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Abstract

Negotiation under the Curse of Knowledge

by Thibaud Pierrot*

An individual is affected by the curse of knowledge when he fails to appreciate the viewpoint of a lesser-informed agent. In contrast to a rational person, the cursed individual behaves as if part of his private information were common knowledge. This systematic cognitive bias alters many predictions derived from game theory which involve an asymmetry of information between the players. We investigate in this article how the curse of knowledge modifies individual behaviours in negotiation situations. We report the results of a laboratory experiment that was designed to isolate the effect of the curse of knowledge by varying the information available to the players ceteris paribus. Our analysis of the expectations and choices of subjects playing the ultimatum game in different information settings indicates that the curse of knowledge can lead to an increase of impasses in the negotiation and partially explains empirically observed phenomenons such as abnormally high rates of bargaining failures. Unlike previous behavioural research, that is mostly based on motivated beliefs and actions, this work provides a purely nonstrategic explanation for negotiation impasses observed in many real life situations.

Keywords: curse of knowledge, hindsight bias, negotiation, experiments

JEL classification: C91, D80, D82, D83, D84

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1 Introduction

Reaching a mutually beneficial agreement is not as trivial in practice as it appears in theory. This observation, deeply rooted in real life experience seems paradoxical in light of classic microeconomic theory. Farber and Katz's (1979) model, for instance, predicts that an agreement must be reached when the costs and risk associated with third-party involvement exceed the potential benefits of litigation. Even though this seems obvious from a rational point of view, the reality of negotiation situations often differs from this prediction. One emblematic example of recent history is the Apple Inc. vs. Samsung Electronics Co. patent litigation regarding the design of smartphones. It lasted over four years, involved more than 50 lawsuits worldwide and multiple trials in the U.S. including the intervention of the supreme court. The costs and risks associated with third-party involvement clearly exceeded the potential benefits of a litigation. This discrepancy between theoretical predictions and empirical observations has led many behavioural scientists to investigate the psychological biases that can impair people's ability to negotiate (see Caputo, 2013, for a complete review of the articles on negotiation in behavioural sciences[1] and Babcock et al., 1995, for a prime example of this literature).

In this paper, we contribute to this research agenda by investigating a cognitive bias which may prevent bargainers from reaching an agreement in a negotiation situation: the curse of knowledge. This work documents for the first time the effect of this bias in a negotiation situation. Indeed, as many bargaining problems involve an asymmetry of information between the players in multiple dimensions, e.g. the valuation of the good at stake or the outside options of the other party, the curse of knowledge is likely to have substantial consequences on the settlement reached. Does it distort the players' strategies? Can it be held responsible for part of the high rate of impasse observed empirically? How does it affect the negotiation outcomes when it interacts with the fairness preferences of the bargaining parties? Who is

[1] "Negotiation" (Bazerman et al., 2000) also provides an interesting review of the articles on biases in negotiation.

most affected by this curse during a negotiation? Our goal is to investigate these questions and provide some answers based on experimental data.

To fix ideas, let us consider the following hypothetical situation: two individuals are working on a common project yielding an uncertain profit that they have to share once their task is completed. The production process generating this profit is a black box and each bargainer has access to some information regarding it. We explore the role played by information asymmetry in this context by comparing a framework where all information available is common knowledge to a condition where one (or both) bargainer(s) possess a different private information regarding the production process. In the last scenario the curse of knowledge is likely to occur between the two bargainers and to have an impact on their strategy. Therefore, it may modify the outcome of the negotiation.

We conduct a laboratory experiment designed to isolate the causal effect of the curse of knowledge on the outcome of a negotiation. We use the ultimatum game as a stylised negotiation situation and a real effort task (a change-detection task) to determine the proposer's endowment. It is via this task that we induce the curse of knowledge in one of our treatments. By providing the respondents of our ultimatum game with extra information regarding the task we can observe the causal effect of the curse on both players' strategy.

Introduced into the economic literature by Camerer et al. (1989), the curse of knowledge designates the inability of a better informed agent to appreciate the viewpoint of a lesser-informed person. An individual affected by the curse thinks and behaves as if part of his private information were common knowledge.[2]

[2]The curse of knowledge is an interpersonal version of the hindsight bias Fischhoff (1975) - i.e. the concept, well documented in the psychology literature, that labels the tendency to believe that "an event is more predictable after it becomes known than it was before it became known" (Roese & Vohs, 2012). Both the curse of knowledge and the hindsight bias share a common mathematical definition (Camerer et al., 1989). They are formalised as a failure of the law of iterated expectations. A person suffering from the hindsight bias exhibits a tendency to forget how ignorant he was before the event occurred and thinks that he"knew it would happen" (Fischhoff & Beyth, 1973). Correspondingly, an agent under the curse of knowledge fails to take into account

Many behavioural economists have investigated this cognitive bias. Camerer et al. (1989) have shown in an experiment that the curse of knowledge hurts privately informed agents who are trading with lesser informed partners but that the market experience in a double oral auction reduces the impact of the bias. Loewenstein and Moore (2006) found that people are willing to purchase information that, due to the curse of knowledge, negatively impacts their ability to form accurate expectations regarding the performance of others and, ultimately, decreases their own pay-off. Danz (2013) showed that the curse of knowledge induces overconfidence, leading to a detrimental increase of self-selection into competition.[3] These examples demonstrate the impact of the curse of knowledge in many economic contexts.

