Beliefs about Others: A Striking Example of Information Neglect

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Abstract

In many games of imperfect information, players can make Bayesian inferences about other players' types based on the information that is contained in their own type. Several behavioral theories of belief-updating even start from the assumption that players project their own type onto others also when it is not rational. We investigate such inferences in a simple environment that is a vital ingredient of numerous game-theoretic models and experiments, in which types are drawn from one out of two states of the world and participants have to guess the type of another participant. We find little evidence for irrational (over-)projection. Instead, between 50% and 70% of the participants in our experiment completely neglect the information contained in their own type and base their beliefs and choices only on the prior probabilities. Using several experimental interventions, we show that this striking neglect of information is very robust.

JEL classification: C91, D83.

Keywords: Projection, Bayesian inference, biased belief-updating.

1. Introduction

We examine how people make inferences from their own type about other people's types. There are many situations in which such inferences play a role. Just to name two examples that have been extensively discussed in the literature, inferences about others' types play a critical role in auctions with correlated valuations (Cremer and McLean, 1985, 1988; Brusco, 1998; Breitmoser, 2019) and elections with correlated political preferences (Goeree and Großer, 2007; Taylor and Yildirim, 2010; Agranov et al., 2017; Tolvanen, 2017).

For settings like the above, the theoretical prediction is that people make rational Bayesian inferences about the type distribution based on the information that is contained in their own type. Such inferences are standard in economic theories with fully rational agents. Several behavioral theories, such as social projection, information projection, or type projection (Dawes, 1989; Madarász, 2012, 2015; Breitmoser, 2019) even assume that people over-infer from their own type and thus over-project it onto others. This assumption is supported by a number of empirical studies (*e.g.,* Messé and Sivacek, 1979; Offerman et al., 1996; Aksoy and Weesie, 2012; Blanco et al., 2014; Danz et al., 2018). However, it also stands in stark contrast with findings from other studies in which inferences are not about another person's type. These studies show that people often neglect available sources of information (*e.g.,* Friedman, 1998; Page, 1998; Hanna et al., 2014; Esponda and Vespa, 2014; Enke and Zimmermann, 2019). In light of this evidence, it would be important to study a situation that is a wide-spread ingredient of both theoretic and experimental work and in which both (over-)projection and information neglect are possible. This is what we do in this paper.

In a laboratory experiment with three consecutively developed treatments, we make the players' types very salient and thus create favorable conditions for finding rational projection and over-projection. For the purposes of this paper, we use the term "rational projection" to refer to situations in which the rational response directionally coincides with the projection response, but does not overshoot to over-projection. The basic set-up that we use to study projection is a common ingredient in many experimental studies of games of imperfect-information (*e.g.,* Guarnaschelli et al., 2000; Holt and Smith, 2009, 2016; Bouton et al., 2016; Fehrler and Hughes, 2018).

There are two possible states of the world, a dark urn and a light urn. Each urn contains two balls of its own color and one ball of the other urn's color. One of the states/urns is randomly drawn. Then, player A's type (a dark ball or a light ball) is drawn from the true state of the world. After replacement of A's ball, player B's type (ball) is drawn from the same urn. Player A does not get to see B's type. Instead, player A's task is to guess B's type. Between rounds, we vary the prior probabilities of the states of the world.[1]

In this setup, the Bayesian response often coincides with the response of an over-projecting agent. Nevertheless, we would have been able to disentangle rational projection from over-projection if nec-

[1] Our set-up is "value-neutral" and does not involve "ego-relevant" belief-updating, such as updating from feedback on own performance, to avoid biases through motivated reasoning (see Coutts, 2018).

essary as we elicited participants' beliefs about how likely the other player is of a certain type. However, given the lack of evidence for any type of projection in our data, there is no need to disentangle Bayesian updating from over-projection: while many subjects do react to changes in the prior, they do not react at all to the information that is contained in their own type. When asked about their belief about the other player's type in the easiest setting of a 50-50 prior for either urn, a majority of around 70%(!) of subjects state the prior probability, for example.[2] We test the robustness of this result with a battery of interventions that nudge participants toward making use of this source of information. The interventions that we employ include (i) belief-elicitation tasks (with respect to both the other's type and the state of the world) between the guessing rounds to highlight the importance of belief-updating, (ii) tasks without replacement to highlight the importance of replacement, (iii) tasks with several additional draws from the selected urn to stimulate learning, (iv) the use of physical urns and balls to avoid potential confusion about computerized processes, and (v) questions about the subject's reasoning behind previous choices to increase deliberation and facilitate the identification of reasoning errors. While participants do react to the interventions themselves, none of the interventions is very effective in reducing information neglect in the subsequent type-guessing task; only asking for beliefs slightly reduces it. Hence, we conclude that the striking degree of information neglect that we observe is a robust finding.

The self-described reasoning of participants suggests that many believe that nothing has changed when the ball is put back into the urn as compared to the situation before receiving the ball, and hence that the probability that the other person has the same type must be the prior probability. This resembles the "no change principle" that many people appear to be following in the more complicated Monty Hall problem (Burns, 2017)—a classic setting in which information neglect is the rule rather than the exception.[3] Next, we discuss the related literature and state our hypotheses.

2. Related literature and hypotheses

2.1. Projection

"Projection" can be defined as follows. A projecting person infers from their own type that another person shares their type with a probability that is higher than the *prior* probability. This can be the rational result of Bayesian updating—when one's type is indeed informative about the other player's type—or irrational. Our definition includes all sorts of projection, from social projection (Dawes, 1989) to information projection (Madarász, 2012), action projection (Al-Nowaihi and Dhami, 2015) and type projection (Breitmoser, 2019).

[2] This is also a strong piece of evidence against stochastic choice as a possible alternative explanation for the low projection rates that we find in our main task. If participants were randomizing their choices and answers, they would not be so consistent in their belief statements.

[3] We describe and discuss the Monty Hall problem in the next section.

Social projection is an established concept in psychology, incorporating the assumption that people tend to project their own preferences, behavior and intentions onto others (Ross et al., 1977). A mathematical foundation for social projection was first suggested by Dawes in his rationalization of the false-consensus effect (Dawes, 1989). Today, the terms "false-consensus bias" and "social-projection bias" are often used synonymously. Closely related to social projection, Madarász (2012; 2015) studies projection of information from an informed participant to an uninformed one.

Another closely related concept is type projection. It incorporates a social-projection bias similar to the one defined above and also relates to information projection. Game-theoretically—though perhaps not psychologically—all bits of private information, preferences and informative signals can be subsumed under the term "type" and treated equivalently with the set of tools that are available for the analysis of games of imperfect information. Breitmoser (2019) sets up an elegant model of type projection in Bayesian games, where some players overestimate the probability that other people in their group share their type. He argues that people over-infer from their own type and project it onto others. He defines "type" in the context of auctions with two-sided imperfect information as a person's signal about the object value. A type-projecting agent believes that with some probability p, their opponents have the same type as herself, and with probability $(1-p)$, their opponents have the types that Bayesian updating would indicate. The projecting agents then best-respond to the mixture of Bayesian and projected types.

There is evidence for projection both in non-strategic and strategic environments and both between individuals (Messé and Sivacek, 1979; Offerman et al., 1996; Aksoy and Weesie, 2012; Blanco et al., 2014; Danz et al., 2018) and within individuals but between different points in time (Gilbert et al., 1998; Read and Van Leeuwen, 1998; Conlin et al., 2007; Danz et al., 2015), which we interpret as suggesting that it might be a general phenomenon. In line with the literature on projection, we thus state the hypothesis that participants (over-)infer from, and thus (over-)project, their own types in our simple belief-updating tasks.

Projection Hypothesis: *Participants (over-)infer from their own types and thus (over-)project their own types onto others.*

However, a second strand of literature has revealed evidence that subjects often neglect available sources of information.

2.2. Information Neglect

Several theories predict that people will fail to take into account one or another element of the information structure, often in situations in which non-trivial contingent reasoning is necessary.[4] We subsume

[4]For recent general discussions of the difficulties with contingent reasoning see Miller and Sanjurjo (2019) and Martínez-Marquina et al. (2019). Note also the various terms used in the literature to describe related concepts to information neglect, *e.g.* conservatism (Edwards, 1968; Fischhoff and Beyth-Marom, 1983; El-Gamal and Grether, 1995) and base rate fallacy (Meehl and Rosen, 1955; Kahneman and Tversky, 1972; Bar-Hillel, 1980).

these theories under the label “information-neglect theories”.

For example, there is the work by Eyster and Rabin (2005, 2010), who argue that there are two ways in which people in strategic settings may err when inferring from information—first, an extreme form of inferential neglect (cursed equilibrium), and second, a form of inferential naivety. Type projection is conceptually related to cursed equilibrium (Eyster and Rabin, 2005). Both models are solution concepts for Bayesian games, in which agents distort the correlation between the opponents’ actual types and their strategies. The difference between cursed equilibrium and type-projection equilibrium is that a type-projecting agent projects his own type onto his opponents, while a cursed agent acts as if she faces a random type that is drawn from the prior type distribution. This results from a neglect of a possible correlation between the other player’s (potential) types and their actions. Put differently, a cursed player neglects the implicit information about the type she is facing, which is revealed through the history of play, and stems from the fact that different types have different incentives to choose certain actions.[5] In another contribution, the same authors contrast cursed “rational herding” and “naïve herding” (or inferential naïvety; Eyster and Rabin, 2010). Under inferential naïvety, players fail to fully attend to the strategic logic of the setting they are in. In consequence, they naïvely believe that each previous player’s action reflects solely that player’s private information.

