers back to you. Please do not include your name or other information that could be used to identify you in the study responses.
- This is a minimal risk study. We cannot and do not promise or guarantee that you will receive any benefits from participating.
- Questions, Concerns, or Complaints: If you have any questions, concerns or complaints about this research study - its procedures, risks and benefits - contact Tony Fan, tonyqfan@stanford.edu.
- If you have questions about your rights as a research participant or are not satisfied with how this research is being conducted, you may contact the Stanford University IRB at irb2-manager@lists.stanford.edu to speak to someone independent of the research team.

Being in this study is voluntary. Please exit the webpage if you do not want to participate.

If you agree to participate in this study, please click "Yes, I agree" and "Next." After you click "Next," we will ask you a few questions to determine if you qualify for this study.

Yes, I Agree

Next

Please read carefully

Please make sure that you read the entire paragraph on this page and follow the instructions.

Many professional athletes have become prominent public figures. The following is adapted from Wikipedia:

Some historians – most notably Bernard Lewis – claim that team sports as we know them today are primarily an invention of Western culture. British Prime Minister John Major was more explicit in 1995: "We invented the majority of the world's great sports.... 19th century Britain was the cradle of a leisure revolution every bit as significant as the agricultural and industrial revolutions we launched in the century before." It is critical that the data we collect in this experiment be accurate, and we therefore need to screen out bots and participants who are speeding through the survey without reading the questions. We have included the question below for this purpose. Select only the bottom option, regardless of which athletes you have heard about recently. If you do not select only the bottom option, then you will not be compensated for this survey. The Industrial Revolution and mass production brought increased leisure which allowed more time to engage in playing or observing (and gambling upon) spectator sports, as well as less elitism in and greater accessibility of sports of many kinds. With the advent of mass media and global communication, professionalism became prevalent in sports, and this furthered sports popularity in general.

Based on the text you read above, which of the following athletes have you been asked to enter?

Answer	Select
Lionel Messi	☐
Serena Williams	☐
LeBron James	☐
Tom Brady	☐
Roger Federer	☐
None of the Above	☐

Next

WELCOME

You are now invited to participate in a research study run by the Department of Economics at Stanford University on decision-making. All the responses you will give as part of this study will be strictly anonymous: We will not connect your Prolific ID to any of the answers you give in this study. Your anonymity is thus guaranteed.

Please read and follow all the instructions we give in the study carefully; they contain everything you need to know. Please always scroll down to make sure that you read the entire page.

Most participants complete this study in 15 to 25 minutes. Please start this study only if you have that much time in a single session, and are able to take it on a full screen laptop or computer, NOT a tablet or smartphone. If you do not complete the study, or if the study times out on you, we will not be able to pay you.

You will earn a fixed payment of $3 just for completing this study.

This study consists of three parts. At the end of the study, we will randomly choose one of the three parts. This part will determine your bonus payment (up to $2). The amount of the bonus payment will depend both on the decisions you make in the chosen part and on luck. Your total payment will be the sum of the fixed payment $3 and the bonus payment.

When you are ready, click "Next" to start the first part of the study.

Next

Part 1 begins when you click "Next."

Next

Part 1: IQ Test

In Part 1 of this study, you will take a short IQ test. The test is designed to measure the test taker's reasoning ability. Its result is regarded as an estimate of fluid intelligence. The test was developed and used for academic research on IQ, and was routinely administered to entrants to military services throughout the world. Several high IQ societies accept it as a qualification for admission.

The IQ test has 20 multiple choice questions and you have 5 minutes to answer as many questions as you can. In each question, you are asked to identify the missing element that completes a pattern. Please focus on the shape of the element; the size may be different from those in the pattern.

Your final score is the number of correct answers minus the number of incorrect answers. Questions unanswered will not count towards the score. If your final score is positive, you will get 10 bonus cents for each point you score. If your final score is 0 or less, you won't get any bonus payment, but you also won't lose any money.

When you are ready, click "Next."

Next

Part 1: IQ Test

The test will start soon...

When you click "Start IQ Test," the IQ test will start.

