

ONLINE APPENDIX FOR:  
DISENTANGLING SUBOPTIMAL UPDATING:  
STRUCTURE, SEQUENCING, AND COMPLEXITY

Marina Agranov      Pellumb Reshidi

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## Contents

|          |                                                            |           |
|----------|------------------------------------------------------------|-----------|
| <b>1</b> | <b>Instructions</b>                                        | <b>2</b>  |
| 1.1      | Common Instructions . . . . .                              | 2         |
| 1.2      | Baseline Treatment Instructions . . . . .                  | 4         |
| 1.3      | Simultaneous Treatment Instructions . . . . .              | 5         |
| 1.4      | Sequential Treatment Instructions . . . . .                | 6         |
| <b>2</b> | <b>Interface</b>                                           | <b>7</b>  |
| 2.1      | Baseline Treatment Interface . . . . .                     | 7         |
| 2.2      | Simultaneous Treatment Interface . . . . .                 | 8         |
| 2.3      | Sequential Treatment Interface . . . . .                   | 10        |
| <b>3</b> | <b>Individual Level Analysis</b>                           | <b>10</b> |
| 3.1      | Primary Data Patterns . . . . .                            | 10        |
| 3.2      | Individual-Level Effect of Information Structure . . . . . | 12        |
| 3.3      | Classifying Types: K-means Clustering . . . . .            | 15        |
| 3.4      | Classifying Types . . . . .                                | 19        |
| <b>4</b> | <b>Additional Analysis</b>                                 | <b>20</b> |
| 4.1      | Aligned Information Posteriors . . . . .                   | 20        |
| 4.2      | Pilot Data . . . . .                                       | 20        |

# 1 Instructions

## 1.1 Common Instructions

The instructions shown in this subsection were seen by participants regardless of their treatment. These initial instructions aimed to familiarize participants with the mechanism through which they submitted their posteriors.

Figure 1: Initial Instructions I

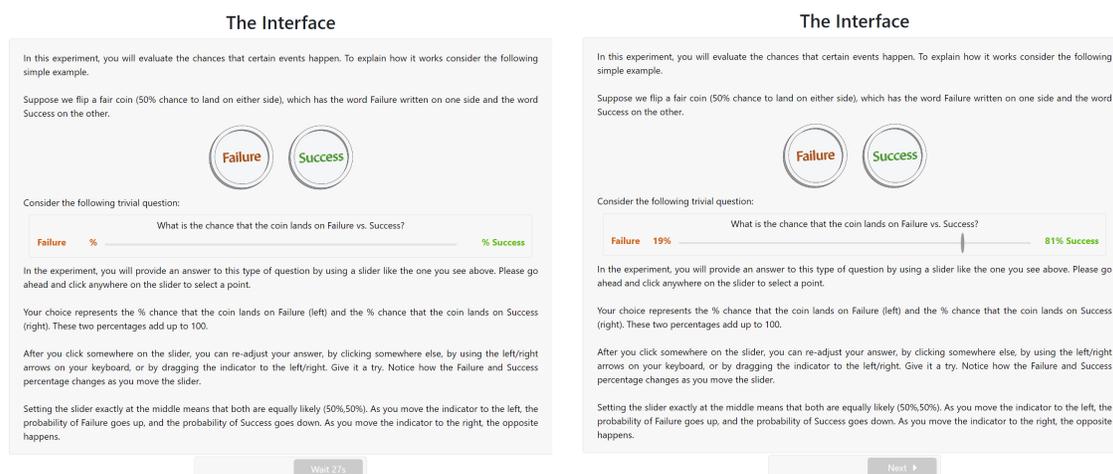
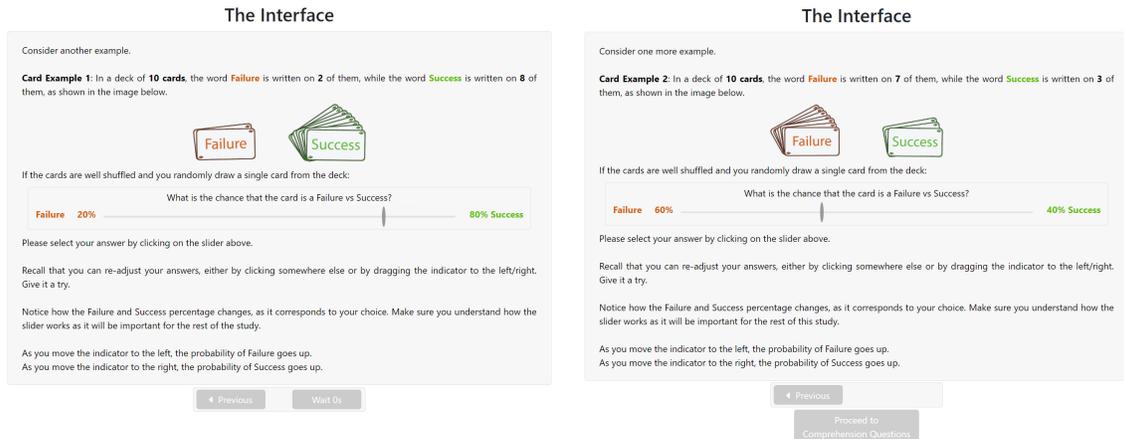


Figure 1 shows the initial page presented to the participants. To ensure that participants spend time internalizing the information, the *Next* button was made available only after a countdown of 30 seconds.<sup>1</sup> On this, and every other page, there is initially no indicator on the slider via which participants submit their probabilities. We made this decision to prevent participants from being anchored. The indicator and accompanying probabilities show up only after participants click somewhere on the slider. Compare the left (before clicking) and right (after clicking) screenshots in Figure 1.

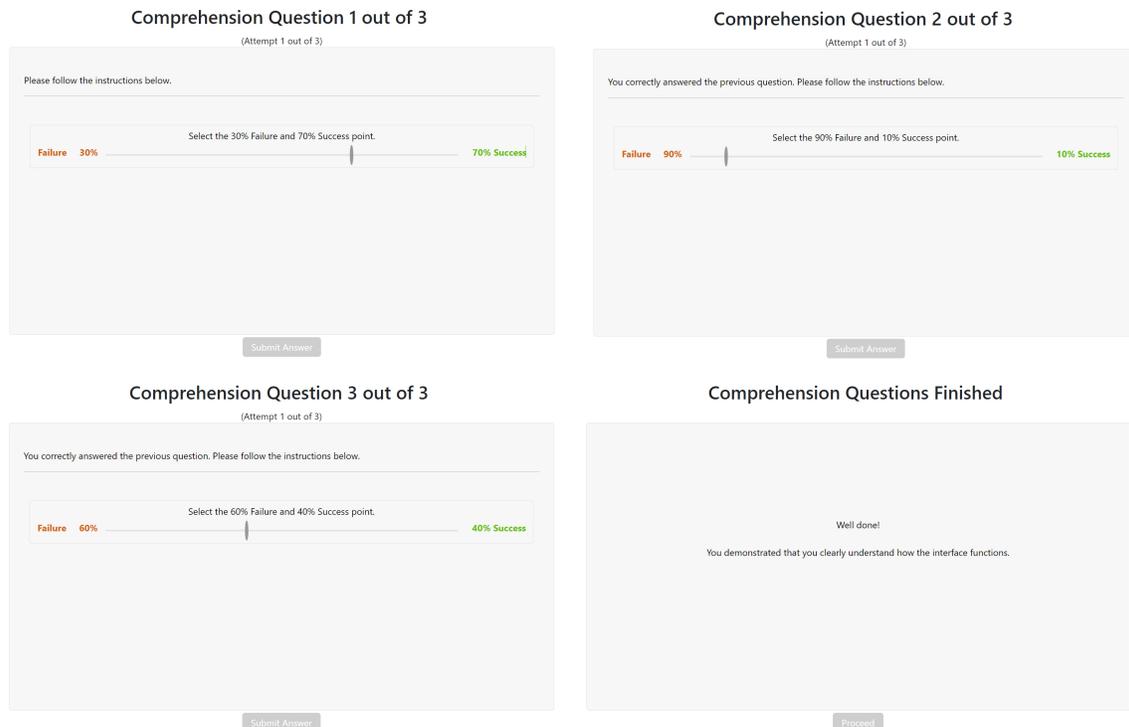
<sup>1</sup>Compare buttons on the bottom of the left and right screenshots shown in Figure 1. The left screenshot is taken 3 seconds after the page was loaded, whereas the right screenshot is taken after at least 30 seconds.