Our experimental design also constitutes a relevant contribution to the literature on the role of information asymmetries in the ultimatum game, see Huck (1999) for a comprehensive summary of the main findings regarding this topic. It is related to Kagel et al. (1996) who conduct an experiment where the subjects play an ultimatum game over the split of chips that have a different monetary value for the players. Their treatments vary with respect to the information available to the players concerning the chip values of their partner. They find that different negotiation outcomes are triggered by the information conditions.

The novelty of our approach compared to Kagel et al. (1996) and most earlier work on information asymmetries in the ultimatum game is that our experiment is tailored to shift the players' beliefs via the curse of knowledge without altering the game itself. The features of the ultimatum game that is played remain identical in the two treatments that we conduct, including the players' information regarding the game. However, when Kagel et al.(1996) reveal information about the chip values to their subjects in some of their treatments, they change an important aspect of the

the ignorance of others.

[3] As for results relative to the hindsight bias, here are a couple of examples: Bias and Weber (2008) who show theoretically and experimentally that the hindsight bias leads to investors underestimating the volatility in financial markets, which impairs their investments performance; and Danz et al. (2014) who find that principals suffering from hindsight bias are less likely to delegate optimally to agents in a delegation game.

game. If the chips have a different value for the two bargainers, knowing these values implies a trade-off between efficiency and equality that do not exist in the treatment where this information is hidden. In this context, the subjects can follow different motives (maximising efficiency or equality) in the different treatments. Indeed, Kagel et al.(1996) find that the subjects cherry-pick their most preferred motive, mostly to their advantage, and that the treatment effect is at least partly due to motivated actions. In our experiment the players' motives remain unchanged between the treatments and the subjects have no motivation to believe that the endowment is higher or lower. Their best strategy is to be as accurate as possible.

Our data show that the curse of knowledge has a causal impact on the negotiation outcome in the ultimatum game. We find that when the respondents receive private information regarding the real effort task that was used to determine the proposers' endowments, they expect this endowment to be larger, due to the curse of knowledge, and are more likely to reject offers that they would have accepted otherwise. In our experiment, the bias increases the expected endowment and the lowest acceptable offer stated by the respondents by respectively 47% and 42% on average. As they do not anticipate the effect of the curse on the respondents, the proposers report similar expectations and do not adapt their strategies. They choose the same offers across treatments. This leads to a higher rate of rejection and a lower profit in the treatment where respondents are cursed by knowledge.

This paper proceeds as follows. We present the experimental design in the next section. In section 3 we derive our hypothesis from a simple behavioural model. We report the results in section 4 and conclude in section 5.

2 Experimental design

Our experiment is designed to observe the effect of the curse of knowledge on the outcome of a negotiation between two parties. We use the ultimatum game as a stylised negotiation situation and the change-detection task as a medium to trigger the curse of knowledge. This task, explained in the following section, is used to determine the proposer's endowment in the ultimatum game.

2.1 Change-detection task

The change-detection task consists of finding the difference between two nearly identical pictures within a limited amount of time. The pictures are presented sequentially in a 14-second video clip. They are displayed alternatively for one second with a blank screen of 150 milliseconds in-between, i.e. the first image is displayed followed by a blank screen, then the second image is displayed followed by another blank screen. This sequence is repeated six times. At the end of the video clip the first image appears again on the screen together with a red circle at the centre of it. The subject performing the task has 20 seconds to move the circle where the difference between the two pictures lies by clicking on the image. Figure 1 shows an example of the change-detection task.