Note:

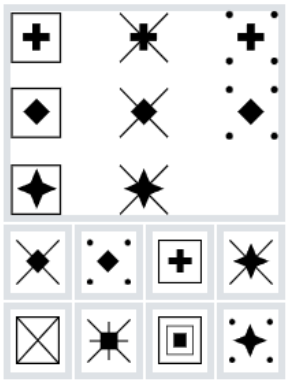
- There are 20 multiple choice questions in total, and your score is the number of correct answers minus the number of incorrect answers. Questions unanswered will not count towards the score.
- You will have 5 minutes to answer as many questions as you can. There will be a clock at the top of the page that tells you the remaining time.
- To answer each question, simply click the option that you think completes the pattern. Please focus on the shape of the options; the size may be different from those in the pattern. You may click the option again to delete your answer. You may click another option to change your answer.
- The test has 20 pages, one for each question. To move on to a different question, click its question number at the bottom of the page. You can always go back to previous questions within the time limit.
- When the time is up, the page will automatically skip to the next part of the study.

Good luck!

Start IQ Test

Part 1: IQ Test

Time left to complete IQ test: **4:51**



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Part 1: IQ Test

The IQ test has ended.

Please answer the following question:
How important is it to you to be able to perform well in the IQ test?
(0 = Not important at all, 10 = Extremely important)

Your answer to this question will NOT affect your payment in this study.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Next

You have completed Part 1. Part 2 begins when you click "Next."

Next

Part 2: Belief about Performance

Please read the following instructions carefully. Please always scroll down to make sure that you read the entire page. We will test your understanding of the instructions. You can only proceed once you answer all questions about the instructions correctly.

In the rest of the study (Part 2 and Part 3), we will ask you several questions. In each question, you can earn a possible bonus of $2, and you make the most money by giving your best guess. In the end, if Part 2 is chosen to count for your bonus, your bonus payment for the study will be the bonus payment associated with the question in Part 2. So you should give your best guess in this question.

In Part 2, we will ask you what you think is the chance that you scored in the top half of all our IQ test participants on the platform. If you want to see details about how the bonus payment will be determined for this question, click "Payment Details" below. The bonus payment for the questions in Part 3 will be determined similarly.

Payment Details

When you are ready, click "Next" to answer some questions about the instructions.

Next

Understanding Questions

Your answers to the following questions will not affect your payment. However, you can only proceed once you answer all these questions correctly.

Q1: Which question will you be asked in Part 2?

- ○ The chance that I scored among the top 25% of all participants in the IQ test
- ○ The chance that I scored among the top half of all participants in the IQ test
- ○ The chance that I scored among the top 75% of all participants in the IQ test
- ○ The amount of payment in this study

Q2: How can you maximize your bonus payment in Part 2?

- ○ By giving an answer that is as high as possible
- ○ By giving my best guess
- ○ By giving an answer that is as low as possible
- ○ By randomly giving an answer

Q3: In the end, if Part 2 is randomly chosen to determine your bonus payment for this study, what will your bonus payment be?

- ○ The bonus payment associated with the question in Part 2
- ○ It will always be $2

After you finish all the questions, click "Next." If any of your answers are incorrect, you will get an error message below each of your incorrect answers. Once you correct all your answers, you can proceed to the rest of the study by clicking "Next" again.

Next

Part 2: Belief about Performance

We will now ask you how likely you think you scored in the top half among all our IQ test participants on the platform.

This question may be chosen to determine your bonus payment. You make the most money by reporting your best guess.

What do you think is the chance that you scored in the top half? Please enter your answer (between 0 and 100) below.

I think there is a _____ % chance that I scored in the top half.

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

You have completed Part 2. Part 3 begins when you click "Next."

Next

Part 3: The Selected Ball

Please read the following instructions carefully. Please always scroll down to make sure that you read the entire page. We will test your understanding of the instructions. You can only proceed once you answer all questions about the instructions correctly.

In Part 3, there are 20 balls hidden in a box. Among these 20 balls, there are exactly **9** balls that have TOP written on them. The other **11** balls have BOTTOM written on them. We will call them TOP balls and BOTTOM balls, respectively.

We have randomly selected one of these 20 balls. This means that **without any additional information** there is a **45%** chance that the randomly selected ball is a TOP ball. This ball will be important for Part 3 and we will call it the **Selected Ball**.

In the rest of Part 3, we will give you some additional information about **the identity of the Selected Ball (i.e., whether it is a TOP ball or a BOTTOM ball)** and then ask you some related questions. In each question, you can earn a possible bonus of $2, and you make the most money by giving your best guess. In the end, if Part 3 is chosen to count for your bonus, we will randomly choose one question in Part 3 to count for your bonus. So you should give your best guess in every question as if it is the question that counts - because it can be!