Figure 2: Initial Instructions II



Instructions continue by giving participants two more examples and reminding them how the mechanism works; see Figure 2. After these examples, participants are invited to start a simple comprehension test to ensure they know how to use the slider properly, see Figure 3.

Figure 3: Initial Instructions II



If participants submitted wrong answers more than twice, they were not al-

lowed to continue the study. Successful participants continued with treatment-specific instructions.

## 1.2 Baseline Treatment Instructions

Figure 4: Baseline Treatment Instructions

The figure displays six sequential screenshots of the 'Instructions' screen for a baseline treatment. Each screen contains the following information:

- Details of the Main Question:** The experiment consists of several rounds. In each round, a project is selected randomly from a pool of projects (with each project having the same probability of being selected). Within this pool of projects, 85% of projects are Failures while 15% are Successful. Your task is to evaluate the chance that the project that was randomly selected is a Failure vs. Success. To aid your evaluation, the computer will run a test on the selected project. Test Accuracy is 80% which means that:
  - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
  - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.
 We will ask you to submit two evaluations:
  - If the test is Positive, what is the chance that the project is a Success vs. Failure?
  - If the test is Negative, what is the chance that the project is a Success vs. Failure?
- Prior Information:** Throughout the experiment you will be reminded of the information regarding the chances of Failed and Successful projects as well as the accuracy of the test. In particular you will see the box below.
 

Prior Information:

  - 85% of Projects are Failures; 15% of Projects are Successful.
  - Test Accuracy is 80% which means that:
    - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
    - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.
- How Payments are Calculated:** In every question of this type, you will use the slider to indicate the probabilities of Failure and Success. Let  $X$  represent your chosen probability of Failure, and consequently  $100 - X$  will be your chosen probability of Success. After you submit your choice of  $X$ , the program will generate a number from 0 to 100, with each number being equally likely. Call this number  $Y$ . Your chosen number  $X$ , the randomly generated number  $Y$ , and whether the outcome is Failure or Success will determine your chances of winning \$20. If  $Y$  is greater than or equal to  $X$ , you will win \$20 with  $Y\%$  chance. If  $Y$  is less than  $X$ , you will win \$20 if the outcome is Failure. Given this payment scheme, it is always in your best interest to choose  $X$  that represents your best evaluation of the chance that Failure and Success will happen. **The important thing to remember is that we have chosen the payment scheme so that it is always in your best interest to honestly report your best evaluation of the chance that Failure and Success happens.**
- Rounds:** You will play a total of 20 rounds. Rounds are independent of each other. You will receive \$5 for completing the experiment. In addition, you have a 20% chance of receiving a bonus payment of \$20. If you are selected to receive the bonus payment the computer will randomly select one of the 20 rounds. Each round is equally likely to be chosen. Your answers in the randomly selected round will determine whether you receive the bonus or not, as will be described shortly. Whether you are selected to receive the bonus payment and which round counts for your bonus will be determined at the end of the experiment. **Therefore, it is in your best interest to do your best in every single round, because that might be the round that determines your bonus!** **Important:** The prior information, i.e., the fraction of Failure and Success Projects and the Test Accuracy, is the same in every round. Moreover, rounds are completely independent of each other and your submitted guesses do not influence the chances of a randomly selected project being a success or a failure or the test results. If you are confident in your answer, you can continue to submit the same answers as you move through the rounds. However, if, given the feedback, you have a new evaluation, naturally, you can change your answers.
- Summary:**
  - You will play a total of 20 rounds.
  - All rounds are the same in terms of Failure/Success probabilities and test accuracy.
  - Rounds are completely independent of each other, that is, the outcomes of previous rounds do not affect the chances that the next project is a Failure or Success.
  - To maximize your payment, given the test result, you should give your best evaluation of the chance that the project is a Failure vs. Success.
  - If you are confident in your answer, you can continue to submit the same answer.
  - If given the feedback you have a new evaluation, naturally, you can change your answer.
- End of Instructions:** This is the end of Instructions. To proceed click the Begin Study button.

## 1.3 Simultaneous Treatment Instructions

Figure 5: Simultaneous Treatment Instructions

The figure displays six sequential screenshots of the experiment's instruction page, titled "Instructions".

- Details of the Main Question:** Explains that the experiment consists of several rounds. In each round, a project is selected randomly from a pool. Within this pool, 50% of projects are Failures and 50% are Successful. The task is to evaluate the chance that the randomly selected project is a Failure vs. Success. Two tests are run: Test 1 (85% accuracy) and Test 2 (80% accuracy). Test 1 results: Success (85% Positive, 15% Negative), Failure (85% Negative, 15% Positive). Test 2 results: Success (80% Positive, 20% Negative), Failure (80% Negative, 20% Positive). A "Next" button is at the bottom.
- Visual Examples:** Shows two examples of the question interface. The first shows "If Test 1 is Positive and Test 2 is Positive" with a slider between "Failure" and "Success". The second shows "If Test 1 is Positive and Test 2 is Negative". Below are instructions on how to interact with the slider and a "Submit" button.
- Prior Information:** Reminds the user of the 50% Failure/50% Success ratio and the test accuracies. A "Next" button is at the bottom.
- Rounds:** States there are 20 rounds, independent of each other. The user will receive \$5 for completing the experiment. A 20% chance of a \$20 bonus is mentioned. A key instruction: "Therefore, it is in your best interests to do your best in every single round, because that might be the round that determines your bonus!". A "Next" button is at the bottom.
- How Payments are Calculated:** Explains that a number  $X$  (0-100) is chosen for Failure probability and  $100 - X$  for Success probability. A randomly generated number  $Y$  (0-100) determines the outcome: if  $Y \geq X$ , it's Success; if  $Y < X$ , it's Failure. A "Next" button is at the bottom.
- Summary:** Summarizes the 20 rounds, independence, and the goal to maximize payment. A "Begin Study" button is at the bottom.

# 1.4 Sequential Treatment Instructions

Figure 6: Sequential Treatment Instructions

The figure displays six sequential screenshots of the 'Instructions' page for an experiment. Each screenshot is a light gray box with a title 'Instructions' at the top. The content of each screenshot is as follows:

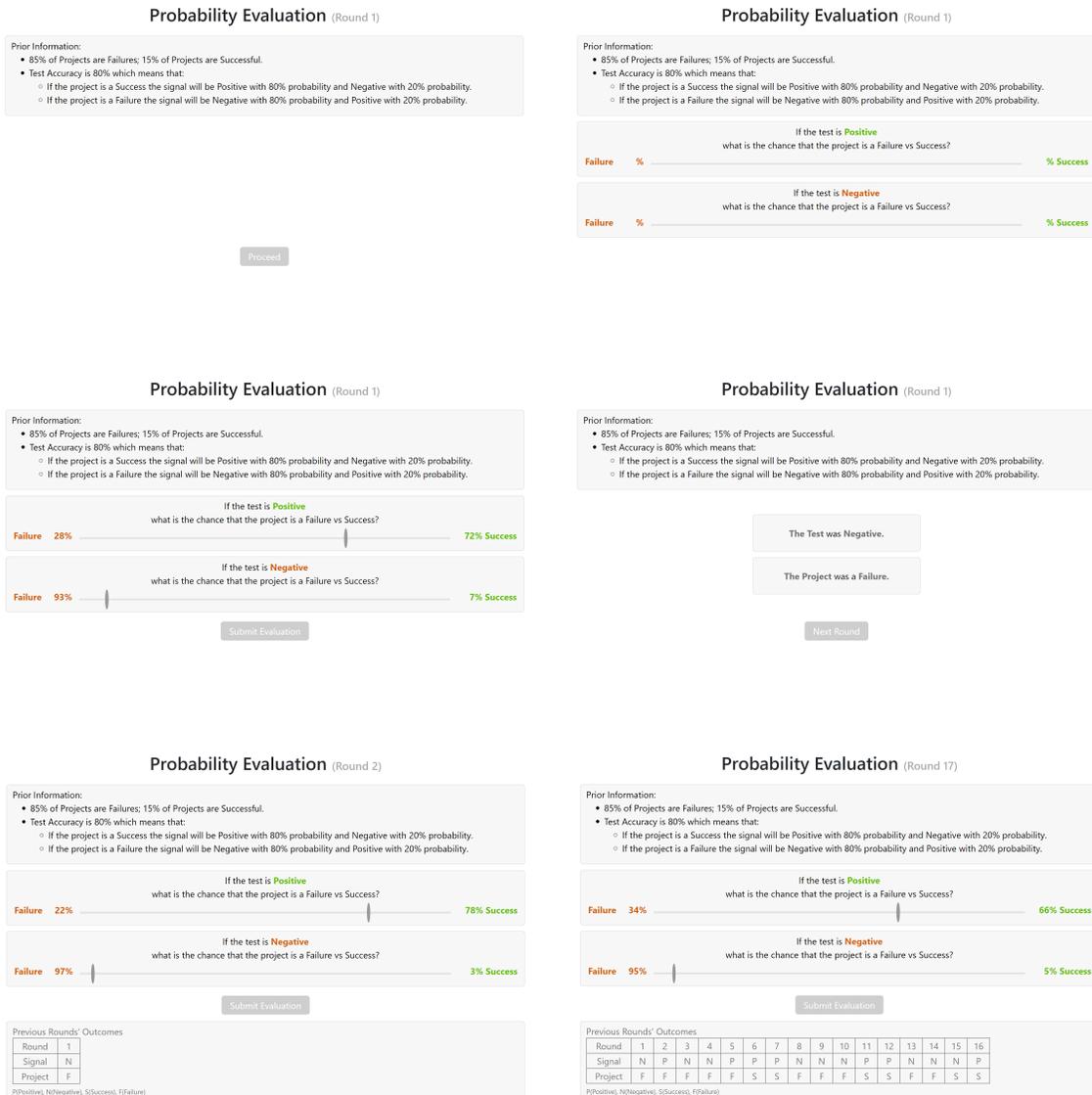
- Top-left:** 'Details of the Main Question'. The experiment consists of several rounds. In each round, a project is selected randomly from a pool of projects (with each project having the same probability of being selected). Within this pool of projects 50% of projects are Failures while 50% are Successful. Your task is to evaluate the chance that the project that was randomly selected is a Failure vs. Success. To aid your evaluation, the computer will run two tests on the selected project. Test 1 Accuracy is 85% which means that: If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability. If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability. Test 2 Accuracy is 80% which means that: If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability. If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. We will ask you to submit an evaluation after receiving Test 1 results. Afterwards we will ask you to submit two more evaluations: Given the result of Test 1, if Test 2 is Positive, what is the chance that the project is a Success vs. Failure? Given the result of Test 1, if Test 2 is Negative, what is the chance that the project is a Success vs. Failure? A 'Next >' button is at the bottom.
- Top-right:** 'Details of the Main Question'. Here is how it will look like. Test 1 is Positive. what is the chance that the project is a Failure vs Success? A slider shows 'Failure %' on the left and '% Success' on the right. Below the slider, it says: 'Once more, you can click, drag, or re-click anywhere on the interval to choose the chance of Failure vs Success that you think is correct in each question.' 'Make sure to read Test 1 results carefully, as they may change from round to round.' 'In the actual round, once you make both decisions a Submit button will appear. When you click the Submit button you will no longer be able to change your answers.' 'Previous <' and 'Next >' buttons are at the bottom.
- Middle-left:** 'Details of the Main Question'. After receiving the result of Test 1 and submitting your evaluation, you will be asked for two more evaluations. For each possible Test 2 result (Positive and Negative), you will select a point that indicates the chance that the randomly selected project is a Success vs. Failure given the test result. You will also be reminded of the result of Test 1. See below. Test 1 is Positive. If Test 2 is Positive, what is the chance that the project is a Failure vs Success? If Test 2 is Negative, what is the chance that the project is a Failure vs Success? 'Once more, you can click, drag, or re-click anywhere on the interval to choose the chance of Failure vs Success that you think is correct in each question.' 'Make sure to read Test 1 and Test 2 results carefully, as they may change from round to round.' 'In the actual round, once you make both decisions a Submit button will appear. When you click the Submit button you will no longer be able to change your answers.' 'Previous <' and 'Next >' buttons are at the bottom.
- Middle-right:** 'Prior Information'. Throughout the experiment you will be reminded of the information regarding the chances of Failed and Successful projects as well as the accuracy of the test. In particular you will see the box below. Prior Information: 50% of Projects are Failures; 50% of Projects are Successful. Test 1 Accuracy is 85% which means that: If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability. If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability. Test 2 Accuracy is 80% which means that: If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability. If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. 'Feedback'. At the end of each round, once you submit your answers, you will see the actual test result, and whether the project was a Failure or Success. This information will be summarized at the bottom of the screen in a table, which will keep track of the outcomes of all rounds that you have previously played. 'Previous <' and 'Next >' buttons are at the bottom.
- Bottom-left:** 'Rounds'. You will play a total of 20 rounds. Rounds are independent of each other. You will receive \$5 for completing the experiment. In addition, you have a 20% chance of receiving a bonus payment of \$20. If you are selected to receive the bonus payment the computer will randomly select one of the 20 rounds. Each round is equally likely to be chosen. Your answers in the randomly selected round will determine whether you receive the bonus or not, as will be described shortly. Whether you are selected to receive the bonus payment and which round counts for your bonus will be determined at the end of the experiment. Therefore, it is in your best interests to do your best in every single round, because that might be the round that determines your bonus. Important: The prior information, i.e., the fraction of Failure and Success Projects and the Test Accuracy, is the same in every round. Moreover, rounds are completely independent of each other and your submitted guesses do not influence the chances of a randomly selected project being a success or a failure or the test results. If you are confident in your answer, you can continue to submit the same answers as you move through the rounds. However, if, given the feedback, you have a new evaluation, naturally, you can change your answers. 'Previous <' and 'Next >' buttons are at the bottom.
- Bottom-right:** 'How Payments are Calculated'. In every question of this type, you will use the slider to indicate the probabilities of Failure and Success. Let X represent your chosen probability of Failure, and consequently 100 - X will be your chosen probability of Success. After you submit your choice of X, the program will generate a number from 0 to 100, with each number being equally likely. Call this number Y. Your chosen number X, the randomly generated number Y, and whether the outcome is Failure or Success will determine your chances of winning \$20. If Y is greater than or equal to X, you will win \$20 with Y% chance. If Y is less than X, you will win \$20 if the outcome is Failure. Given this payment scheme, it is always in your best interest to choose X that represents your best evaluation of the chance that Failure and Success will happen. The important thing to remember is that we have chosen the payment scheme so that it is always in your best interest to honestly report your best evaluation of the chance that Failure and Success happens. 'Previous <' and 'Next >' buttons are at the bottom.

## 2 Interface

### 2.1 Baseline Treatment Interface

We present various screenshots of the interface presented to participants in the baseline treatments at different stages of the study. We highlight important features below.

Figure 7: Baseline Treatment Interface



- As clarified in the instructions, throughout the experiment, at the top, participants see information regarding the prior probability of successful/failed projects as well as the signal accuracy.
- As clarified in the instructions, when asked “*If the test is Positive/Negative, what is the chance that the project is a Failure vs. Success?*” there is initially no indicator on the slider. We made this decision to prevent participants from being anchored. Only after they click somewhere on the slider does the indicator and the accompanying probabilities show up. For a concrete example, compare the top right and middle left screenshots in [Figure 7](#).
- After clicking the “Submit Evaluation” button, participants were informed about the particular realized value of the signal and whether the project was a Failure or Success. See the middle right screenshot above.
- The realized signals and project outcomes from previous rounds are summarized in a table at the bottom of the interface. See bottom left for an example in Round 2 and bottom right for an example in Round 17. We keep track of past outcomes to shut down possible effects that imperfect recall may have.