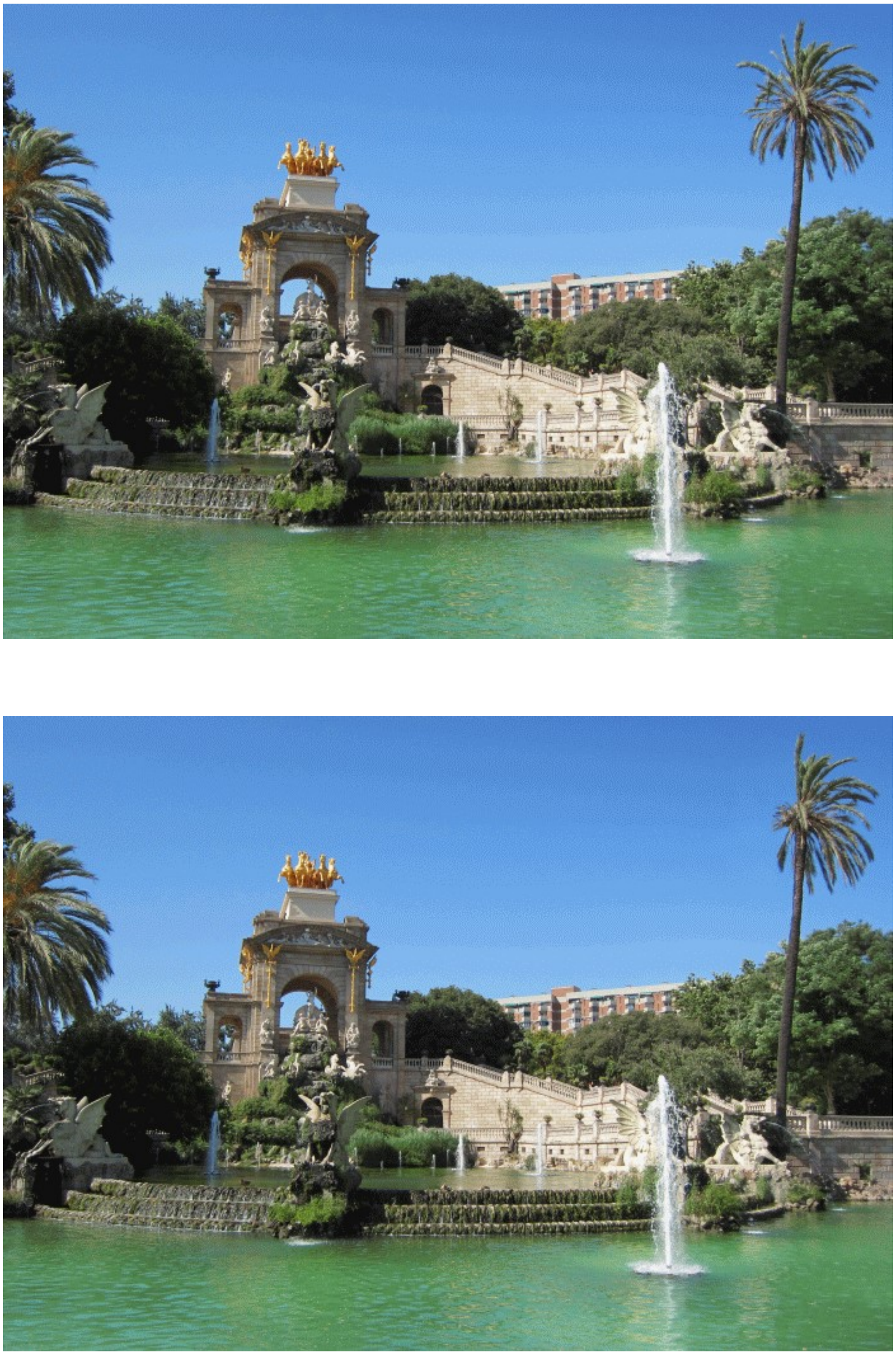


Figure 1: Example of the change-detection task.

This type of task is used in the psychology literature to study change-blindness, i.e. the inability or difficulty to detect changes (Rensink et al. 1997). It has also proven to be an efficient way to induce the curse of knowledge in previous economic studies (Loewenstein et al. 2006, Danz 2013).[4] This is due to the fact that, upon knowing the right answer to a change-detection question, this answer appears trivial to the informed party. This characteristic allows us to create an experimental framework that isolates the effect of the curse of knowledge and to study its impact on the negotiations between two participants.

2.2 Ultimatum game

The subjects play an ultimatum game where they must bargain over an endowment M given to the proposer. M is determined by the performance of a third party, i.e. another subject who played in a previous session, in a series of 10 change-detection tasks. Each correct answer provided by the third party endows the proposer with 4€, i.e. $M \in \{0, 4, 8, 12, ..., M_{max} = 40\}$. The proposer's endowment is generated by a third party in order to replicate the classic "windfall gain" version of the ultimatum game where the proposer is not responsible for the endowment's size. This allows us to compare our results to the most common framework for the ultimatum game in the literature and to avoid the effect of having a proposer that is fully entitled to the endowment, which may add noise to our results.

The proposer's endowment is private information, i.e. unknown to the respondent, but the change-detection tasks are displayed to both players before the ultimatum game starts. This feature is implemented to allow the participants to appreciate the difficulty of the task and form expectations about M. It also permits us to induce an asymmetry of information that triggers the curse of knowledge in one of the experimental treatments.

[4] We thank David Danz for providing us with the set of pictures that he used in his work.

The ultimatum game starts after the display of the change-detection task. An offer of $s \in [0, M]$€ is chosen by the proposer and a lowest acceptable offer $l \in [0, M_{max}]$ is chosen by the respondent. If $s \geq l$ the offer is accepted and the proposer obtains $M - s$ € and the respondent s €. Otherwise, the offer is rejected and both players gain 0€.

The respondents are randomly assigned to two treatments in a between-subjects design: the *ctrl* treatment where the change-detection task is displayed on every player's screen in the same fashion and the *CoK* treatment where the difference between the pictures is highlighted to the respondents only.[5] The curse of knowledge is triggered in this treatment since the respondents know the answer to the change-detection task while the proposers and the third party performing the task do not have access to this information.

In the two treatments, the game structure is common knowledge. It is explained in the instructions to both the respondents and the proposers. This feature was implemented to guarantee that the instructions did not deceive the players in any treatment. Consequently, the *CoK* treatment also differs with respect to the proposers. Indeed, they know that the respondents have access to extra information regarding the change-detection task during the experiment. This information may have an effect on their strategy which renders non-trivial the impact of the bias on the negotiation outcome. The proposers may foresee the effect of the CoK and adapt their strategy or be blind to it and select the same offers in both treatments.