There are further information-neglect concepts. First, correlation neglect in the updating process can make beliefs excessively sensitive to well-connected information sources (Levy and Razin, 2015; Enke and Zimmermann, 2019). Second, pivotality neglect and difficulties to infer from hypothetical events cause biases that can explain naïve voting and bidding behavior (Esponda and Vespa, 2014). Third, base-rate neglect (Bar-Hillel, 1980) and other fallacies are known to cause ignorance of some relevant (for example, statistical) information in favor of using other irrelevant information. Fourth, Hanna et al. (2014) develop a theory of learning through noticing and present supporting evidence from a field experiment, in which farmers often fail to notice readily available information to optimize their production technology.

Finally, the most studied situation in which information is often neglected is the Monty Hall problem (Friedman, 1998; Page, 1998). In this puzzle, a game-show participant faces three doors. Behind two of the doors, there is a worthless prize (a “goat”), while behind the third, there is a highly valuable prize (a “car”). The most popular protocol now proceeds as follows: the participant chooses one of the three doors, which remains closed. The game-show host (famously, Monty Hall in “Let’s make a deal”) opens one of the remaining two doors but never opens the door hiding the car (uniformly randomizing which door to open when the participant’s initially chosen door hides the car). Finally, the participant is asked whether she wants to stick to her original choice of doors or to switch to the other unopened door that she had not chosen at the outset. Under this set of rules (in particular, that the host always opens a door, that the opened door never hides a car, and that the host randomizes between goat-hiding

[5]A classic example is the inference that a buyer can (neglect to) make about the value of a product (the seller’s type) from the seller’s willingness to sell it at a certain price in Akerlof’s (1970) market for lemons.

doors), it should be clear that switching yields a probability of two thirds of getting the car.[6] However, most people who are confronted with the puzzle prefer to stick to their initial choice, even after many repetitions (*e.g.,* Friedman, 1998).

In the Monty Hall problem, most people seem to be "cursed". They neglect the information contained in the host's choice of which alternative door to open: if this choice was random (and not restricted to doors hiding goats), then switching and non-switching would lead to the same probabilities. Note though that cursedness alone would not be enough to explain choices in the Monty Hall problem: if people saw the two remaining options as equivalent, they should not *favor* sticking to their initial choice.[7] After Friedman (1998) introduced the problem into economics, a number of researchers have studied variants of the Monty Hall problem, looking at whether individual biases in the task would be reflected in market prices of assets on the possible doors (Kluger and Wyatt, 2004; Siddiqi, 2009), at whether communication and competition eliminate the bias or at how intelligence and communication relate to learning the optimal strategy (Palacios-Huerta, 2003).[8] Tor and Bazerman (2003) attribute non-switching (as well as two other empirical phenomena) to missing attention and a resulting failure "to consider all of the information needed".

This review of information-neglect studies and theories is certainly not exhaustive but sufficient to raise doubts about whether people are always able to make use of the information contained in their own type.[9] Hence, people may not project their type onto others, even when it would be rational. We thus formulate the following alternative hypothesis to projection:

Information-Neglect Hypothesis: *Participants neglect the information that their types contain.*

In several of the studies discussed in this subsection, nudges are used to make subjects use the available information. We discuss these nudges and how they relate to our own in the following.

2.3. Nudging people to use the available information

Enke and Zimmermann (2019) show that repeatedly pointing the subjects to the correlation structure, by juxtaposing a set-up with correlation and a set-up without correlation, effectively reduces correlation neglect and makes subjects take this element of the information structure into account. In our set-up, we contrast the basic set-up with replacement with a set-up without replacement to point the subjects to the fact that the second ball is always drawn from the same urn.

[6]See, *e.g.,* Selvin (1975b,a), Nalebuff (1987), or Gillman (1992).

[7]See, for example, Friedman (1998) for a discussion of additional forces that may combine with cursedness to yield the observed non-switching behavior.

[8]"Competition" here includes detailed empirical feedback on the competitors' strategies and performance (see Slembeck and Tyran, 2004).

[9]Further recent studies on behavioral updating, which are less closely related, include the works of Ambuehl and Li (2018), Coutts (2018), and Martínez-Marquina et al. (2019), who look at various mistakes people make in Bayesian updating but not specifically at information neglect.

Esponda and Vespa (2014) try several interventions to make subjects condition their behavior on the hypothetical information contained in the event of being pivotal. These include feedback, sequential rather than simultaneous play and several verbal hints. However, when they switch back to the main task in the experiment, error rates jump back to the initial, high level. Taking a similar approach, we also implement several interventions to improve participants' reasoning.

Hanna et al. (2014) summarize the relevant information for the farmers who are then better able to notice them and take them into account. In our experiment, we go to great length in order to make the set-up as clear and easy to understand as possible. We try two different decision screens and even use physical urns and balls to demonstrate the information structure at the beginning of the session. Not noticing or understanding what happens at which point in time can thus be ruled out as an explanation for information neglect in our experiment.

For the Monty-Hall set-up, Page (1998) shows that increasing the number of doors from three to at least ten increases the percentage of people who switch, but that switching in the many-doors problems does not mean participants would switch in a subsequent or simultaneously administered three-doors task. Instead of increasing the number of urns, we implement an intervention in which several balls are drawn from the same urn, which makes it easier to understand that the color of a drawn ball is an informative signal of the urn's color.

3. Set-up

The main task in our experiment is a 'Guessing Task', variations of which can often be found in experimental studies of imperfect-information settings. In this task, participants have to guess the color of another participant's ball after being informed about their own type (receiving a colored ball). To this task, we add different parts in the different treatments to draw our conclusions about projection. In Treatment 1, the Guessing Task is followed by a Belief-Elicitation Task. In the Belief-Elicitation Task, we ask participants for the probabilities of the other participant's ball being of each of the two possible colors and about the probabilities of the different states of the world. We add this Belief-Elicitation Task as a diagnostic tool to understand the participants' reasoning behind their Guessing-Task choices. In particular, the Belief-Elicitation Task would have allowed us to differentiate Bayesian updating from over-projection.

After finding evidence for information neglect in Treatment 1, we conduct two subsequent treatments as robustness checks. Also in Treatments 2 and 3, the basic task remains the Guessing Task. In all treatments, the session starts with the Guessing Task. Then, in alternating fashion, participants face three different intervention tasks and the Guessing Task again. We choose the different intervention tasks to nudge participants into realizing that they could learn from the color of their own ball. Before Treatment 3, we demonstrate the whole process behind the Guessing Task in front of participants: how an urn is randomly selected and how the balls are drawn with replacement. We demonstrate the process to ensure participants' failure to update is not due to the task being too abstract or poorly understood.

3.1. *Experimental design*

3.1.1. *Guessing Task*

Nature draws one of the two states of the world, or one of eight urns, as depicted in Figure 1. The states of the world can either be Dark (D) as on the left side or Light (L) as on the right side of Figure 1, with three balls in each urn. In D-urns, a fraction of $2/3$ of the balls is dark (d) and a fraction of $1/3$ is light (l). In L-urns, a fraction of $2/3$ of the balls is light (l) and a fraction of $1/3$ is dark (d). The possible priors are: $Pr(D) = 4/8$ or $Pr(D) = 5/8$, or $Pr(D) = 7/8$.[10]

First, the participants are randomly divided into pairs, and for each pair an urn is drawn. Nature's draw of the urn is not revealed, thus it is unknown in the remainder of the particular situation whether the balls are drawn from a D- or an L-urn. Then participant i receives a private signal s_i in the form of a ball drawn from the urn (see Figure 2). After replacement, participant j in the group receives a private signal s_j from the same urn. Participant i then has to guess whether participant j saw a light or a dark signal s_j.

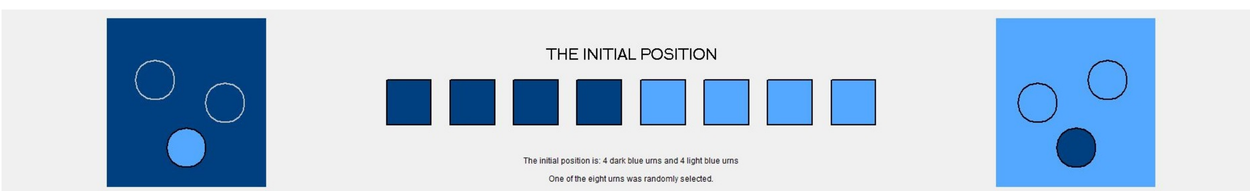


Fig. 1. Representation of the prior distribution in the experiment in the 4/8-situation (four dark and four light urns).

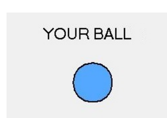


Fig. 2. Representation of the drawn signal in the experiment (one light ball).

In all situations of our laboratory experiment, a participant's own type is informative about the state of the world she and her partner both are in. Therefore, projecting one's own type onto the other participant can be rational. In the example in Figures 1 and 2, the prior probability $Pr(D)$ is $4/8 = 1/2$. After receiving the (informative) signal, it is thus rational for participant i to project her own signal

[10]To control for color effects, we also included situations with $Pr(D) = 3/8$ and $Pr(D) = 1/8$. For simplicity, we pool equivalent (counter-balanced) situations throughout the paper, *e.g.*, receiving a d-signal in $Pr(D) = 5/8$ and receiving an l-signal in $Pr(D) = 3/8$. With a slight abuse of notation, we subsume both situations in the corresponding results tables under "d-signal in $Pr(D) = 5/8$".

onto the other participant by guessing that $s_j = s_i$. This is also the case for the $5/8$ prior but not for the $7/8$ prior. We let the participants perform the Guessing Task 18 times (six times per prior).[11]

In the Guessing-Task setting, we thus measure projection as follows. Rational projection, occurs if the participants guess the same color as their signal in: (i) close to 100% of the cases when the correct Bayesian posterior is larger than 50% and (ii) close to 0% of the cases when the correct Bayesian posterior is smaller than 50% (allowing up to 10% trembles, we would expect $\geq 90\%$ same-color guesses for the first type of situation and $\leq 10\%$ for the second one). Over-projection can be distinguished from rational projection in two ways: by asking for participants' beliefs (see below), and by observing same-color guesses in close to 100% of the cases when the correct Bayesian posterior is smaller than 50%. Under-projection occurs if the participants *do not* guess the same color as their signal in close to 100% of the cases when the correct Bayesian posterior is larger than 50%. To identify information neglect as the source of under-projection, we need to ask participants about the probability they assign to the other player having the same type.