## 2.2 Simultaneous Treatment Interface

The image displays two screenshots of the 'Probability Evaluation' interface for Round 1. Both screenshots show a 'Prior Information' section with the following text:

- 50% of Projects are Failures; 50% of Projects are Successful.
- Test 1 Accuracy is 85% which means that:
  - If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability.
  - If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability.
- Test 2 Accuracy is 80% which means that:
  - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
  - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.

The left screenshot shows a 'Proceed' button at the bottom. The right screenshot shows two conditional questions with sliders:

If Test 1 is **Negative** and Test 2 is **Positive**  
what is the chance that the project is a Failure vs Success?  
Failure % \_\_\_\_\_ % Success

If Test 1 is **Negative** and Test 2 is **Negative**  
what is the chance that the project is a Failure vs Success?  
Failure % \_\_\_\_\_ % Success

### Probability Evaluation (Round 1)

**Prior Information:**

- 50% of Projects are Failures; 50% of Projects are Successful.
- Test 1 Accuracy is 85% which means that:
  - If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability.
  - If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability.
- Test 2 Accuracy is 80% which means that:
  - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
  - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.

If Test 1 is **Negative** and Test 2 is **Positive**  
what is the chance that the project is a Failure vs Success?

Failure 58% 42% Success

If Test 1 is **Negative** and Test 2 is **Negative**  
what is the chance that the project is a Failure vs Success?

Failure 97% 3% Success

### Probability Evaluation (Round 1)

**Prior Information:**

- 50% of Projects are Failures; 50% of Projects are Successful.
- Test 1 Accuracy is 85% which means that:
  - If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability.
  - If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability.
- Test 2 Accuracy is 80% which means that:
  - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
  - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.

Test 1 was Negative.

Test 2 was Negative.

The project was a Failure.

### Probability Evaluation (Round 2)

**Prior Information:**

- 50% of Projects are Failures; 50% of Projects are Successful.
- Test 1 Accuracy is 85% which means that:
  - If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability.
  - If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability.
- Test 2 Accuracy is 80% which means that:
  - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
  - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.

If Test 1 is **Positive** and Test 2 is **Positive**  
what is the chance that the project is a Failure vs Success?

Failure 3% 97% Success

If Test 1 is **Positive** and Test 2 is **Negative**  
what is the chance that the project is a Failure vs Success?

Failure 44% 56% Success

**Previous Rounds' Outcomes**

|          |   |
|----------|---|
| Round    | 1 |
| Signal 1 | N |
| Signal 2 | N |
| Project  | F |

P(Positive), N(Negative), S(Success), F(Failure)

### Probability Evaluation (Round 17)

**Prior Information:**

- 50% of Projects are Failures; 50% of Projects are Successful.
- Test 1 Accuracy is 85% which means that:
  - If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability.
  - If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability.
- Test 2 Accuracy is 80% which means that:
  - If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
  - If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability.

If Test 1 is **Negative** and Test 2 is **Positive**  
what is the chance that the project is a Failure vs Success?

Failure 57% 43% Success

If Test 1 is **Negative** and Test 2 is **Negative**  
what is the chance that the project is a Failure vs Success?

Failure 96% 4% Success

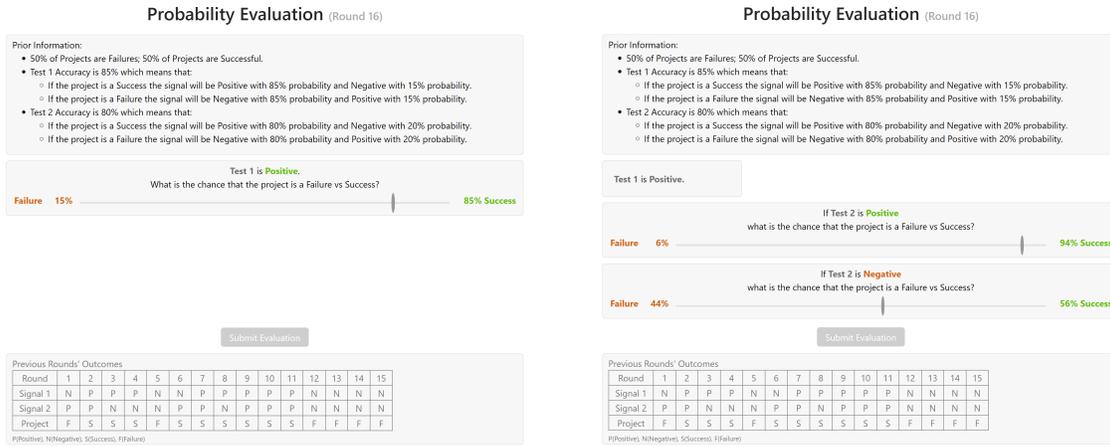
**Previous Rounds' Outcomes**

|          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
|----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|
| Round    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Signal 1 | N | P | N | N | N | N | P | N | N | P  | N  | P  | N  | N  | P  | N  |
| Signal 2 | N | N | N | N | N | P | P | N | P | P  | N  | N  | N  | P  | N  | P  |
| Project  | F | S | F | F | F | F | S | F | F | S  | F  | S  | S  | F  | S  | F  |

P(Positive), N(Negative), S(Success), F(Failure)

- Most of the design choices are unchanged from the Baseline treatment. However, in the simultaneous treatment, participants received both signals at the same time.

## 2.3 Sequential Treatment Interface



- Once more, most of the design choices are unchanged from the previous treatments. However, in the sequential treatment, participants received signals sequentially. Upon receiving the first signal, their posterior probability was elicited. Afterward, participants stated their posteriors conditional on the realized value of the second signal.
- The interface displays the outcome of the first signal when participants make choices conditional on the outcome of the second signal.

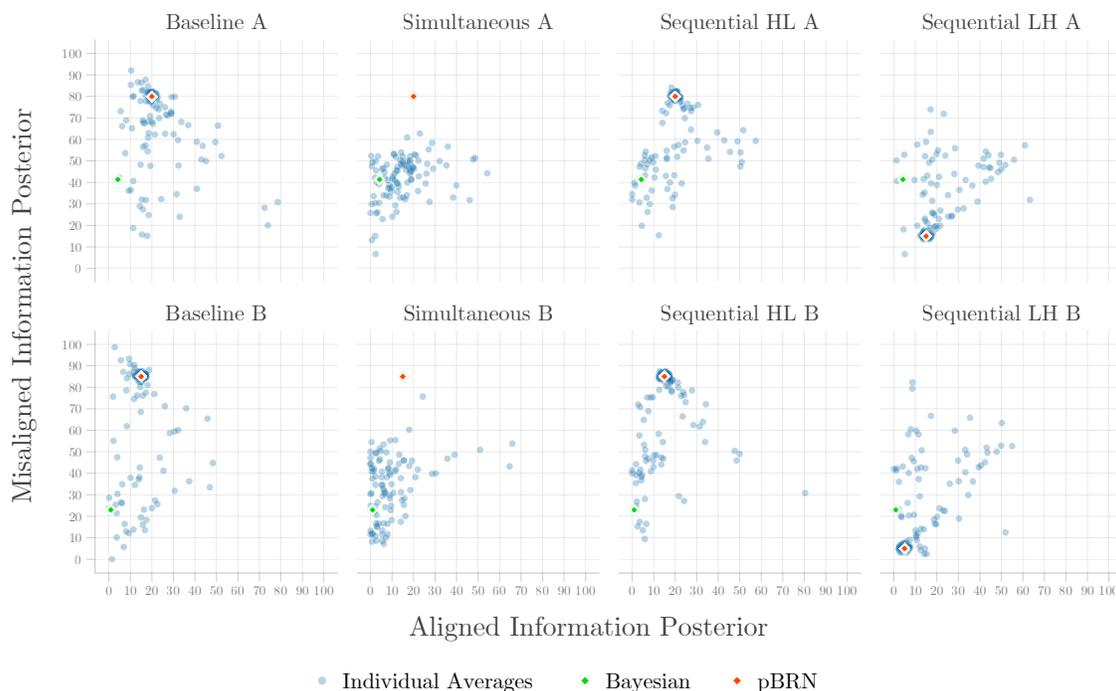
## 3 Individual Level Analysis

### 3.1 Primary Data Patterns

We now shift our attention to individual-level behavior. For each participant, we calculate their average elicited beliefs across all rounds for both aligned and misaligned information and present these averages in [Figure 8](#).<sup>2</sup> Therefore, each datapoint in the figure represents the average behavior of a single participant.