2.3 Experimental procedure

We conduct six sessions of the experiment. At the beginning of a session, every participant reads the complete set of instructions that explains in detail the change-

[5] This feature does not allow the respondent to infer the endowment since the third party's answers are not observed in any of the treatments.

detection task, the way expectations are recorded, the ultimatum game and the information structure. The instructions, available in Appendix 1, are common to all the participants within a treatment. They contain the information relative to both roles, i.e. proposers and respondents, and the subjects learn their role only at the end.

Afterwards, an experimental session proceeds as shown in Figure 3. In step (1), each subject is randomly matched with another participant in the room and with a third party who performed the change-detection task in a former session. Meanwhile, in each group, one of the two subjects is randomly assigned the role of proposer and the other the role of respondent.

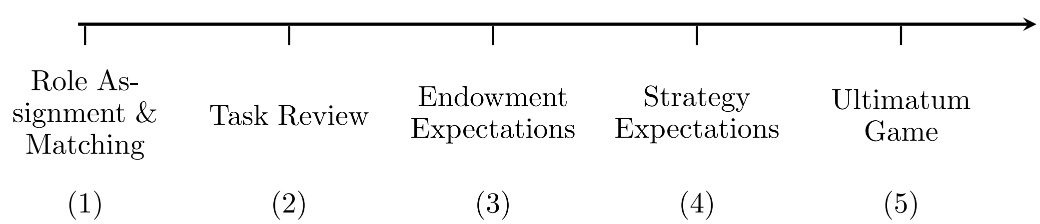


Figure 2: Time-line of the Experiment

During step (2), Task Review, the participants see the 10 change-detection questions that were formerly answered by the third party. The timing of the tasks and the breaks between questions are reproduced in the exact same way that the third party experienced them when performing the task. The aim of this feature is to allow the subjects to form beliefs about the size of the *endowment*.

In the *ctrl* treatment, all the questions appear on the participants' screens in the exact same fashion as they were displayed to the subjects who performed them. In the *CoK* treatment, the questions are presented to the respondents together with their answers. The areas containing the difference between the two pictures are highlighted by a blue rectangle that appear on the respondents' screens as shown in Figure 3. This blue rectangle constitutes the only difference between the two treatments.

Figure 3: Example of the change-detection task in z-Tree

Respondents' Screen in the *CoK* Treatment

Once the players have seen the change-detection task, the experiment proceeds with steps three to five. The participants (3) report their predictions regarding the size of the endowment, (4) report their expectations regarding the choice of their group member in the ultimatum game, and (5) choose their strategy for the ultimatum game. When answering the expectations questions, the players receive no further information. The proposers are informed of their endowment only during step (5).

The two expectations are recorded in the form of a probability distribution. The subjects are given bins that are labelled with a range of possible outcomes and have to fill these bins with probabilities that must add up to 100%. For example, to report their expectations regarding the endowment M the subject assigns a probability that it is: 0, $[1, 4]$, $[5, 8]$, $[9, 12]$ and so on. The strategies in the ultimatum game consist of typing a single number: for the proposer, his offer to the respondent in his group; for the respondent, her lowest acceptable offer.

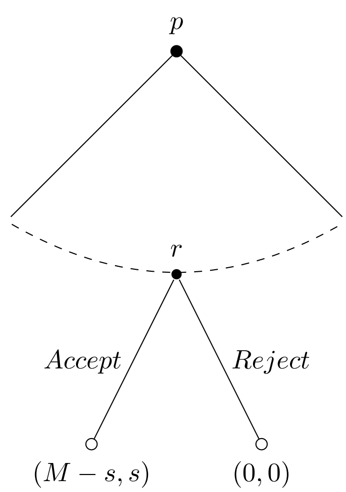
The players are informed of the outcomes in their group at the end of the experiment. They are shown the proposer's endowments and offer as well as the respondent's lowest acceptable offer. They are paid according to their choices in the ultimatum game and earn 3€ for the completion of the expectations tasks and a 5€ show-up fee.

3 Theory

This section is dedicated to the formalisation of our experimental framework as well as the behavioural concepts that we use to formulate the hypotheses that are tested in our data analysis. We characterise (1) the game's framework, (2) the concept of curse of knowledge and, (3) the model of social preferences on which we base our pre-experimental conjectures.

3.1 Ultimatum game framework

In our experiment, a proposer p and a respondent r play an ultimatum game with the endowment $M \in [0, M_{max}]$. The proposer must suggest an offer $s \in [0, M]$ while the respondent chooses a lowest acceptable offer $l \in [0, M_{max}]$. If $s \geq l$ the offer is accepted and the proposer obtains $M - s$ € and the respondent obtains s €. Otherwise, the offer is rejected and both players gain 0€.



The proposer's endowment, $M \in [0, M_{max}]$, depends on how many tasks from a set of 10 change-detection tasks a third party solved in a previous session. This set of tasks is displayed to both players before the ultimatum game starts. In the control treatment, every player observes each task in the same fashion as the third party while in the CoK treatment the respondent is provided with the answers to the 10 tasks while seeing them on his screen.