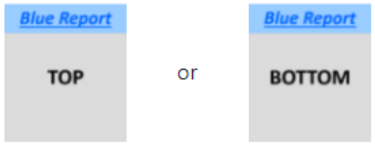
When you are ready, click "Next."

Next

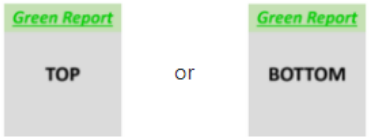
Reports

To give you some additional information about the identity of the Selected Ball, we will generate two reports: **Blue Report** and **Green Report**. Each report says either TOP or BOTTOM, which indicates whether the Selected Ball is a TOP ball or a BOTTOM ball.

Blue Report



Green Report



However, the reports are not always correct because of how they are generated:

- We have a regular die with six faces. We will roll the die twice.
- The first roll determines the **Blue Report**. If the first roll turns up 1, 2, 3, or 4, the **Blue Report** will be correct; if it turns up 5 or 6, the **Blue Report** will be incorrect.
- The second roll determines the **Green Report**. If the second roll turns up 1, 2, 3, or 4, the **Green Report** will be correct; if it turns up 5 or 6, the **Green Report** will be incorrect.
- Thus, if the Selected Ball is a TOP ball, each report has a two-thirds chance to be TOP; if the Selected Ball is a BOTTOM ball, each report has a two-thirds chance to be BOTTOM.
- So, if the **Blue Report** says TOP, it becomes more likely that the Selected Ball is a TOP ball, but it does not mean that it is a TOP ball for sure. Similarly, if the **Blue Report** says BOTTOM, it becomes more likely that the Selected Ball is a BOTTOM ball, but it does not mean that it is a BOTTOM ball for sure. The same goes for the **Green Report**.

When you are ready, click "Next" below to answer some questions about the reports.

Next

Understanding Questions

Your answers to the following questions will not affect your payment. However, you can only proceed once you answer all these questions correctly.

Q1: How many reports will we generate for the Selected Ball?

- ○ One
- ○ Two
- ○ Three
- ○ Four

Q2: Suppose the Selected Ball is a TOP ball. For each report about the Selected Ball, what is the chance that the report will be TOP?

- ○ One third
- ○ One half
- ○ Two thirds

Q3: Suppose the Blue Report is TOP. Should this report make you more or less confident that the Selected Ball is a TOP ball?

- ○ More confident
- ○ Less confident
- ○ As confident as before

Q4: Suppose the Blue Report is BOTTOM. Should this report make you more or less confident that the Selected Ball is a TOP ball?

- ○ More confident
- ○ Less confident
- ○ As confident as before

Q5: Suppose the Blue Report is TOP. Does this mean that the Selected Ball is a TOP ball for sure?

- ○ Yes
- ○ No

Q6: Suppose the Blue Report is BOTTOM. Does this mean that the Selected Ball is a BOTTOM ball for sure?

- ○ Yes
- ○ No

Q7: Which of the following statements about the two reports of the Selected Ball is correct?

- ○ If the Blue Report is TOP, then the Green Report must also be TOP
- ○ Even if the Blue Report is TOP, the Green Report may still be BOTTOM

After you finish all the questions, click "Next." If any of your answers are incorrect, you will get an error message below each of your incorrect answers. Once you correct all your answers, you can proceed to the rest of the study by clicking "Next" again.

Next

Part 3: The Selected Ball

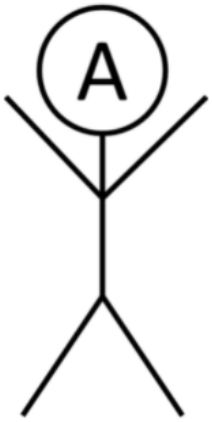
We have generated the **Blue Report** and the **Green Report** about the Selected Ball as we described to you.

There are two computer players: Ann and Bob. Each of them will show you exactly one report about the Selected Ball.