<sup>2</sup>In the Online Appendix, we show the counterpart of [Figure 8](#) utilizing only the last five rounds. All main features remain unchanged.

Figure 8: Average Individual Choices



Notes: To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value. The top(bottom) row displays data across treatments under parametrization A(B).

As can be seen, whenever information is released sequentially, the individual-level average posteriors are heavily bunched around the pBRN level.<sup>3</sup> This bunching phenomenon persists regardless of whether the sequential information delivery stems from an informative prior and a single signal (Baseline treatment) or an uninformative prior and two signals (Sequential treatments). Only when information is released simultaneously do we observe beliefs that are not heavily concentrated around the pBRN levels. These findings align with **Result 9** (Drivers of Base-rate Neglect) in the main text, demonstrating the substantial impact of recency bias.

**Result 1 (De-Bundling).** *The Simultaneous treatment is the only treatment leading to individual-level beliefs that are not strongly concentrated around the pBRN level.*

<sup>3</sup>Note that, given our normalization, in Sequential LH, the pBRN level is (15,15) under the first parametrization and (5,5) under the second.

Figure 9 displays the counterpart of Figure 8 utilizing data from the last five rounds only. As can be seen, the takaways are unchanged.

Figure 9: Average Individual Choices: Last Five Rounds



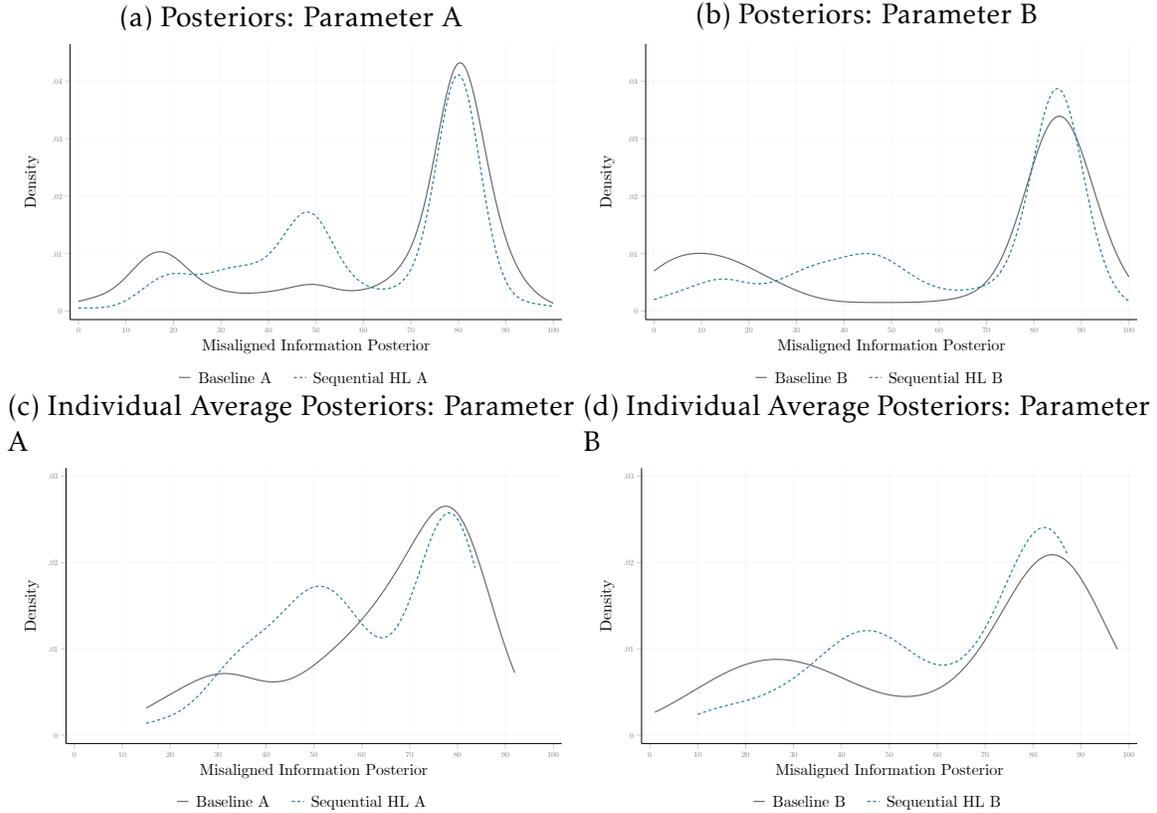
Notes: To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value. The top(bottom) row displays data across treatments under parametrization A(B).

### 3.2 Individual-Level Effect of Information Structure

Recall that we observe no significant differences between average beliefs reported in the Baseline and the Sequential HL treatments in both parameterizations A and B (4.4 Information Structure and Sequencing in the main text). Although this holds true on average, in this section, we explore whether the information structure plays a role on an individual level.

In Figure 10a and Figure 10b, we show estimated kernel densities of posteriors from the Baseline and Sequential HL treatments, under parametrization A and B respectively. Within a parametrization, the estimation pools posteriors across

Figure 10: Distribution of Posteriors and Individual-Level Averaged Posteriors



participants and rounds.<sup>4</sup> In both parameterizations, despite the similar means, the distributions exhibit notable differences. In the sequential HL treatments, there is a greater concentration towards intermediate values, which are close to the Bayesian level. While the fractions of participants choosing posteriors around the pBRN levels (80 for A and 85 for B) are comparable, in the sequential HL treatment we see fewer values above these levels and fewer values for low posteriors. In both parameterizations, this mass is redistributed from the more extreme values towards the center in such a way that keeps the mean roughly unchanged. However, we run a Kolmogorov-Smirnov test between the Baseline and Sequential HL distributions and reject the null that they are the same ( $p < 0.01$ ) under both parametrizations A and B.

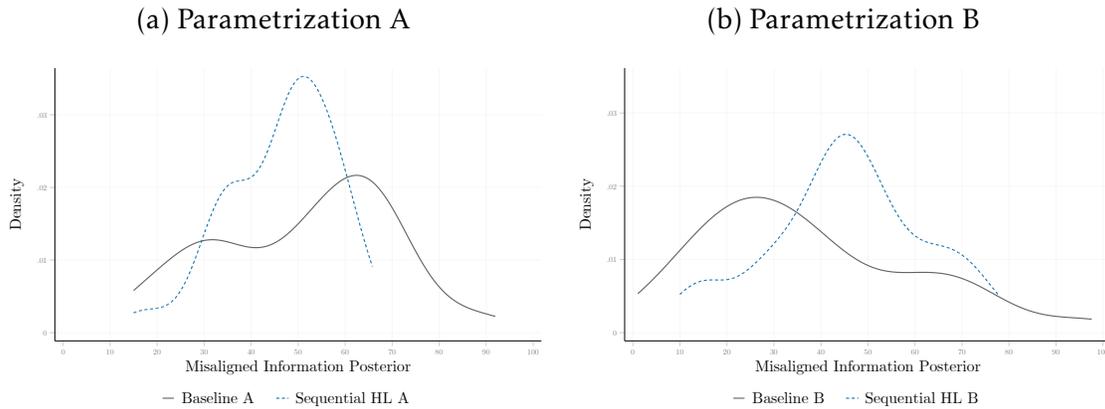
The change between the distributions can be due to small changes in the behavior of many participants, drastic changes in the behavior of some participants,

<sup>4</sup>Due to the consistent behavior exhibited by participants, conditioning on any round results in a qualitatively indistinguishable graph.

or both. To further explore this, we compute the average posterior for each participant across the 20 rounds and estimate kernel densities based on these average posteriors. Doing so allows us to focus on the variation across participants. In [Figure 10c](#) and [Figure 10d](#), we present estimated kernel densities of the average individual-level posteriors in the baseline and sequential HL treatments, under parametrization A and B respectively. As can be seen, a considerable portion of participants, on average, choose levels near the pBRN levels (80 for A and 85 for B). These participants disregard the initial information and solely follow the second signal. For the remainder of the distributions, we see that in the Sequential HL treatment, fewer individuals choose extreme values. Our interpretation of these additional estimated kernel densities is that changing the information structure has no effect on individuals who solely follow the second signal, while for others, it steers their choices towards less extreme values—closer to the Bayesian level.