All the game's features are common knowledge including the information displayed to the respondent.[6] Only the endowment M is the proposer's private information as it is not observed by the respondent.

3.2 Curse of knowledge

The curse of knowledge designates the inability of a better-informed agent to appreciate the viewpoint of a lesser-informed person. It can be formalised as a failure of the law of iterated expectations (Camerer et al., 1989). Let us consider an event A with expectation $E[A]$ and two information sets I_0 and I_1 with $I_0 \subseteq I_1$, i.e. I_1 is strictly more informative than I_0.

The law of iterated expectation implies that $E[E[A|I_0]|I_1] = E[A|I_0]$. This means that a rational agent must be able to compute the expectation $E[A|I_0]$ even though he has access to the more informative set, I_1, as long as I_1 contains I_0. In other words, a rational person can ignore part of the information that he possesses in order to construct the expectation $E[A|I_0]$ as if he only knew I_0.

For an individual who suffers from the curse of knowledge, we write $E[E[A|I_0]|I_1] = \omega E[A|I_1] + (1-\omega)E[A|I_0]$. Where I_1 is the information available to the individual, I_0 is the information set of the lesser-informed agent and ω is the degree of the curse of knowledge exhibited by the individual. This notation implies that a cursed agent is unable to construct $E[A|I_0]$ when they have access to the information set I_1.

In our experimental framework, the respondent has to form expectations regarding the third party's performance in the change-detection task in order to estimate the proposer's endowment M. This requires him to apprehend the tasks' difficulty in the perspective of the third party. In this setting, we can formalise the expectation

[6] The proposer knows whether he is playing against a respondent who knows the answers of the change-detection task.

of a cursed respondent in the following way:

$$E[E[M|I_p]|I_r]_r = \omega E[M|I_r] + (1-\omega)E[M|I_p]$$

Where $E[E[M|I_p]|I_r]_r$ is the expectation of the respondent regarding the endowment M when having access to the information I_r while the other players only have access to I_p.

In the *ctrl* treatment, where all the players have access to the same information set, i.e. $I_r = I_p$, there is no room for the curse of knowledge to have any effect on the respondent's beliefs regarding the endowment. For any ω it holds true that $E[E[M|I_p]|I_r]_r^{ctrl} = E[M|I_p] = E[M|I_r]$.

In contrast, the *CoK* treatment introduces an information asymmetry between the respondent and the other players by displaying the answers to the change-detection task on the respondent's screen. Assuming that if the third party was given all the answers during the task he would obtain the highest endowment, i.e. $E[M|I_r] = M_{max}$, the respondent's expectation can be written as: $E[E[M|I_p]|I_r]_r^{cok} = \omega M_{max} + (1-\omega)E[M|I_p]$, leading us to formulate our first hypothesis:

Hypothesis 1a: *The curse of knowledge results in upward biased expectations of the respondents regarding the proposers' endowments in the CoK treatment:* $E[M]_r^{cok} = \omega M_{max} + (1-\omega)E[M]_r^{ctrl} > E[M]_r^{ctrl}$.

As the treatment only modifies the respondents' information set, it must have no effect on the proposers' expectations regarding their endowment.[7]

Hypothesis 1b: *The proposers' expectations regarding their endowment is not affected by the treatment:* $E[M]_p^{cok} = E[M]_p^{ctrl}$.

With ***Hypothesis 1a*** we anticipate an effect of the curse of knowledge on the re-

[7] As specified in the experimental design section, we record this expectation before the endowment is revealed to the proposers.

spondents' expectations. Nevertheless this change in expectation does not necessarily need to impact a respondent's strategy in the ultimatum game. Under the assumption of rational agents who only care about their own pay-off, the endowment M plays no role in defining the best strategy for both players. The subgame perfect Nash equilibrium is to accept any offer higher than 0 for the respondent and to propose the smallest possible amount for the proposer. Nevertheless, as we will see in the following section, introducing preferences for fairness in the players' utility functions implies that the strategies of both players are affected by the curse of knowledge, which leads to different predictions than for the purely rational and selfish players.

3.3 Model of social preferences

We assume that the players' preferences can be represented by a utility function taking into account both their own pay-off and the other player's pay-off. As in Fehr & Schmidt (2000) the utility of individual i matched with individual j for an allocation $\pi = (\pi_i, \pi_j)$ is expressed in the following way:

$$U_i(\pi) = \pi_i - \alpha_i max[\pi_j - \pi_i, 0] - \beta_i max[\pi_i - \pi_j, 0]$$

where it is assumed that $i \neq j$ $\beta_i \leq \alpha_i$ and $0 \leq \beta_i \leq 1$. α_i and β_i are the coefficients of the inequality aversion of the individual. α_i (β_i) prevails when $\pi_j \geq \pi_i$ ($\pi_j < \pi_i$) as it is assumed that individuals may have a different tolerance for inequality depending on whether their own pay-off is the highest or lowest.