3.1.2. *Belief-Elicitation Task*

After the Guessing Task, we elicit the participants' beliefs. We ask the participants for the probability that the other participant's ball is dark or light for each situation they may face, and for the probability that the urn is dark or light if they saw a dark or a light signal.[12] Using these four questions for each situation, we can see if participants update at all, whether they update their beliefs in the right or the wrong direction, and at which step they might fail to update correctly.

3.2. *Interventions*

After finding evidence for information neglect rather than projection in Treatment 1, we conduct two subsequent treatments as robustness checks. In Treatments 2 and 3, we include four iterations of the Guessing Task each. In each of the four Guessing-Task iterations of Treatments 2 and 3, the participants perform the Guessing Task 12 times (six times per prior, including counter-balancing). We try to facilitate projection (rational updating) by three interventions each, which are all tailored to nudge

[11]The participants performed the Guessing Task in six sequences of the following order: 4/8-situation and 5/8-situation (and 7/8-situation in Treatment 1) followed by counter-balanced 4/8-situation and counter-balanced 5/8-situation (and counter-balanced 7/8-situation in Treatment 1). The counter-balanced situations included light and dark instead of dark and light balls and urns. The guesses were incentivized as follows: One out of all Guessing Tasks was randomly selected, and participants received € 6 if the corresponding guess was correct.

[12]The participants performed the Belief-Elicitation Tasks in the following order: ball-probability questions for the 4/8-situation and for the 5/8-situation (and for the 7/8-situation in Treatment 1), followed by urn-probability questions for the 4/8-situation and for the 5/8-situation (and 7/8-situation in Treatment 1). The beliefs in Treatment 1 were incentivized as follows: Participants received € 0,50 for each belief that did not differ by more than 2.5 percentage points from the correct probability. To give participants an additional incentive to report their beliefs precisely, they additionally received another € 0,50 for each belief that did not differ by more than 0.5 percentage points from the correct probability in Treatment 2. In Treatment 3, we used the loss-aversion-adjusted scoring rule introduced by Offerman and Palley (2016). The belief-elicitation rules in Treatments 2 and 3 serve as robustness checks for the results from Treatment 1. They both are designed to avoid belief reports at 50% whenever the participant's true belief does not coincide with 50%.

participants into realizing that they could learn something about the other participant's type from their own type. To make space for these interventions we restrict our attention to fewer priors in these treatments. While we implement all three priors (4/8, 5/8 and 7/8) in Treatment 1, we implement only 4/8 and 5/8 in Treatments 2 and 3. Please refer to Table 1 for an overview of the three treatments.

Treatment 1	Treatment 2: Robustness checks	Treatment 3: Robustness checks
		Intervention 0: Physical urns
Guessing Task	Guessing Task	Guessing Task
Belief elicitation I	*Intervention 1: w/o replacement draws*	*Intervention 1: Belief elicitation III*
	Guessing Task	Guessing Task
	Intervention 2: Belief elicitation II	*Intervention 2: Strategy elicitation*
	Guessing Task	Guessing Task
	Intervention 3: Strategy elicitation	*Intervention 3: Several draws*
	Guessing Task	Guessing Task

Table 1: Overview of the three treatments.

Treatment 2. The three interventions are a repetition of the Guessing Task where the balls are drawn without replacement, the Belief-Elicitation Task, and a strategy-elicitation stage. Intervention 1, the Guessing Task without replacement, is meant to draw the participants' attention to the fact that the balls are drawn from the same urn, and that there is replacement in the main task. This should bring the participants' attention to the fact that drawing two balls of the same color was more likely than drawing two balls of different colors. In contrast to the Guessing Task where the participants mostly need to "go after their signals" or project, they have to "go against their signals" or under-project in Intervention 1.[13]

Intervention 2 of Treatment 2, the Belief-Elicitation Task, is meant to nudge the participants into realizing that the urns have different posterior probabilities after observing their specific signal. Note that in Treatment 1, we include the Belief-Elicitation Task only as a diagnostic tool after the Guessing Task. In Treatment 2, we are interested in what happens to the Guessing-Task choices after the Belief-Elicitation part. In Intervention 3, we ask participants to write down the reasoning behind their reported probabilities from Intervention 2. Intervention 3 should prompt participants to think again—and more deeply—about the task, giving them another opportunity to adjust their subsequent Guessing-Task choices.

Treatment 3. We start Treatment 3 by adding a demonstration using physical urns to the instructions at the beginning of the treatment. The participants first read on-screen instructions about the Guessing

[13]As for the Guessing Task, participants perform Intervention 1 involving only without-replacement draws 12 times: six times per prior, including counter-balancing.

Fig. 3. Props used for the demonstration of the instructions.

Task and the experiment in general, similarly as in Treatments 1 and 2. Then right before the beginning of the first Guessing-Task iteration, the participants learn about the process in the Guessing Task again, only this time it is demonstrated with physical urns and commented by the experimenter. For this purpose, we use a number of dark and light table-tennis-sized balls for demonstration. Furthermore, we use non-transparent bags as urns that are black on the outside and dark or light respectively on the inside. The appearance and numbers of the balls and bags are composed in a way that mimics the appearance and numbers described in the on-screen instructions right before (see Figure 3).

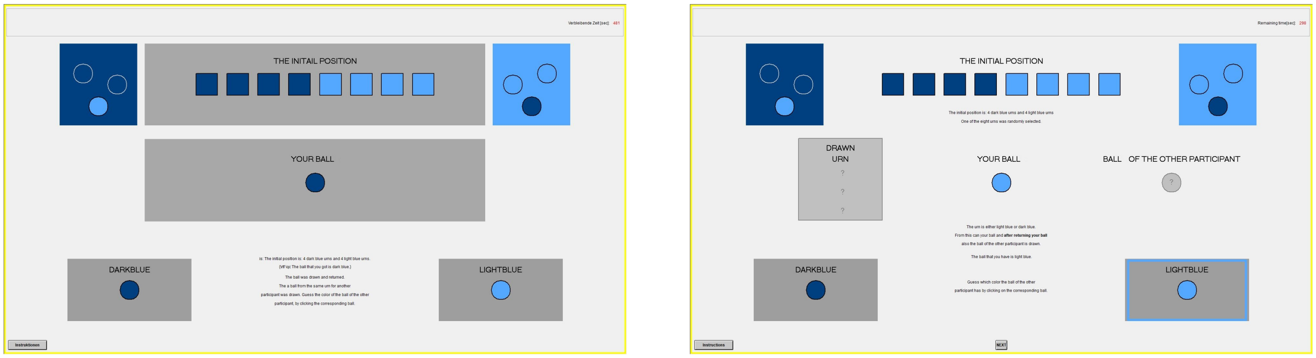
In Treatment 3, the three in-between interventions are—again—a Belief-Elicitation Task, the strategy-elicitation task, and a guessing task with several draws. The rationale for the first two interventions is two-fold. First, they are meant to capture any changes induced by our pre-play demonstration of the situation. Second, this time we use the L-adjusted scoring rule introduced by Offerman and Palley (2016) for the Belief-Elicitation Task, which approximates a proper elicitation procedure without drawing the belief reports towards 50%.[14]

Intervention 3 of Treatment 3, the Guessing Task with several draws, should draw the participants' attention to the fact that signals are informative. After seeing the first-drawn signal from the randomly drawn urn (as in the Guessing Task), we show participants three additional with-replacement signals from this urn before they have to make their guess about the color of the other participant's ball. Seeing many balls of the same color should make participants realize that one of the urn types is more likely to be the randomly drawn one. Thus, we may expect participants to transfer this insight when returning to the single-signal Guessing Task afterwards.

Finally, note that we add an additional robustness check between Treatment 1 and Treatments 2 and 3. Namely, we provide more detailed decision screens and more elaborate instructions in Treatments 2 and 3, as depicted in Figure 4.[15] In particular, the more elaborate screen in Figure 4(b) stresses the intermediate step of one particular urn having been drawn, as well as the fact that both balls (being positioned on the same line as the urn) come from the same urn.

[14]To save time, we only elicited beliefs for the 4/8-prior in Treatment 3.

[15]Please see the instructions in Appendix B.



(a) (b)

Fig. 4. Changes in the decision screen from Treatment 1 (a) to Treatments 2 and 3 (b).

3.3. *Procedure*

We programed all treatments in z-Tree (Fischbacher, 2007) and recruited all participants using ORSEE (Greiner, 2015). We conducted eight experimental sessions in total—four for Treatment 1 and two each for Treatments 2 and 3. In Treatment 1, 116 students (average age: 22 years old, standard deviation sd=2; 38% male) participated and earned an average payment of €18 (sd=5), including a show-up fee of €6. The length of the sessions was about 90 minutes.[16] In Treatment 2, 58 students (average age: 23 years, sd=2; 48% male) participated. They earned an average payment of €13 (sd=4; show-up fee: €6). Sessions lasted for approximately 70 minutes. In Treatment 3, 54 students participated (average age: 21 years, sd=2; 48% male) and earned an average payment of €16 (sd=5; show-up fee: €6). The length of the sessions was around 70 minutes.