Below, we estimate the kernel densities under both parameterizations after removing participants that seem to behave in a pBRN manner. We remove participants from the analysis if their average aligned and misaligned posteriors are within 10 points from the pBRN posterior level.<sup>5</sup>

Figure 11: Individual-Level Averaged Posteriors Excluding pBNE



Compared to [Figure 10a](#) and [Figure 10b](#), the difference between the estimated kernel densities becomes starker. This is in line with our interpretation that in-

<sup>5</sup>For parametrization A, this implies we drop participants whose misaligned posteriors are between 70 and 90 and whose aligned posteriors are between 10 and 30. For parametrization B, this implies we drop participants whose misaligned posteriors are between 75 and 95 and whose aligned posteriors are between 5 and 25.

formation structure seems to have minimal to no effect on participants who show pBRN behavior; however, for other non-pBRN participants, the effect is sizable. This is in line with our interpretation of the differential effect of information structure. In other words, for participants who only focus on the most recent information, the particular information structure does not play a substantial role—they ignore the initial information regardless. On the other hand, for participants who somewhat incorporate both the initial and the more recent information, the specific information structure can influence belief updating.

**Result 2** (Effect of Information Structure). *Elicited beliefs of participants who exclusively rely on recent information are unaffected by information structure. For other participants, a change in the information structure results in less extreme reported beliefs.*

### 3.3 Classifying Types: K-means Clustering

We next proceed by classifying participants into different types. To determine the number of types and the types themselves, we utilize K-means clustering, which, simply put, is a method that partitions  $n$  observations into  $k$  clusters/groups. Each observation is associated with the cluster with the nearest mean (centroid). This results in a partitioning of the data space into Voronoi cells. Specifically, K-means clustering minimizes within-cluster variances (squared Euclidean distances). This is one of the most commonly used unsupervised classifiers.<sup>6</sup> By employing this procedure, we bypass the need to determine types subjectively. Instead, we rely on the unsupervised classification procedure to determine both the number of types and their characteristics. To determine the number of clusters, we employ two commonly used approaches, the *elbow method* and the *silhouette score*. Details of these approaches are presented in the [Section 3.4](#). Based on this initial analysis, the suggested number of clusters is three.

Since our aim is to evaluate how the share of different types changes across treatments, we separate the typical K-means clustering into two parts. The first part, clustering, involves determining the centroids for each cluster. We do this by pooling the data across treatments within a parametrization. Having determined

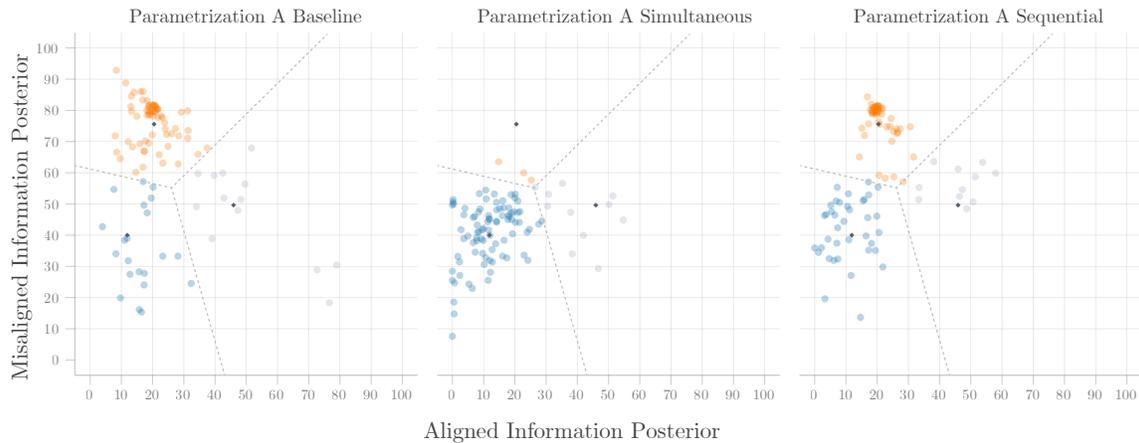
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<sup>6</sup>An unsupervised classifier is a machine learning algorithm that automatically identifies patterns and groups data without prior labeled training examples.

the centroids, we then proceed with the second part, classification, which simply associates each observation to the cluster with the nearest mean.<sup>7</sup> To identify the centroids, we use a standard iterative refinement technique. To summarize, we do the following: (i) determine the number of clusters, (ii) determine the centroids, and (iii) classify participants.

We follow the exercise described above for treatments one through three. We exclude the sequential LH treatment for technical reasons.<sup>8</sup> The clustered data is shown in Figure 12, along with the three centroids and the corresponding Voronoi sets they generate.

Figure 12: Parametrization A Clustering



Notes: Participants are categorized into three separate clusters. Dark gray dots mark the centroids of these clusters, and dashed lines represent the Voronoi cells corresponding to these centroids.

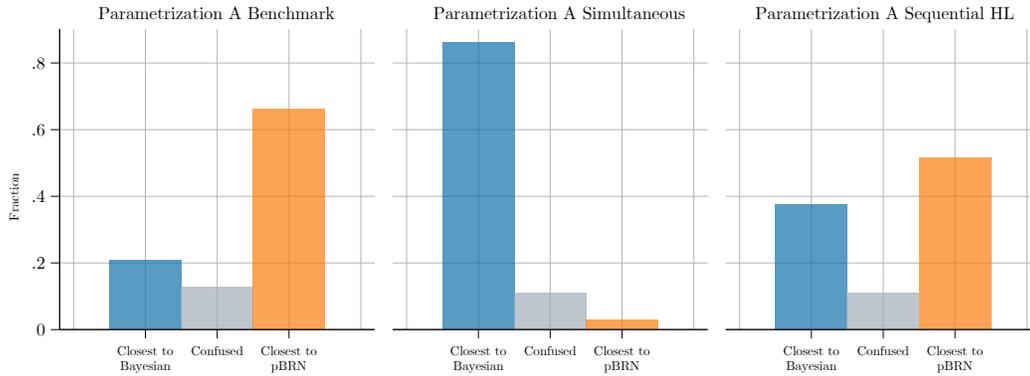
We see the emergence of three distinct clusters, with their centroids exhibiting close proximity to the Bayesian posterior (4.2,41.38), the 50-50 posterior, and the pBRN posterior (20,80). Consequently, we interpret the first group as roughly Bayesian, or closest to Bayesian, the second as potentially exhibiting confusion, and the third as roughly pBRN, or closest to pBRN. We label the second cluster as

<sup>7</sup>Had we not followed the procedure described above, and instead, had we estimated centroids for each treatment, there would be no natural way to compare shares of participants belonging to different groups across treatments since what a group is would differ from treatment to treatment.

<sup>8</sup>In the sequential LH treatment, if we do not normalize the data, as we have done in the main analysis, the Bayesian posterior will have a different position compared to the three other treatments. If we normalize the data, the pBRN posterior will have a different position compared to the three other treatments. This, in turn, hampers our ability to have a natural interpretation of the clusters. Hence, we proceed with the clustering exercise for the first three treatments only.

potentially confused due to the fact that, regardless of the prior and signal value, whether positive or negative, participants consistently opt for values close to 50. We display the fraction of each type across treatments in [Figure 13](#).