Applying these preferences to our game yields:

$$U_p(s, M) = M - s - \alpha_p max[2s - M, 0] - \beta_p max[M - 2s, 0] \quad (1)$$

$$U_r(s, M) = s - \alpha_r max[M - 2s, 0] - \beta_r max[2s - M, 0] \quad (2)$$

To choose the optimal lowest acceptable offer l, the respondent must form an expectation regarding the realisation of M that we denote by $E[M]$. We assume that the respondent maximises his expected utility $EU_r(s, E[M])$.

In case of rejection by the respondent, the utility of both players is $U(0,0) = 0$. Thus, it is a dominated strategy for the respondent to accept any offer s that yields $EU_r(s, E[M]) < 0$. For any offer s that yields $EU_r(s, E[M]) > 0$, the respondent's best response is to accept that offer. Hence, a rational respondent maximises his expected utility by choosing l such that[8]:

$$\begin{aligned} EU_r(l, E[M]) &= EU(0,0) = 0 \\ \Rightarrow 0 &= l - \alpha_r max[E[M] - 2l, 0] \\ \Rightarrow l &= \frac{\alpha_r}{1 + 2\alpha_r} E[M] \end{aligned}$$

As ***Hypothesis 1a*** states that $E[M]_r^{cok} > E[M]_r^{ctrl}$ for the respondents, we now derive the following hypothesis regarding the respondents' strategy:

Hypothesis 2a: *The respondents' lowest acceptable offers are higher in the CoK treatment than in the ctrl treatment:* $l_{cok} > l_{ctrl}$.

The proposers maximise their utility as described in equation (1) by best responding to the respondents choice of l. To do so, their strategy must be to choose a proposal

[8]Theoretically, the respondent also wants to choose a maximal acceptable offer m above which all proposals are rejected. This would yield the following decision criteria:

$$\begin{aligned} l &= \frac{\alpha_r}{1 + 2\alpha_r} E[M] \;\; if \;\; E[M] > 2s \\ m &= \frac{-\beta_r}{1 - 2\beta_r} E[M] \;\; if \;\; E[M] < 2s \end{aligned}$$

But since we do not allow our respondent to choose such a maximal acceptable offer in our experiment, we discuss only the choice rule for the minimal acceptable offer l.

s such that:

$$s = \begin{cases} \frac{1+\alpha_p}{1+2\alpha_p}M & \text{if } l < \frac{1+\alpha_p}{1+2\alpha_p}M \\ [0, \frac{1-\beta_p}{1-2\beta_p}M] & \text{if } l > \frac{1-\beta_p}{1-2\beta_p}M \\ l & \text{otherwise} \end{cases}$$

With this strategy, a proposer ensures a minimum utility of 0 from the game when the lowest acceptable offer of the respondent is too high to find a mutually beneficial split and extracts the maximum utility from the game when the respondent selects a lowest acceptable that leaves room for a compromise. Assuming that a relevant number of proposers choose $s = l$, we obtain :

Hypothesis 2b: *The proposers' offers are higher in the CoK treatment than in the ctrl treatment:* $s_{cok} > s_{ctrl}$.

Yet an increase in l also means that a lower ratio of settlements may be reached. Indeed, the number of respondents reporting a lowest acceptable offer too high to be met by a reasonable proposal, i.e. $l > \frac{1-\beta_p}{1-2\beta_p}M$, may increase in the CoK treatment as the lowest acceptable offers become larger. Defining *settle* as the ratio of settlements reached, we conjecture that

Hypothesis 3: *The ratio of settlements is lower in the CoK treatment than in the ctrl treatment:* $settle_{cok} < settle_{ctrl}$.

Finally, to close our theoretical framework, we assume that the players hold correct beliefs regarding their group member's strategy, i.e. they use the model to form their beliefs about the strategy chosen by the other person in their group and these beliefs correspond to the strategies that are played. This assumption, coupled with the hypotheses 2a and 2b, leads us to the two following hypotheses:

Hypothesis 4a: *The respondents' expectations regarding the proposers' offers are higher in the CoK treatment than in the ctrl treatment:* $E[s]_{cok} > E[s]_{ctrl}$.

Hypothesis 4b: *The proposers' expectations regarding the respondents' lowest acceptable offer are higher in the CoK treatment than in the ctrl treatment:* $E[l]_{cok} > E[l]_{ctrl}$.

Note that the assumption of correct beliefs which allows us to close the model and derive ***Hypothesis 4a*** and ***Hypothesis 4b*** is not necessary for ***Hypothesis 3*** to hold. Assuming that the proposers are myopic to the effect of the curse of knowledge on the respondents' strategies would also result in lower chances of settlement in the CoK treatment. The respondents would increase their $lowest\ acceptable\ offer$ while the proposers would not change their $offer$, which would result in a higher likelihood of rejection as well.

To sum up, our theoretical model predicts a shift in the expectations and the strategies of both players between the two treatments. This shift, due to the curse of knowledge, would result in a different allocation of the endowment in favour of the respondent and in a lower rate of settlements. This scenario and all our hypotheses are tested in the following section.