4. Results

4.1. *(No) Projection*

4.1.1. *Guessing Task*

Starting with Treatment 1, the results show that many participants update their beliefs less than expected by theories of type projection or Bayesian updating, or they do not update at all. In the rightmost column of Table 2, we show how much projection we would expect if participants learned from their signals. For comparison, we show the actual projection frequency in the middle column *Frequency of projection* (we calculate the average frequency of projection for each participant, and then average over all participants). The column shows how often the participants actually guess the same color signal that they received.

[16] Participants in the sessions for Treatment 1 also participated in a completely unrelated pilot treatment for another study after Treatment 1. The instructions for the additional treatment were only distributed only after Treatment 1 was finished.

Prior	Signal	Frequency of projection	Theoretical predictions	
4/8-situation	d or l	**76.0%**	100% projecting	(56%)
5/8-situation	d	94.5%	100% projecting	(59%)
	l	**36.1%**	100% projecting	(52%)
7/8-situation	d	94.7%	100% projecting	(64%)
	l	6.9%	0% projecting	(41%)

Table 2: Results of the Guessing Task in Treatment 1. The percentages in parentheses in the column to the right are the correct posterior probabilities for the other player having the same color.

Let us focus first on the simplest situation, $Pr(D) = 4/8$. The result of 76% differs strongly from the 100% benchmark. Keeping in mind that random choice would mean 50% same-color guesses—and that projection would mean that participants *always* go with the signal—76% same-color guesses is a low rate. Another result from the non-50%-prior situations also indicates that the participants are biased towards the prior information: The 36% in the 5/8-situation differ even more strongly from the 100% benchmark. The other percentages in the 5/8-situation and 7/8-situation, on the contrary, are quite close to the respective benchmarks. However, following the prior coincides with rational projection in these situations.

4.1.2. Belief-Elicitation Task

The results from the Belief-Elicitation Task complement the results from the Guessing Task in Treatment 1 and show even stronger evidence for information neglect and against projection, especially if we again focus on the simplest 4/8-situation as in Figure 5. The panel on the left shows the participants' beliefs that the other participant shares their type (the correct Bayesian posterior being 56% as indicated by dashed line). The panel on the right shows the participants' beliefs that the urn's color corresponds to their own ball's color. More than 60% of the participants report beliefs of 50% for both balls and urns, which coincides with the $4/8$ prior. A small minority of participants report ball-beliefs of 67%. These participants seem to be 100% sure about the urn they are facing—or neglect that a 67% probability can only be correct if they were completely certain about the randomly drawn urn.

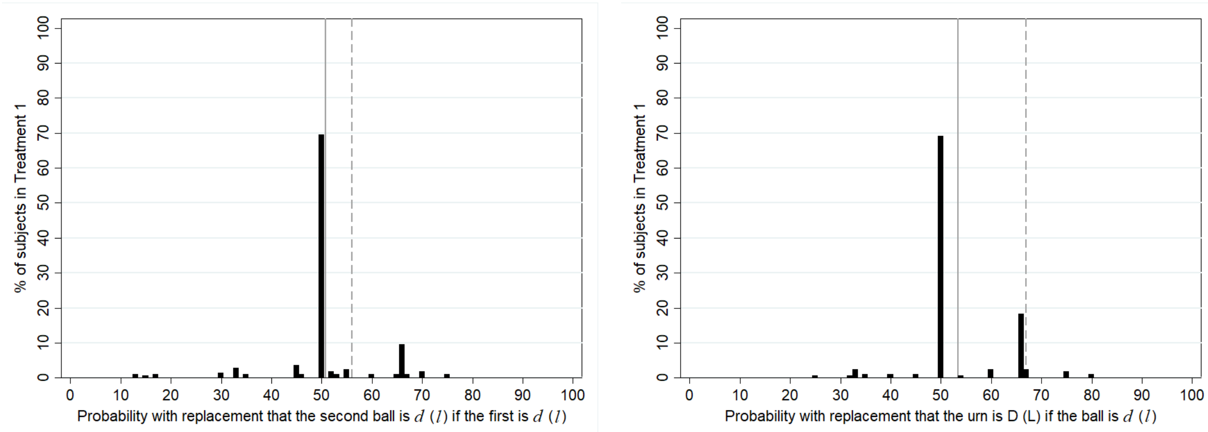


Fig. 5. Results of the Belief-Elicitation Task in Treatment 1 (with ball-beliefs on the left and urn-beliefs on the right). Theoretical predictions are represented by the dashed line, average beliefs by the solid line.

In both cases, the beliefs differ from the theoretical prediction (dashed line; Wilcoxon signed-rank tests, p-values $<$0.001). Roughly 70% of the participants report beliefs of 50% (for both the urn and the ball color; 55% of the participants report beliefs of 50% in all four probability questions), that is, more than half of the participants appear to believe that they cannot learn anything about the unknown selected urn from their received signal.

For the situations with asymmetric priors, fewer participants state exactly the prior (see Figures 8–10 in Appendix A), which is unsurprising as the prior has to be computed first and does not coincide with 50%. To get an idea of the prevalence of information neglect and correct belief updates, we count (1) the number of stated beliefs (about both urn and ball colors) for the three situations of Treatment 1 which are close to the correct posterior (± 2.5 percentage points) and (2) those which are either close to the prior (± 2.5 percentage points) or exactly 50% (see Table 3).

Situation (prior)	Close to correct posterior (1)	Close to prior or exactly 50% (2)	Ratio of correct updates to info neglects (1)/(2)
4/8-situation	52	325	0.16
5/8-situation	57	194	0.29
7/8-situation	58	149	0.39

Table 3: Number of stated beliefs per situation that are (1) close to the correct posterior (± 2.5 percentage points) or (2) either close to the prior (± 2.5 percentage points) or exactly 50%, for the different situations. Within situations we pool the beliefs after d and l signals and the belief about the color of the urn.

4.2. *Nudging Interventions*

Before we discuss the effects of our interventions, please recall that we would see "50%" of the participants making the rational choice if they were guessing light or dark completely randomly and, in accordance with the theoretical predictions, we would expect to see "100%" in all the iteration columns in Tables 4 and 5. What we see instead is that the share stays below 82% in even the 'best' iterations of the 4/8-situation.

The only intervention that helps to some extent is the Belief-Elicitation Task. In both Treatments 2 and 3, it brings up percentages in the Guessing Task by around 5-8 percentage points (Wilcoxon signed-rank tests between individual percentages of Bayesian choices in the Guessing Tasks before and after the Belief-Elicitation intervention yield $p = 0.051$ for the difference between the second and third iterations in Table 4, and $p = 0.014$ for that between the first and second iterations in Table 5). About 10-16% of the "information neglect" people seem to change their behavior from neglect to projection, and their performance does not deteriorate again afterwards. Otherwise, neither asking for strategy descriptions, nor having a task without replacement, nor having a task with multiple draws, nor physically enacting the situation helps (all p-values>0.400 and >0.477, Wilcoxon signed-rank tests for Treatments 2 and 3, respectively). In light of these results, we conclude that none of the interventions improves the participants' performance in the Guessing Task by much.

Note that it is not the case that people do not respond to any interventions—they do. They rarely guess their own signal when the ball is not replaced (see column 4 of Table 4), and they guess the correct (more likely) color most of the time when they see multiple signals (of the same color, see the bold-faced figures in Tables 8 and 9 below). However, they do not seem to transfer anything to our main Guessing Task (compare column 5 of Table 4, and the final column of Table 5). In the following, we discuss behavior in the belief- and strategy-elicitation interventions in more detail.

Prior	Signal	1^{st} iter.	*Interv. 1*	2^{nd} iter.	***Interv. 2***	3^{rd} iter.	*Interv. 3*	4^{th} iter.
4/8-situation	d or l	71.0%	*21.7%*	69.0%	*s.4.2.1*	76.1%	*s.4.2.2*	73.0%
5/8-situation	d	89.8%	*57.0%*	88.3%	*s.4.2.1*	94.8%	*s.4.2.2*	94.2%
	l	30.3%	*2.7%*	22.3%	*s.4.2.1*	28.2%	*s.4.2.2*	24.6%

Table 4: Results of the four Guessing-Task iterations and three Interventions in Treatment 2.

Prior	Signal	1^{st} iter.	***Interv. 1***	2^{nd} iter.	*Interv. 2*	3^{rd} iter.	*Interv. 3*	4^{th} iter.
4/8-situation	d or l	71.3%	*s.4.2.1*	79.0%	*s.4.2.2*	80.2%	*s.4.2.3*	81.2%
5/8-situation	d	91.2%	*s.4.2.1*	90.6%	*s.4.2.2*	96.8%	*s.4.2.3*	96.8%
	l	37.1%	*s.4.2.1*	31.4%	*s.4.2.2*	32.0%	*s.4.2.3*	28.5%

Table 5: Results of the four Guessing-Task iterations and three Interventions in Treatment 3, after the Intervention 0 with physical urns.

4.2.1. Belief-Elicitation interventions

The situation concerning the reported beliefs in Treatment 2 barely improved compared to Treatment 1. Let us again first focus on the simplest 4/8-situation, as in Figure 6. Roughly 60% of the participants report beliefs of 50%. Again, a small minority of participants report beliefs of 66% or 67%.