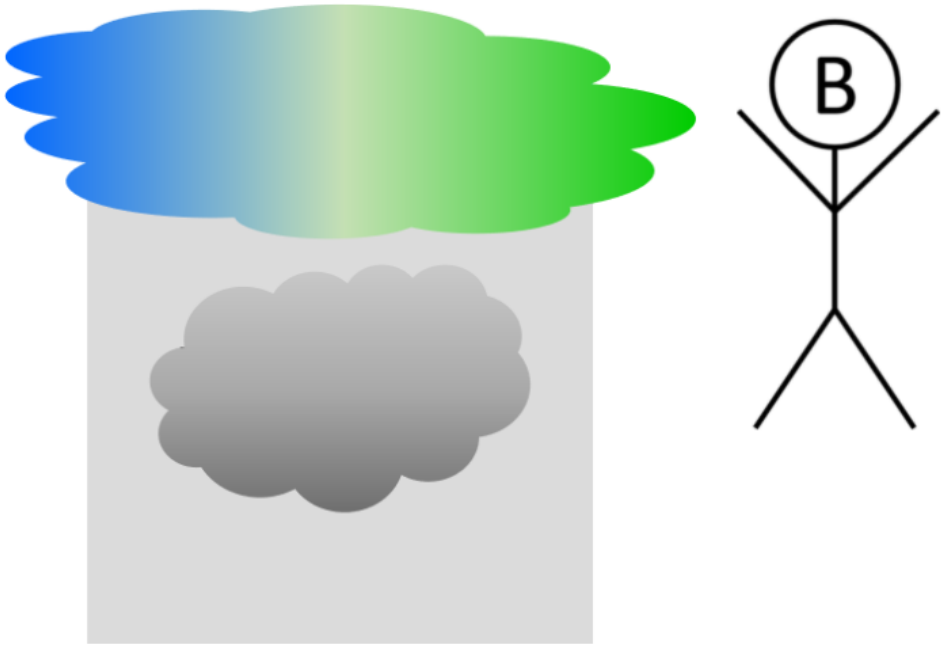
Ann:

Bob:

Ann will show you the **Blue Report**. You will see a message like below. The grey cloud will be replaced by TOP if the **Blue Report** actually says TOP and replaced by BOTTOM if the **Blue Report** actually says BOTTOM.



Bob will randomly choose one of the **Blue Report** and the **Green Report** to show you. Specifically, Bob will flip a coin; Bob will choose **Blue Report** if the coin comes up heads, and choose **Green Report** if the coin comes up tails. You will see a message like below. The grey cloud will be replaced by TOP if the chosen report actually says TOP and replaced by BOTTOM if the chosen report actually says BOTTOM. You won't know whether the chosen report is the **Blue Report** or the **Green Report** because the identity of the report is covered by a blue and green cloud that will not be removed.



When you are ready, click "Next" below to answer some questions about the instructions.

Next

Understanding Questions

Your answers to the following questions will not affect your payment. However, you can only proceed once you answer all these questions correctly.

Q1: Which report will Ann show you?

- ○ Blue Report
- ○ Green Report
- ○ Either Blue Report or Green Report

Q2: Which report will Bob show you?

- ○ Blue Report
- ○ Green Report
- ○ Either Blue Report or Green Report

After you finish all the questions, click "Next." If any of your answers are incorrect, you will get an error message below each of your incorrect answers. Once you correct all your answers, you can proceed to the rest of the study by clicking "Next" again.

Next

Part 3: The Selected Ball

When you are ready, click "Next" to see Ann and Bob.

Next

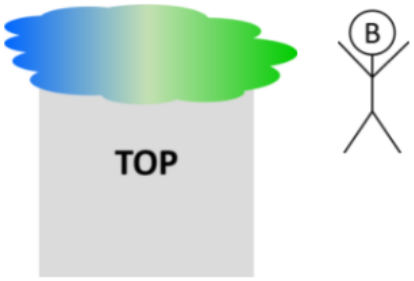
If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Part 3: The Selected Ball

Ann's Report (the Blue Report)

Bob's Report (the Blue Report or the Green Report)



To confirm, choose what Ann shows you:

- ○ TOP
- ○ BOTTOM

To confirm, choose what Bob shows you:

- ○ TOP
- ○ BOTTOM

When you are ready, click "Next."

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Guess about Bob's Report

Now that you have seen both Ann's Report and Bob's Report, we will now ask you to guess the identity of Bob's Report (in other words, whether it is the **Blue Report** or the **Green Report** of the Selected Ball).

If this question is chosen to determine your bonus payment, you will get a bonus payment of $2 if your guess is correct. Otherwise, you will not get the bonus. Thus, you make the most money by giving your best guess.

Please indicate your guess of the identity of Bob's Report:

- ○ Green Report
- ○ Blue Report

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Confidence in Your Guess

Your guess was that Bob's report is the **Blue Report** of the Selected Ball. Now we want to get a sense of how confident you are about your guess. Specifically, we will ask you what you think is the chance that Bob's Report is the **Blue Report**.