4 Results

In this section, we analyse the results collected during our experiment. First, we briefly expose our sample's descriptive statistics. We then specify which variables of interest are examined and how they are computed. We present our findings, starting with the respondents' decisions before turning to the proposers' decisions. For each role we present the average treatment effects on the expectations and strategies of our subjects and explore the treatment effect on the complete distributions of behaviours in our sample. Note that we consider a result to be significant when the p-value associated with its test statistic is lower than 5% (unless otherwise specified).

4.1 Descriptive statistics

The descriptive statistics of our experiment are summarised in Table 1. Overall, 136 subjects participated in six sessions that were conducted in September 2018.[9] The participants were randomly assigned to the *ctrl* or to the CoK treatment and to the role of proposer or respondent. Hence, 34 independent observations were collected per treatment for each role.

[9] Another 24 subjects participated in a pilot session conducted in August. They were used as the third-party for our main experiment. They performed the change-detection task under the same incentive scheme (4€ per right answer) and their performance in this task determined the proposers' endowments in the main experiment.

	Treatment		
	CoK	*ctrl*	*both*
# of Subjects	68	68	136
Age (year)	25.2	25	25.1
Gender (1=man)	0.57	0.57	0.57
Endowment (€)	11.3	11.3	11.3
Profit in UG (€)	3.1	3.6	3.4
Total gain (€)	11.1	11.6	11.4

Table 1: Descriptive Statistics

The statistics presented in Table 1 show that our sample is balanced in terms of age and gender, respectively 25 years old on average and 57% of male in both treatments. The average proposer's endowment is 11.3€[10] and the profit from the ultimatum game is, on average, 3.4€. It is a little smaller for the treated group than for the control group. This profit is added to the 5€ show up fee and the 3€ paid to all subjects after they answered the expectation questions. This results in an average payment of 11.4€.

4.2 Treatment comparison

The endowment M, the proposal s and the lowest acceptable offer l are recorded as scalars and can be analysed without further transformations. All expectations are recorded in the form of probability distributions. To perform our analysis, we compute individual measures of the average expectation regarding the endowment M, $E[M] = \sum_{\forall b} \ (p_b * M_b)$. Where p_b is the probability that the subject assigns to

[10] This endowment is equal in both treatments because only one session with the third parties performing the change-detection task was conducted in August 2018. The performance of the 24 subjects participating in this session was used to determine the endowments in each of the six sessions conducted afterwards and analysed in this document.

the event described in bin b and M_b is the average endowment labelled in bin b. For example, if a subject reports 20% in the second bin, labelled $[1, 4]$, it means that he believes that there is a 20% chance that the endowment will be between 1 and 4. Therefore, $p_2 = 0.20$ and $M_2 = 2.5$.

Similarly, $E[s] = \sum_{\forall b} \ (p_b * s_b)$ is computed for the expectations regarding the proposal s and $E[l] = \sum_{\forall b} \ (p_b * l_b)$ for the expectations of the lowest acceptable offer l. We also introduce three variables that help us to analyse the treatment effect. The variable *settle* is a dummy that takes the value 1 when a settlement is reached and 0 otherwise. The variable *share* is the proportion of the endowment that a proposer is offering, i.e. $share = \frac{s}{M}$. Finally, we denote min_share the minimum share of the endowment that a respondent is willing to accept according to his expectations for the endowment, i.e. $min\_share = \frac{l}{E[M]}$.

For the rest of our analysis, three observations have been removed from our sample corresponding to three respondents who exhibited irrational behaviour. They reported a lowest acceptable offer that was larger than their average expectation of the proposer's endowment. In other words, they were only willing to accept more than 100% of the average endowment that they thought the proposer would get. This strategy cannot be reconciled with our theoretical framework and we suspect that it is due to a misunderstanding regarding the game. Nevertheless, as a robustness test, we provide in Appendix 2 the results of our data analysis without these exclusions.

4.2.1 Respondents' expectations and strategy

Our main results are presented in Table 2 and Figure 5. We find that the expectations and strategies of the respondents are significantly impacted by the curse of knowledge in the direction that our theory predicts.

	CoK		$ctrl$		ΔT	$p - val$
$E[M]$	24.8	(5.7)	16.9	(4.9)	7.9	0.00***
$E[s]$	11.6	(5.4)	8.6	(3.6)	3.1	0.00***
l	7.5	(5.4)	5.3	(3.9)	2.2	0.03**
min_share	0.31	(0.2)	0.31	(0.2)	0.0	0.46
# obs	34		31			

Table 2: Treatment Effects - Respondents

Table containing the averages of $E[M]$, $E[s]$, l and min_share reported by the respondents in each treatment, the difference between both treatments, ΔT, and the corresponding p-value for a one-sided t-test. The figures in parentheses are the associated standard deviations. The stars represent the level of significance associated with the one sided t-test comparing both treatments; with * being the 10% level, ** 5% and *** 1%.

The respondents' expectations regarding the size of the endowment are significantly higher in the CoK than in the *ctrl* treatment. The change-detection task was effective in producing the curse of knowledge for the respondents. Indeed, when they are shown the correct answers during the task, the subjects expect that, on average, almost two more changes are detected (out of 10) which represents a 46% increase and translates into an increase of 7.9€ in expected endowment. This result replicates the previous findings of Danz (2013) and Loewenstein et al. (2006). Note that the true endowment of the proposers was 11.3€ which implies that the respondents were too optimistic in both treatments.