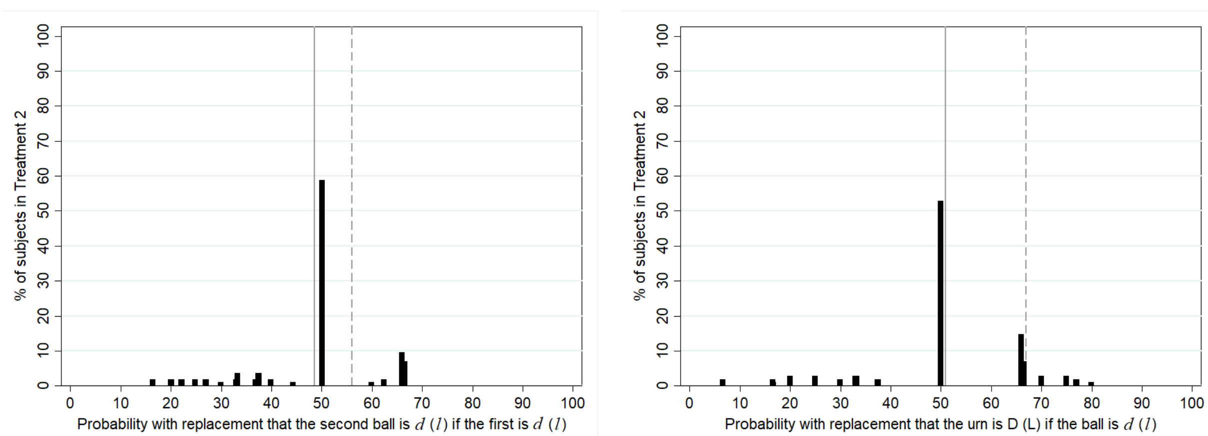


Fig. 6. Results of the Belief-Elicitation Task in Treatment 2 (with ball-beliefs on the left and urn-beliefs on the right). Theoretical predictions are represented by the dashed line, average beliefs by the solid line.

In contrast, there is a notable change in reported beliefs in Treatment 3 compared to Treatments 1 and 2. Only 40.7% of the participants report beliefs of 50% in Treatment 3 for the ball-probabilities, as depicted in the left panel of Figure 7 below. A minority of participants (14.8% and 13.0% for d and l accordingly) report beliefs of 66% or 67%.

The largest difference between the treatments is in terms of the beliefs about the urns. Only 16.7% to 18.5% (in l and d, respectively, as depicted in the right-hand panel of Figure 7) report beliefs of 50% for the urn-probabilities in Treatment 3. Instead, 25.9% of participants report beliefs of 66% or 67%. This substantial change in stated beliefs is hard to explain under the assumption that the distributions of the true beliefs are the same under the different belief-elicitation rules.[17] Instead, the results suggest

[17]Under the elicitation rules in Treatment 1 (2), risk- or loss-aversion can maximally explain a shift toward 50% of 2.5

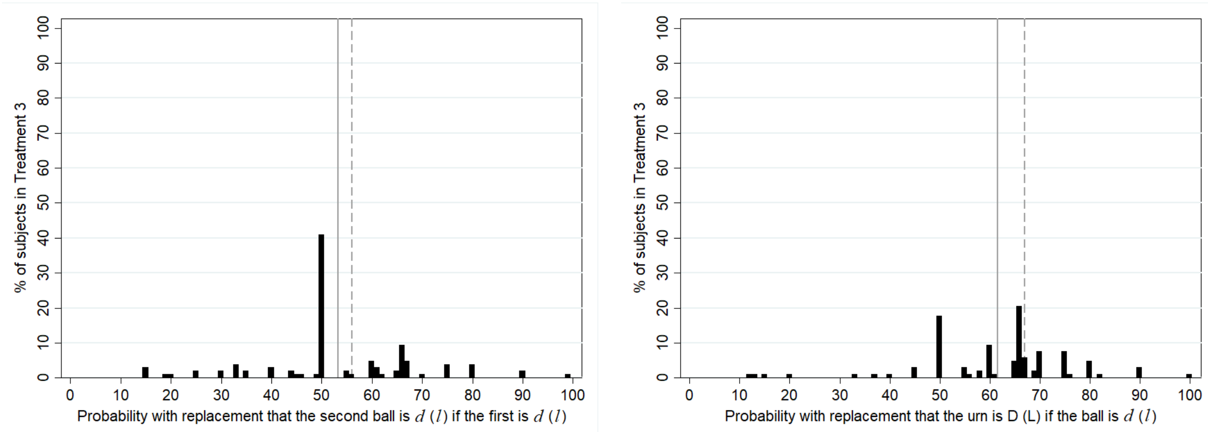


Fig. 7. Results of the Belief-Elicitation Task in Treatment 3 (with ball-beliefs on the left and urn-beliefs on the right). Theoretical predictions are represented by the dashed line, average beliefs by the solid line.

that the participants' beliefs are influenced differently by the elicitation method itself. Potentially, the L-adjusted scoring rule nudges some participants to think differently about the problem.[18]

The results from the belief-elicitation under the L-adjusted scoring rule notwithstanding, it is unclear why so many participants still report 50% ball-probability beliefs in all three experiments. Related to this, it is also unclear why not more participants alter their behavior in the Guessing Task in any of the three treatments, even after the helping interventions. The participants' elicited strategies (Intervention 3 in Treatment 2 and Intervention 2 in Treatment 3) allow us to shed some light on both of these questions.

4.2.2. Strategy-elicitation interventions

How do the participants explain their answers in the Belief-Elicitation Task? We asked the participants to describe in free text their reasoning process behind the answers they provided in the Belief-Elicitation part regarding the 4/8-situation. We classify them into several categories and compare the answers of the participants who report 50% beliefs with those who report non-50% beliefs, as depicted in Tables 6 and 7. The reasoning strategies between these two groups differ substantially, as the participants who report non-50% beliefs mention learning from the signal most often in both Treatment 2 and Treatment 3 (*e.g.,* "I assumed that a dark urn was chosen, as it contains more dark balls; so there are 3 balls, 2 of which are dark").

The participants who report 50% beliefs, however, most often mention the following three reasons be-

(0.5) percentage points. Hence, adjusting for these potential biases could only explain a shift of the same magnitude away from 50%. However, if the stated beliefs under the L-adjusted rule in Treatment 3 were true, they would imply far bigger shifts.

[18] An alternative explanation would be that the physical demonstration of the situation had an influence on the beliefs. However, this seems unlikely as it had no influence on the behavior in the Guessing Task.

Strategy categories	Subjects with 50% beliefs (in percent) Ball beliefs	Urn beliefs	with non-50% beliefs (in percent) Ball beliefs	Urn beliefs
1. Learn from the signal	-	-	46	48
2a. Equal probabilities	32	58	4	4
2b. Equal number of balls	32	29	-	-
2c. No difference after replacement	27	3	4	-
3a. Scarce information	3	7	17	18
3b. False or confused	6	3	29	30
N	34	31	24	27

Table 6: Results of the Intervention 3 (Strategy elicitation) in Treatment 2.

Strategy categories	Subjects with 50% beliefs (in percent) Ball beliefs	Urn beliefs	with non-50% beliefs (in percent) Ball beliefs	Urn beliefs
1. Learn from the signal	-	-	63	77
2a. Equal probabilities	36	20	3	-
2b. Equal number of balls	55	30	3	-
2c. No difference after replacement	-	-	-	-
3a. Scarce information	-	10	6	14
3b. False or confused	-	30	16	2
3c. Other	9	10	9	7
N	22	10	32	44

Table 7: Results of the Intervention 2 (Strategy elicitation) in Treatment 3.

hind their answers. Firstly, they argue that the probability of drawing a dark urn is the same as drawing a light urn (*e.g.*, "Each urn has the same probability of being chosen, hence the uniform distribution 50-50"). Secondly, they count the colors of the balls in both possible types of urns together (*e.g.*, "A light and a dark urn constitute a total of 3 light balls and 3 dark balls; the probability is thus 50%"). Thirdly, they argue that there is no difference which signal has been drawn, given that the draws are with replacement (*e.g.*, "The ball was put back in the urn, such that 6 balls were in the game all the time; of these, there were always 3 light balls and 3 dark balls"). Some of the free-text answers were difficult to categorize meaningfully, either due to scarce content in the written texts, confusion, or other reasons.

The strategies mentioned in Treatment 3 can be categorized similarly to the strategies in Treatment 2. However, the shares of the respective categories differ. In particular, the participants reporting non-50% beliefs mention learning from the signal more often in Treatment 3 than in Treatment 2.

4.2.3. *The several-draws intervention*

In Intervention 3 of Treatment 3, we provide the participants with three additional signals from this urn before making their guess about the color of the other participant's signal. The participants do indeed appear to project their signals more after receiving three or four balls of the same color than after receiving one ball in the single-draw Guessing Task (compare Tables 8 and 9 with Table 5 above). That is, they do appear to understand that the same urn is used for all the four draws—and that this urn is then also used for the other participant in their group. Note, however, that we do not see 100% projection rates even when participants get to see three or four balls of the same color.[19]

Signal	d	l	Prediction	Probability
4 d, 0 l	25	5	100%	65%
%	***83.3%***	*16.7%*		
3 d, 1 l	68	7	100%	60%
%	***90.7%***	*9.3%*		
2 d, 2 l	56	60	-	50%
%	*48.3%*	*51.7%*		
1 d, 3 l	8	70	0%	40%
%	*10.3%*	***89.7%***		
0 d, 4 l	2	23	0%	35%
%	*8.0%*	***92.0%***		

Table 8: Results of the Intervention 3 with four ball draws, 4/8-situation.

Signal	d	l	Prediction	Probability
4 d, 0 l	30	3	100%	65%
%	***90.9%***	*9.1%*		
3 d, 1 l	55	5	100%	62%
%	***91.7%***	*8.3%*		
2 d, 2 l	48	13	100%	54%
%	*78.7%*	*21.3%*		
1 d, 3 l	11	39	0%	43%
%	*22.0%*	***78.0%***		
0 d, 4 l	28	92	0%	36%
%	*23.3%*	***76.7%***		

Table 9: Results of the Intervention 3 with four ball draws, 5/8-situation.

[19] Using this data, we can quantify the fraction of people who, most likely, do not pay any attention to be around 10% (the number of people doing the wrong thing even in the "several-draws" task).