Figure 13: Parametrization A Cluster Histogram

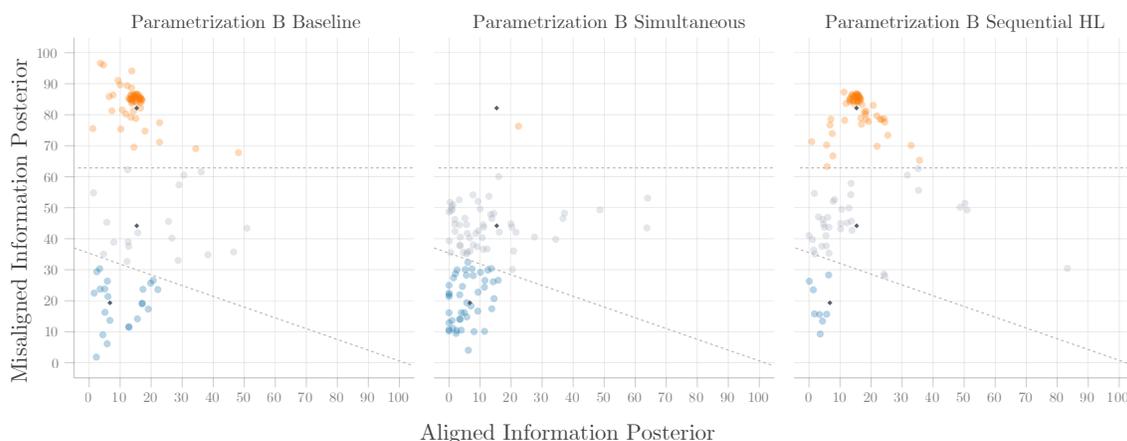


As can be seen, a simultaneous release of information under the first parametrization leads to the largest share of participants classified as closest to Bayesian, with a minuscule share of agents closest to the pBRN level. Importantly, although in the previous section, we saw that the estimated mean under the Baseline and Sequential HL treatments was not statistically different, we see that the composition of the type of participants differs. The Sequential HL treatment is characterized by a higher share of closest-to-Bayesian agents and a lower share of closest-to-pBRN agents. Thus, in line with the evidence presented in [Section 3.2](#), the information structure does seem to have an effect on individual-level behavior.

**Result 3** (Information Structure and Type Classification). *Information structure affects participant categorization.*

We next turn our attention to parametrization B. We once again follow the procedure described above and show the clustered data in [Figure 14](#), along with the three centroids and the corresponding Voronoi sets they generate.

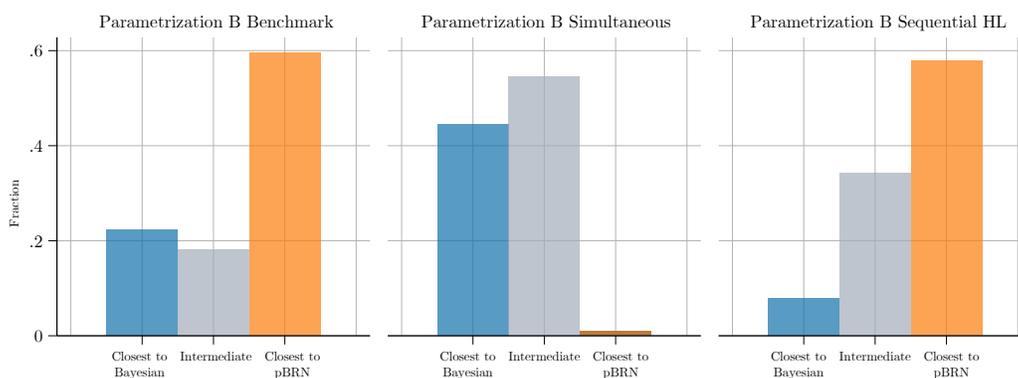
Figure 14: Parametrization B Clustering



Notes: Participants are categorized into three separate clusters. Dark gray dots mark the centroids of these clusters, and dashed lines represent the Voronoi cells corresponding to these centroids.

We see the emergence of three distinct clusters, with their centroids exhibiting close proximity to the Bayesian posterior (0.9,22.97), an in-between posterior, and the pBRN posterior (15,85). Consequently, we interpret the first group as roughly Bayesian, or closest to Bayesian, the second as in between the two extremes, and the third as roughly pBRN, or closest to pBRN. We display the fraction of each type across treatments in Figure 13.

Figure 15: Parametrization B Cluster Histogram



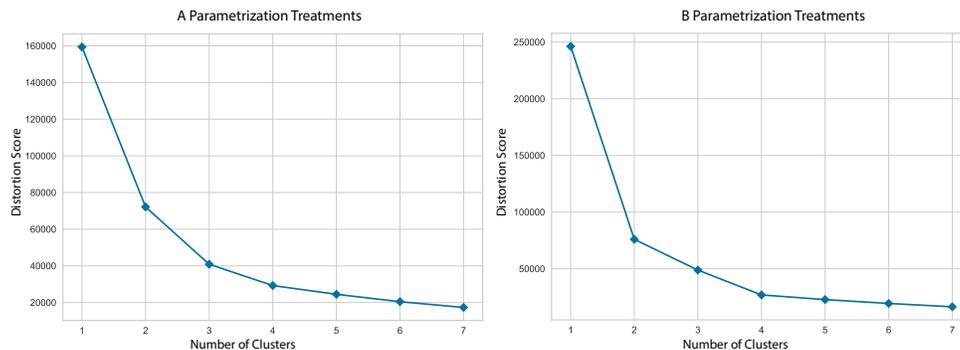
Once more, a simultaneous release of information leads to the largest share of participants classified as closest to Bayesian, with a minuscule share of agents classified as closest to the pBRN level. We once again see that the classification of participants differs between the baseline and sequential HL treatments.

**Result 4** (Types Across Parameters). *We observe variation in both clusters as well as the distribution of participants among these clusters across different parameters.*

### 3.4 Classifying Types

The elbow method is a way to determine the optimal number of clusters in a dataset for k-means clustering. It works by plotting the sum of squared distances between each point and the centroid of its cluster against the number of clusters used. The plot looks like an arm, and the elbow point on the arm represents the best number of clusters to use. This is because the elbow point is where adding more clusters does not significantly improve the clustering results. The elbow method helps to select an appropriate number of clusters for k-means clustering, avoiding underfitting or overfitting the data. The graphs shown in [Figure 16](#) reveal that the elbow method recommends three clusters for parametrization A, while for parametrization B, the score is somewhat ambiguous between two, three, and four clusters. We supplement our calculations by determining the optimal number of clusters via the silhouette method.

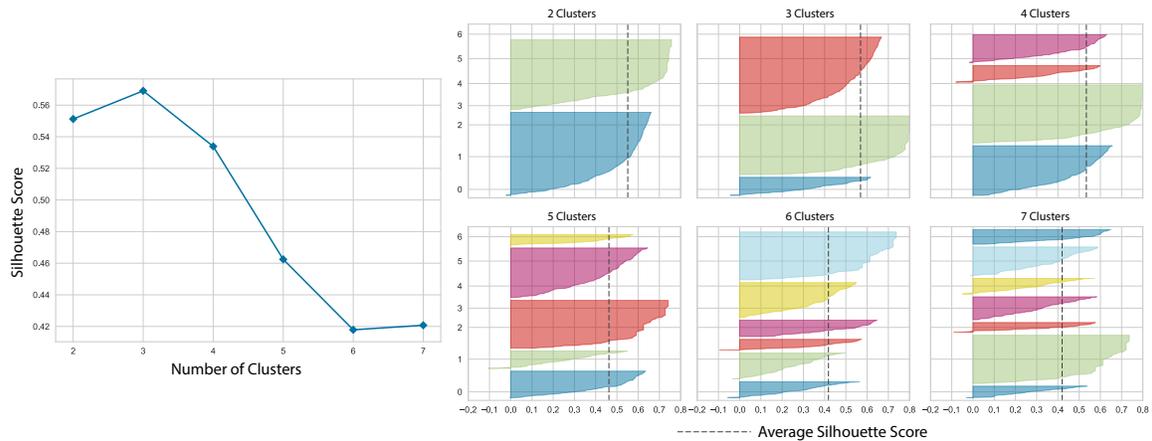
Figure 16: Distortion Score Elbow for K-Means Clustering



The silhouette method is a way to evaluate the quality of clustering results in a dataset. It works by measuring how similar an observation is to its own cluster compared to other clusters. The silhouette score ranges from -1 to 1, with higher values indicating better clustering results. A score of 1 indicates that the observation is well-matched to its own cluster and poorly-matched to other clusters. A score of -1 indicates the opposite, while a score of 0 indicates that the observation is equally similar to its own cluster and other clusters. The silhouette method calculates the average silhouette score of all observations in the dataset and uses this

as a measure of how well the data is clustered. The method can be used to compare different clustering methods or to select the best number of clusters to use in a k-means clustering analysis. By selecting the number of clusters that maximizes the silhouette score, the method can help improve the accuracy and reliability of the clustering results. The graphs shown in [Figure 17](#) reveal that the silhouette score is maximized under three clusters.