This question may be chosen to determine your bonus payment. You make the most money by giving your best guess.

What do you think is the chance that Bob's Report is the **Blue Report**? Please enter your answer (between 0 and 100) in the first blank below.

I think there is a _____ % chance that Bob's Report is the **Blue Report**.

(In other words, I think there is a _____ % chance that Bob's Report is the **Green Report**.)

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Belief about the Selected Ball

Your guess was that Bob's report is the **Blue Report** of the Selected Ball. You also answered that you think there is a **65%** chance that Bob's Report is the **Blue Report** of the Selected Ball.

We will now ask you how likely you think the Selected Ball is a TOP ball.

This question may be chosen to determine your bonus payment. You make the most money by giving your best guess.

Remember that we randomly selected the Selected Ball from a box of 20 balls so that **without any additional information** there is a **45%** chance that the Selected Ball is a TOP ball.

Having now seen Ann and Bob, what do you think is the chance that the Selected Ball is a TOP ball? Please enter your answer (between 0 and 100) below.

I think there is a [ ] % chance that the Selected Ball is a TOP ball.

After you answer the question, click "Next." You can only click "Next" after 30 seconds. This is to make sure that you have sufficient time to think about and answer the question.

Next

If you wish, you can review the instructions about the feedback by clicking "Instructions" below.

Instructions

Both Part 1 and Part 2 of the study are now finished.

Thank you! What do you think?

We would be grateful for any comments on Part 1 [IQ Test], Part 2 [Belief about Performance], and Part 3 [The Selected Ball] of the study. Did you feel comfortable with the instructions? Were you confused by the instructions? If you can tell us which aspects are confusing and what we can do better, we would be very grateful! Thanks in advance!

Feedback on Part 1 [IQ Test]:

Feedback on Part 2 [Belief about Performance]:

Feedback on Part 3 [The Selected Ball]:

After you answer the questions, click "Next."

Next

Demographic questions

Please answer some questions about yourself to complete this study.

Gender: Which gender identity do you most identify with?

- ○ Female
- ○ Male
- ○ Transgender female
- ○ Transgender male
- ○ Gender variant/Non-conforming
- ○ Not listed
- ○ Prefer not to answer

Race: Which race do you most identify with?

- ○ White or Caucasian
- ○ Black or African American
- ○ Hispanic or Latino
- ○ Asian or Asian American
- ○ American Indian or Alaska Native
- ○ Native Hawaiian or Pacific Islander
- ○ Other
- ○ Prefer not to answer

Age: What is your age?

- ○ 18-25 years old
- ○ 26-35 years old
- ○ 36-45 years old
- ○ 46-55 years old
- ○ 56-65 years old
- ○ Above 65 years old
- ○ Prefer not to answer

Education: What is the highest level of school you have completed or the highest degree you have received?

- ○ Some high school
- ○ High school diploma (or equivalent, including GED)
- ○ Some college
- ○ Associate's degree in 2-year college
- ○ Bachelor's degree in 4-year college
- ○ Master's degree
- ○ Doctoral degree (PhD)
- ○ Professional doctorate (JD, MD)
- ○ Prefer not to answer

What is your marital status?

- ○ Single, never married
- ○ Married or domestic partnership
- ○ Widowed
- ○ Divorced
- ○ Separated
- ○ Prefer not to answer

What is the annual income of your household? This includes money from jobs, net income from business, farm or rent, pensions, dividends, interest, social security payments and any other monetary income.

- ○ Less than $10,000
- ○ $10,000 to $29,999
- ○ $30,000 to $49,999
- ○ $50,000 to $69,999
- ○ $70,000 to $99,999
- ○ $100,000 to $149,999
- ○ $150,000 to $199,999
- ○ More than $200,000
- ○ Prefer not to answer

How much of your total personal income comes from work on Prolific?

- ○ A little bit
- ○ A substantial share but less than half
- ○ Most of my income
- ○ All of my income
- ○ Prefer not to answer

Which state do you live in?

What is your Prolific ID?

After you answer the questions, click "Next."

Next

The study is now finished.

Part 3 has been chosen to determine your final bonus payment.

Your bonus payment from Part 3 is $2.00.

Your total payment (the sum of your fixed payment $3 and final bonus payment $2.00) is $5.00.

Thank you for participating. Your total payment $5.00 will soon be transferred to your account.

Your completion code is 17087F09. Please enter this code on the Prolific site.

Thank you for participating. You may close this browser now.

Have a nice day!