5. Discussion and conclusions

The motivation of our investigation was twofold. On the one hand, we started from the observation of two growing strands of the literature that make starkly contrasting predictions regarding the use of information. The first strand is the projection literature that suggests that people typically infer too much from their own type about the types of other players. The second strand of the literature that we dub "information neglect" literature starts from the opposite end and assumes some form of information neglect. On the other hand, one of the central elements of virtually any imperfect-information model (and many experimental studies thereof) pre-supposes a rational use of new information. Hence, it is important to examine this element and explore which of the behavioral effects would dominate in such a setup, over-projection or information neglect—or whether they might cancel out in the average.

In our very simple setting, we find no evidence for (over-)projection. Instead, we find strong evidence for information neglect. Focusing on the situation with a 4/8-prior, for example, we see that up to 70% of the participants report beliefs that would mean they cannot learn anything from their signal (and around 70–75% projection where we would expect 100% projection).

These results raise the question of what the reason for so much information neglect might be, which leads us back to the literature on the Monty-Hall problem. Burns (2017) argues that people follow a "no-change principle", under which probabilities remain the same after the host opens one of the doors. He calls the phenomenon "no-change principle" because the probabilities that he elicits from the participants suggest a reasoning that implies that "there has be no change to these doors, so they maintain their equal status" (Burns, 2017, p.1701). The participants in our experiment seem to commit the same error. Their answers to our questions regarding their reasoning clearly reflect a "no-change principle", too. *The ball has been put back, hence nothing has changed and the probabilities must be the same as the prior probabilities* (categories 2a–2c in Tables 6 and 7), appears to be the faulty logic that many of our participants follow. In this context, our results suggest that information neglect can occur also in set-ups that are much simpler than the Monty-Hall problem, including typical set-ups that involve inferences about others from one's own type.

Acknowledgments

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Appendix A. Further results

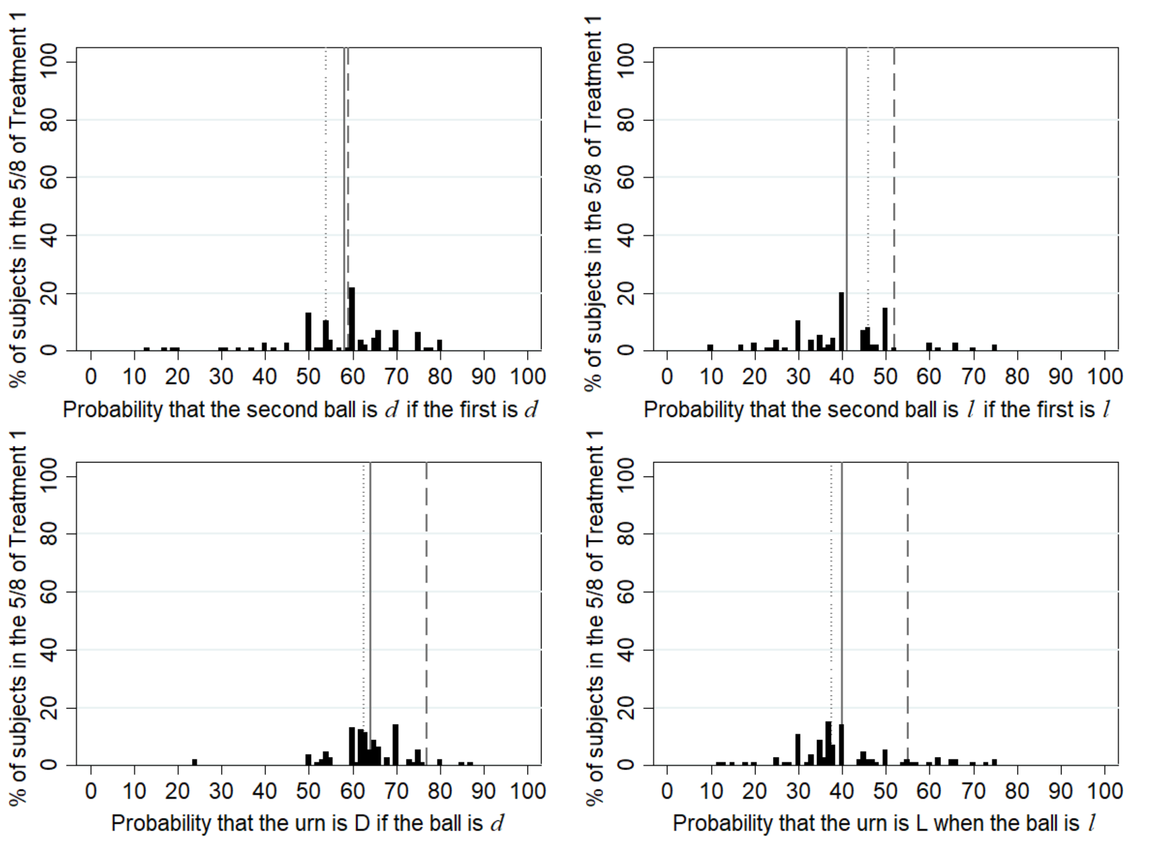


Fig. 8. Results of the Belief-Elicitation Task in Treatment 1 (with ball-probability beliefs on the left and urn-probability beliefs on the right). Theoretical predictions are represented by the dashed, priors by the dotted, and average beliefs by the solid line.

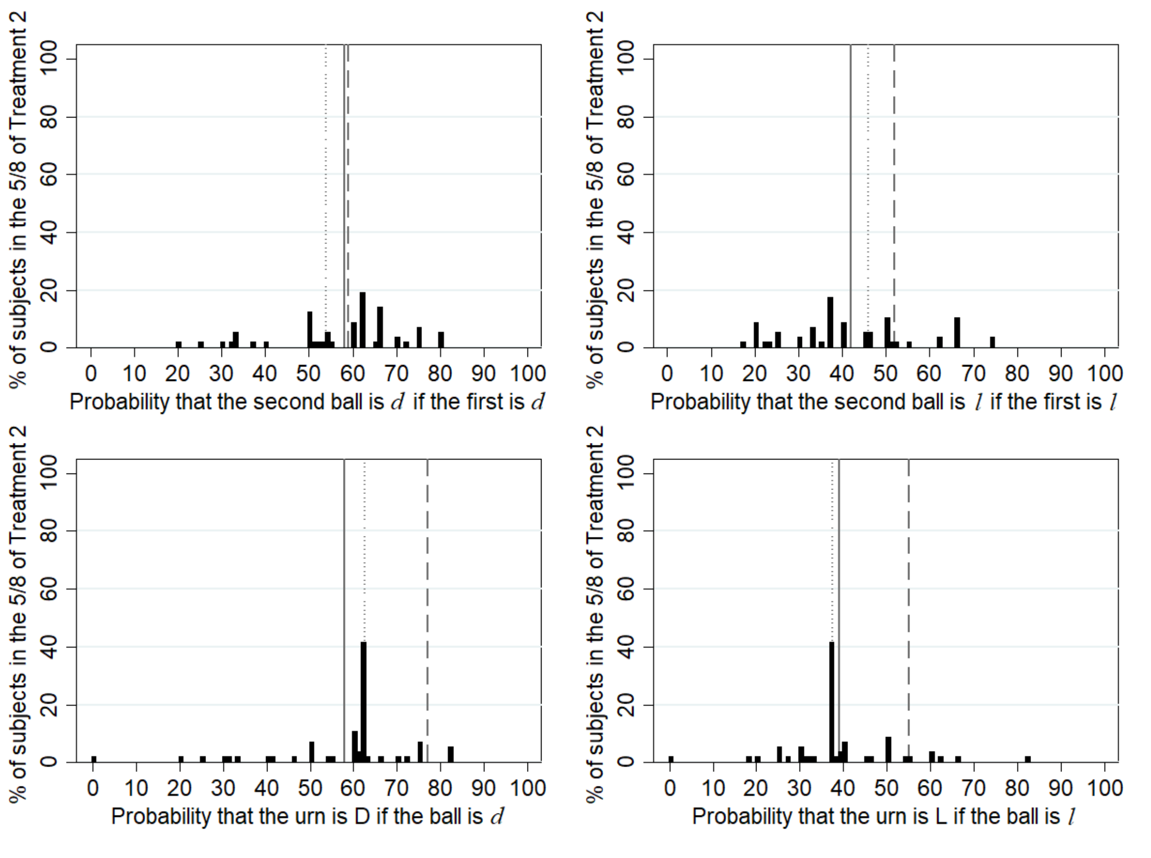


Fig. 9. Results of the Belief-Elicitation Task in Treatment 2 (with ball-probability beliefs on the left and urn-probability beliefs on the right). Theoretical predictions are represented by the dashed, priors by the dotted, and average beliefs by the solid line.