Figure 17: Silhouette Scores For K-Means Clustering



We therefore decide to proceed with the clustering exercise with three clusters.

## 4 Additional Analysis

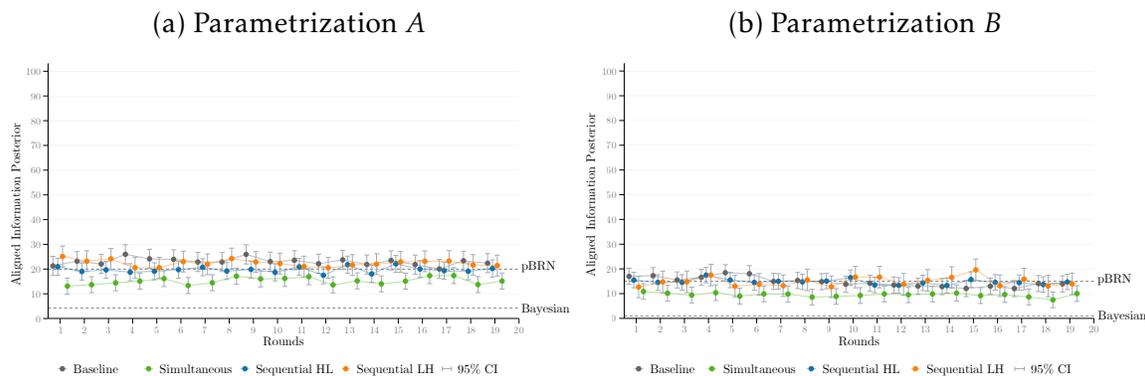
### 4.1 Aligned Information Posteriors

In [Figure 18a](#) and [Figure 18b](#), we graph the average round-by-round beliefs of participants when information is aligned. For the Baseline treatment, these are cases when the realized signal is in the direction in which the prior leans. For all other treatments, these are cases in which both signals have the same realized value.

### 4.2 Pilot Data

**Estimated Means** We conducted two pilot studies under parametrization A for the Baseline and Simultaneous treatment. In [Table 1](#), we compare the estimated

Figure 18: Aligned Information Posteriors



mean from Baseline A and Simultaneous A with the estimated means in their corresponding pilot treatments. The variable *Constant* captures the estimated mean in the regular session, whereas the variable *Pilot* captures the difference of the estimated mean from this value in the pilot treatment. As can be seen, regardless of the error clustering level, the difference is never statistically significant.

Table 1: Estimated Means

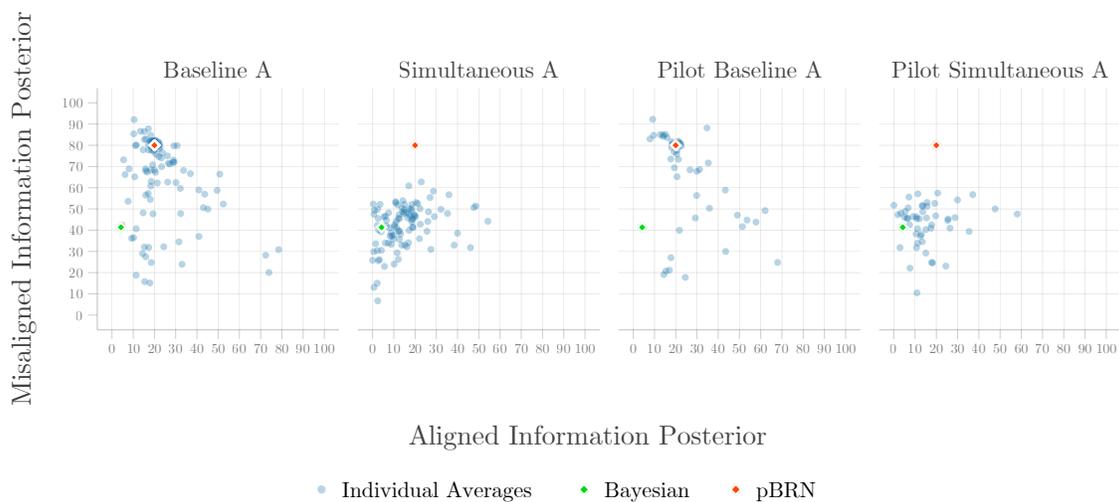
|                 | Baseline A          |                     |                     | Simultaneous A      |                     |                     |
|-----------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|                 | No C                | Ind C               | Ind C + Last 5      | No C                | Ind C               | Ind C + Last 5      |
| <i>Constant</i> | 63.79***<br>(0.595) | 63.79***<br>(1.971) | 60.43***<br>(2.428) | 41.65***<br>(0.384) | 41.65***<br>(0.987) | 40.29***<br>(1.295) |
| <i>Pilot</i>    | 0.434<br>(1.041)    | 0.434<br>(3.680)    | 5.911<br>(4.285)    | 1.001<br>(0.667)    | 1.001<br>(1.740)    | 1.483<br>(2.382)    |
| <i>N</i>        | 3000                | 3000                | 750                 | 3020                | 3020                | 755                 |

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Individual Level Analysis** In Figure 19, we plot the individual level data for Baseline A and Simultaneous A, as well as their corresponding pilot treatments.

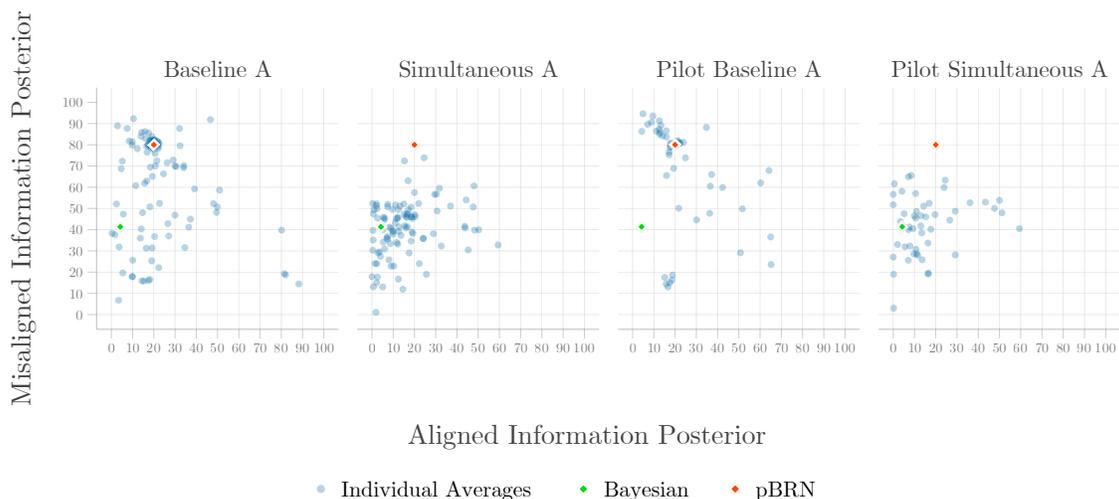
Figure 19: Average Individual Choices



Notes: To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value.

In Figure 20, we do the same utilizing data from the last five rounds only.

Figure 20: Average Individual Choices: Last Five Rounds



Notes: To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value.