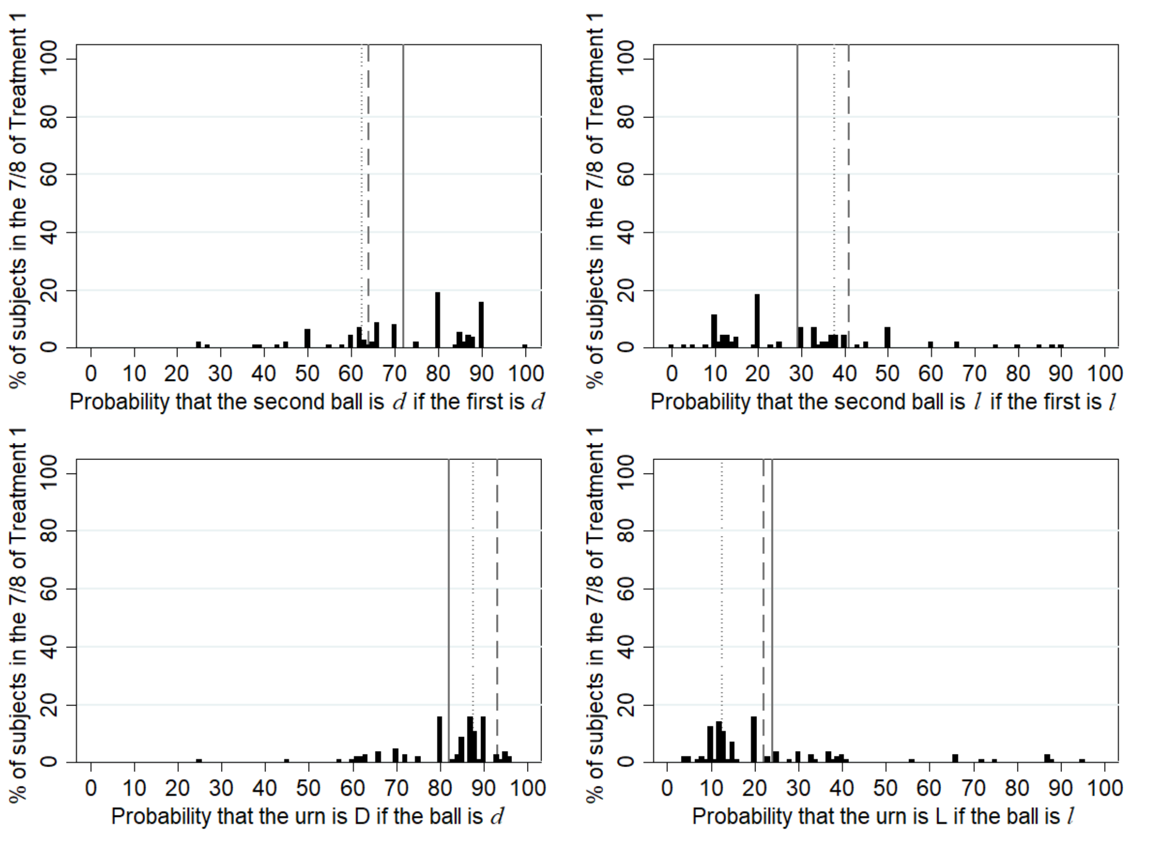


Fig. 10. Results of the Belief-Elicitation Task in Treatment 1 (with ball-probability beliefs on the left and urn-probability beliefs on the right). Theoretical predictions are represented by the dashed, priors by the dotted, and average beliefs by the solid line.

Appendix B. Instructions

The following instructions (translated from German) correspond to the most frequently used text versions over the three treatments. In the meantime, there were a few adjustments between the treatments. Firstly, we changed the layout of the decision screen and the instruction texts before Treatment 2. Secondly, we change the colors of the light blue and dark blue balls to white and blue balls, respectively, before Treatment 3.

B.1. *Instructions for the Guessing Task throughout the three treatments*

Overview

Welcome to this experiment. We ask you not to speak with the other participants and turn off your mobile phone and other mobile technical devices during the experiment. For taking part in today's experiments, you are paid in cash at the end. The amount of the payout depends partly on chance and partly on your decisions. It is thus important that you carefully read and understand the instructions before starting the experiment.

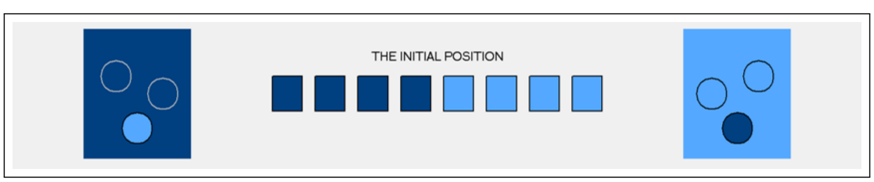
Today's experiment includes **six parts**, each comprising several rounds. In the end, several randomly-drawn rounds will be paid out. From the parts 1, 3, 5 and 6 of the experiment, **one** round is randomly selected and paid out. In addition, **one** randomly drawn round from part 2 and **all** rounds of part 4 are paid out. The not-drawn rounds will not be paid out.

Your payout is based on the points you earned in the rounds, plus 6 euro for completing a subsequent questionnaire. The conversion of the points into euro happens as follows. Each point is worth 50 cents, such that: **10 points = 5.00 euro**. Each participant is privately paid so that other participants cannot see how much you have earned.

Composition of the experiment

This experiment includes six different parts. The 1st, 2nd, 3rd, 5th and 6th parts each comprise 12 identical rounds. In each round, a decision which can be correct or incorrect has to be made. The tasks in these parts are similar in structure. The 4th part comprises 8 identical rounds. In each round, questions which can be correct have to be answered. **Before starting each part of the experiment, you will learn the instructions for the respective part.** On the next two pages, you will find the instructions for **part 1**.

The initial position



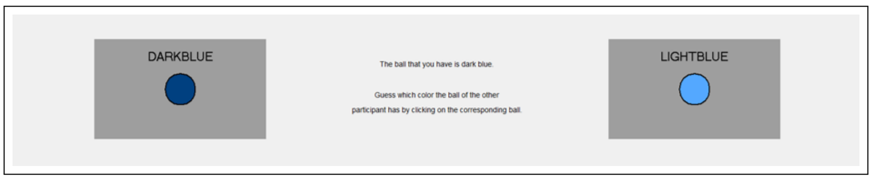
In each round, there are a total of 8 urns of balls. Each urn is either light blue and contains two light blue and one dark blue ball or dark blue and contains two dark blue and one light blue ball.

There can be three different initial positions. Either 3, 4 or 5 of the 8 urns can be dark blue. The remaining urns are light blue. The initial position is displayed in each round at the top of the screen. In the example shown above, you see a dark blue urn on the left, a light blue urn on the right and an initial position in the center with 4 light blue and 4 dark blue urns.

The drawn urn
As you already know, there are two types of urns: the dark blue urns and the light blue urns. The dark blue urn contains 1 light blue and 2 dark blue balls, the light blue urn 2 light blue and 1 dark blue. In each round, one of the 8 urns from the initial position is randomly drawn by the computer. Each urn has the same drawing probability. However, you will not know whether the drawn urn is light blue or dark blue.

Draw of the ball(s)
In each round, one or more balls are drawn randomly from the selected urn. You will see the color of the randomly drawn ball(s) on the screen. Whenever several balls are drawn, they are drawn one after the other and immediately returned. Another player will also receive one or more randomly drawn balls from the selected urn. Each ball in the drawn urns always has the same selection probability. This applies to the other participant as well as to you. Each participant only sees the color of his or her ball(s), not that of the other participant.

The tasks

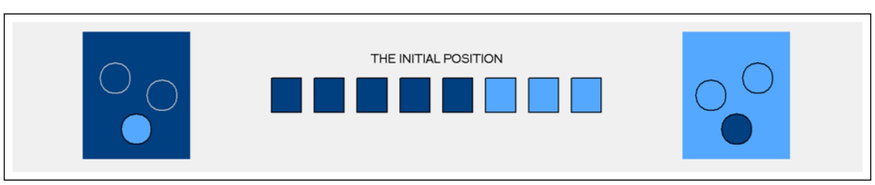


In the first part of the experiment, exactly one ball is displayed to each participant. You then have to guess the color of the ball that was drawn for the other participant. Before making your decision, you will be informed of the (for both identical) initial position and the color of your drawn ball. In the shown example, this is dark blue.

In addition to the normal rounds described so far, there are situations in which neither the urn nor the ball is randomly drawn. The predetermined situations amount for less than 1/6 of all rounds. You cannot distinguish these rounds from the normal rounds. For your payout, however, only those rounds are relevant, as described, for which the randomness decides which urn is drawn and which ball is drawn from this urn.

The payout
From the 12 rounds of the second part, one round is randomly selected. One decision is randomly selected from the 48 rounds of parts 1, 3, 5 and 6 of the experiments. The predefined situations cannot be selected. If you have given the correct answer, that is, the color of the other participant's ball, you receive 12 points. The details on the payment of the 4th part can be found at the beginning of part 4.

Questions?
Take the time to look carefully at the instructions. If you have any questions, please lift your hand. An experimenter will then come to your place.



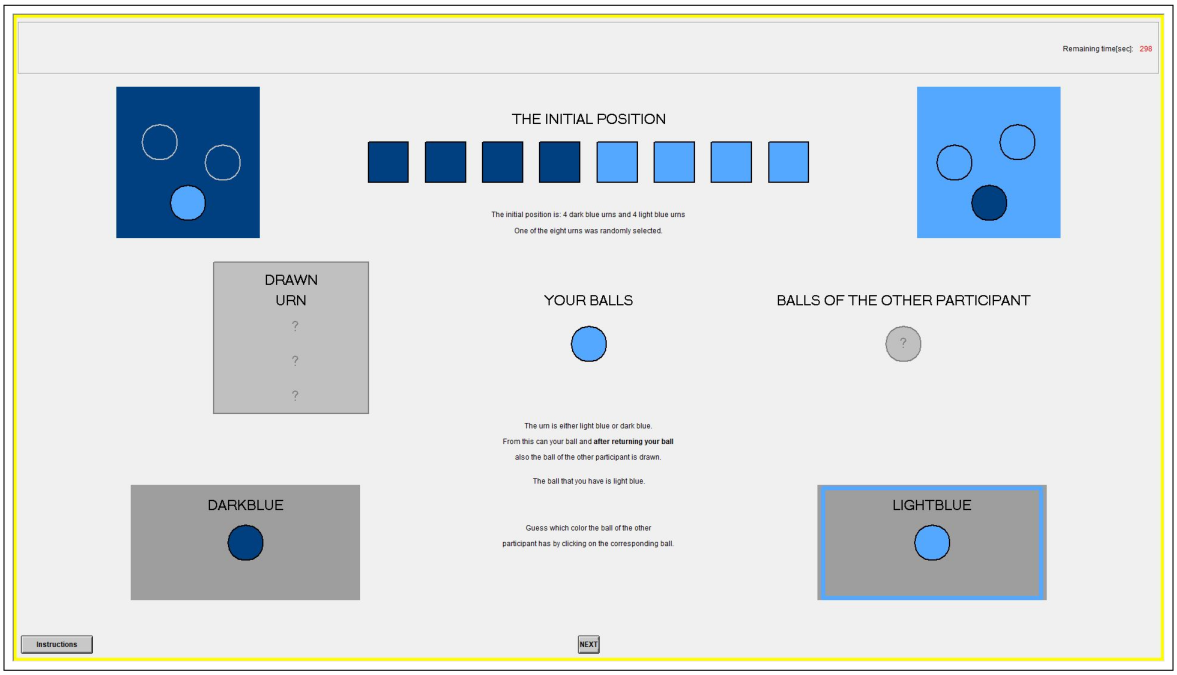
Please answer the following questions about the experiment.

1. How many light blue balls are there in a light blue urn? [...]
2. In the above example, with what probability is a light blue urn drawn (in %)? [...]
3. How many rounds will be paid out in the second part? [...]

Part 1 [Part 3 / Part 5 / Part 6] of the experiment

In each round of the 1st [3rd, 5th, 6th] part, a ball is randomly drawn from the selected urn. You will learn the color of the randomly drawn ball on the screen. The ball is drawn and returned immediately. Another player also receives a randomly drawn ball from the same selected urn after your ball has been returned.

In the [first] part, exactly one ball is displayed to each participant. You then have to guess the color of the ball that was drawn for the other participant. Before making your decision, you will be informed of the (for both identical) initial position and the color of your drawn ball.



Payout [at the end of the experiment]

Participant [...] will now determine the payout-relevant decision by a dice throw. Please wait at your place while the payout-relevant initial positions and situations are diced out.

The first dice roll determines the payout-relevant initial position in the [first] part of the experiment: ”1” for the initial position with 4, ”2” for the initial position with 5 dark blue urns, also ”4” for the initial position with 4, ”5” for the initial position with 5 light blue urns. If a ”3” or ”6” is diced, the throw has to be repeated.

The second dice roll determines the payout-relevant part of the 1st, 3rd, 5th 6th parts: ”1” for the first part, ”3” for the third part, ”5” for the fifth part, ”6” for the sixth part. If a ”2” or ”4” is diced, the throw has to be repeated.

The third dice roll determines the payout-relevant initial position in the second part of the experiment: ”1” for the initial position with 4, ”2” for the initial position with 5 dark blue urns, also ”4” for the initial position with 4, ”5” for the initial position with 5 light blue urns. If a ”3” or ”6” is diced, the throw has to be repeated.

The fourth dice roll determines the payout-relevant situation under the previously diced initial position in the [first] part of the experiment: ”1” and ”4” for situation 1, ”2” and ”5” for situation 2, ”3” and ”6” for situation 3. And the fifth dice throw determines the payout-relevant situation under the previously diced initial position in the second part of the experiment: ”1” and ”4” for situation 1, ”2” and ”5” for situation 2, ”3” and ”6” for situation 3.

In the unlikely event of a predefined situation being diced, the computer randomly selects one of the other situations.

B.2. Interventions

B.2.1. Intervention 1 of Treatment 2

Part 2 of the experiment
In each round of the **2nd part**, a ball is randomly drawn from the selected urn. You will learn the color of the randomly drawn ball on the screen. The ball is drawn and **NOT returned**. Another player also receives a randomly drawn ball after your ball has been returned to the same selected urn.

Each participant thus sees exactly one ball. You then have to guess the color of **the next** ball that was drawn for the other participant. Before making your decision, you will be informed of the (for both identical) initial position and the color of your drawn ball.

B.2.2. Intervention 2 of Treatment 2

Part 4 of the experiment
In the **4th part**, your task is to answer questions. The questions relate to different scenarios. The scenarios will be similar to those in the first, second and thirds parts.

Your task is to specify the probability of a dark blue or a light blue ball being drawn in each scenario, or the probability that the urn is dark blue or light blue in each scenario.

In the **4th part**, you get 1 point for each correct answer. An answer is considered to be correct if the probability that you give is a maximum of 2.5 percentage points away from the correct probability. That is, if the correct probability is x (in %), you get 1 point for each response that is not greater than x+2.5 and not smaller than x-2.5. In addition, you get 1 point for each answer that is not greater than x+0.5 and not smaller than x-0.5. Your income is then converted into euro and paid out privately.

In the first and third part of the experiment, your task was to guess the color of the ball drawn for the other participant. Your ball was drawn and immediately [returned / NOT returned] before the other participant received a ball. Now you must indicate the probability that the ball of the other participant has a certain color and the probability that the urn has a certain color.

The initial position is: 4 [5] dark blue urns and 4 [3] light blue urns. If you saw a dark blue ball under the above initial position, with what probability (in %) was the ball of the other participant also dark blue? [...] If you saw a light blue ball under the above initial position, with what probability (in %) was the ball of the other participant also light blue? [...] If you saw a dark blue ball under the above initial position, with what probability (in %) was the selected urn dark blue? [...] If you saw a light blue ball under the above initial position, with what probability (in %) was the selected urn light blue? [...]

B.2.3. Intervention 3 of Treatment 2

Thank you, you have almost finished part 5 of the experiment. A few questions about your choices in the past parts of the experiment will now follow.

In the 1st, 3rd and 5th part, your task was to guess the color of the ball drawn for the other participant. The ball was drawn and returned immediately before the other participant had received a ball.

Then in the fourth part, you had to specify the probability that the ball had a certain color and the probability that the urn had a certain color. Now we ask you to answer two question about your decisions. The initial position was: 4 dark blue urns and 4 light blue urns.

In Part 4, you answered the following question: If you saw a dark blue ball given the above initial position, what was the probability (in %) that the other player's ball drawn after replacing your ball was also dark blue?

Your answer was (in %): [...] Please describe what you considered when answering this question: (please press ”Enter” after entering the text) [...]

In Part 4, you also answered the following question: If you saw a dark blue ball under the above initial position, with what probability (in %) was the drawn urn dark blue? Your answer was (in %): [...] Please describe what you considered when answering this question: (please press ”Enter” after entering the text) [...]

B.2.4. Intervention 1 of Treatment 3

Part 2 of the experiment

In Part 2, your task is to answer questions. The questions relate to different scenarios. The scenarios will be similar to those in the first part. In the first part of the experiment, your task was to guess what color the ball drawn for the other participant had.

Your task is to indicate the probability with which a blue or white ball is drawn in each scenario, or with what probability the drawn urn is blue or white in each scenario. Your payout will then depend on how well you choose your estimate.

The entering of your probability estimate is done in two steps: (1) First enter your estimate in the input field. (2) After that, another menu will be displayed on the right to reflect your input. Here you can also see how high your payout is if the other participant has indeed drawn a ball of the same color or a different color or if the urn has indeed the same color or a different color.

You can change your estimate in two ways: Firstly, you can enter a new estimate in the input field. Alternatively, you can directly click on a line in the menu on the right and update your estimate by clicking on ”Customize”. When you are satisfied with your decision, press the red ”Confirm” button to proceed to the next task. The button will appear on the right as soon as you have entered your first estimate. The initial position is: 4 [5] blue urns and 4 [3] white urns.

Instructions

In the upper part of the screen, you can see the corresponding initial position. Your task: Indicate how likely you think it is that the other participant's ball is also blue [white] if you have seen a blue [white] ball, given the initial position shown above. Your payout will then depend on how well you choose your estimate.

Entering your probability estimate is done in two steps: (1) First enter your estimate in the input field. (2) After that, another menu will be displayed on the right to reflect your input. Here you can also see how high your payout is if the other participant has indeed drawn a same-colored or different-colored ball.

At this point, you can still change your estimate in two ways: Firstly, you can enter a new estimate in the input box. Alternatively, you can directly click on a line in the menu on the right and update your estimate by clicking on ”Customize”. When you are satisfied with your decision, press the red ”Confirm” button to proceed to the next task. This will appear on the right as soon as you have entered your first estimate.

If you saw a blue ball given the initial position shown above, with what probability (in %) was the other player's ball blue as well? [If you saw a blue ball given the initial position shown above, with what probability (in %) was the urn also blue?] Give your estimate as an integer between 0 and 100.

B.2.5. Intervention 2 of Treatment 3

In the 1st and 3rd part, your task was to guess what color the ball drawn for the other participant was. The ball was drawn and returned immediately before the other player got a ball. In the 2nd part, you had to specify the probability that this ball had a certain color and with what probability the drawn urn had a certain color. Now we ask you to answer two questions about your decisions. The initial position: 4 blue urns and 4 white urns.

In the 2nd part, you answered the following question: If you saw a blue ball under the initial position shown above, with what probability (in %) was the other player's ball also blue? Your answer was (in %): [...] Please describe what you considered when answering this question: (after entering your answer, please press "Enter") [...]

In the 2nd part, you also answered the following question: If you saw a blue ball under the initial position shown above, what was the probability (in %) that the drawn urn was blue? Your answer was (in %): [...] Please describe what you considered when answering this question: (after entering your answer, please press "Enter") [...]

B.2.6. Intervention 3 of Treatment 3

Part 5 of the experiment

In each round of the 5th part, a ball is randomly drawn four times from the drawn-out urn and returned back again. You will see the color of the randomly drawn balls on the screen. Each ball is drawn, displayed and returned immediately. Another participant will then also see four randomly drawn balls from the same drawn urn.

You then have to guess the color of the first drawn ball for the other participant. Before making your decision, you will be informed about the (for both identical) initial position and the colors of your drawn balls.