Result 1a: *The respondents' expectations with regards to the proposers' endowments are significantly larger in the CoK than in the ctrl treatment, i.e.* $E[M]_{cok} > E[M]_{ctrl}$.

The treatment has an effect on expectations regarding the group member's action as well. The respondents expect an average proposal that is 3.1€ higher when they belong to the treated group. Consequently, they modify their strategies in the ultimatum game by choosing a 2.2€ higher lowest acceptable offer in the treatment condition. This 42% increase keeps the minimum accepted share of the respondent, min_share, constant at 31% of the expected endowment. This min_share does not vary between treatments and corresponds to the existing findings in the ultimatum game literature.

Result 2a: *The respondents choose significantly larger lowest acceptable offers in the CoK than in the ctrl treatment, i.e.* $l_{cok} > l_{ctrl}$.

Result 4a: *The respondents expect on average significantly larger offers from the proposers in the CoK than in the ctrl treatment, i.e.* $E[s]_{cok} > E[s]_{ctrl}$.

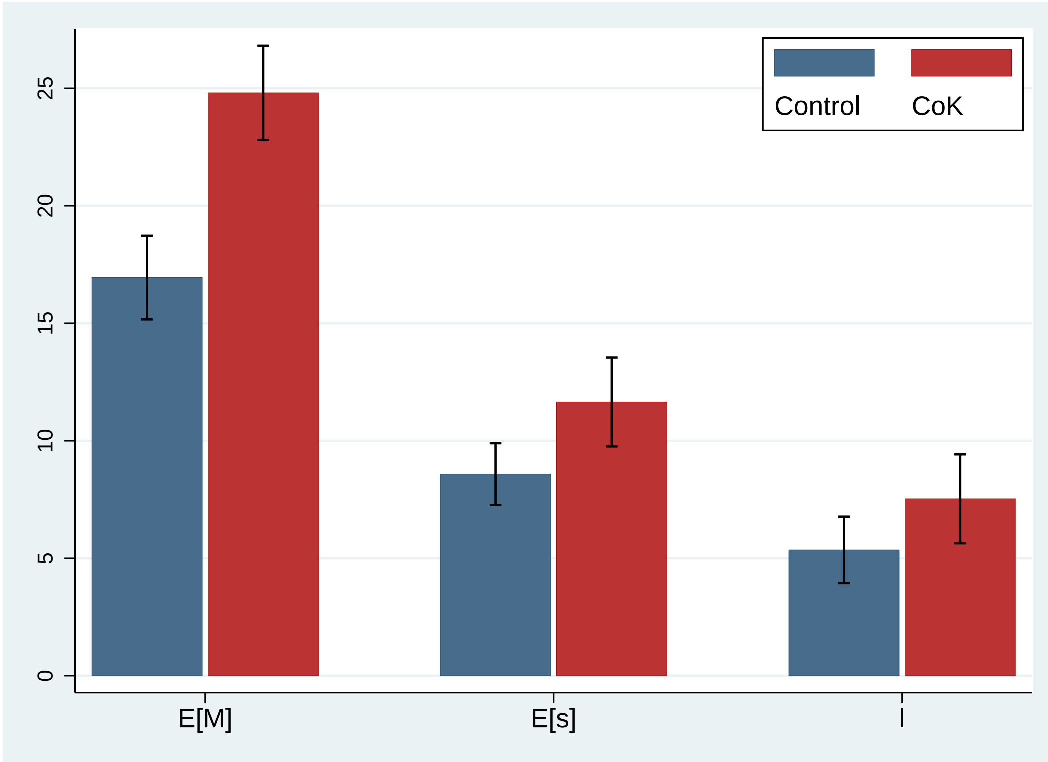


Figure 5: Treatment Comparison - Respondents

Figure showing the averages of $E[M]$, $E[s]$ and l reported by the respondents in each treatment and their associated 95% confidence intervals.

According to our results, the respondents overestimate the third parties' success in the change-detection task in both treatments. The true average success rate is a little lower than 3 out of 10 for an average endowment of 11.3€. In the *ctrl* treatment the respondents expect an average endowment of 16.9€ which is slightly overoptimistic. In the *CoK* treatment, the overestimation is more dramatic. The subjects who are given the true answers to the change-detection questions are expecting the endowments' size to be 24.8€,on average, i.e. 120% more than the true average. Their expectations are significantly higher than the expectations of the participants who had no access to the answers. As a result, they ask for a larger amount of money as a lowest acceptable offer l which corresponds to an identical expected minimum share min_share of the total expected endowment. These findings are in line with the hypotheses 1a, 2a and 4a.

4.2.2 Proposers' expectations and strategy

We present the average treatment effects for the proposers in Table 3 and Figure 6. We observe that the proposers hold similar expectations and choose equivalent strategies in the ultimatum game in both treatments.

	CoK		$ctrl$		ΔT	$p-val$
$E[M]$	17.5	(4.5)	15.5	(7.3)	2.0	0.09*
$E[s]$	10.7	(3.6)	10.7	(5.8)	0.0	0.48
l	5.6	(2.5)	5.7	(2.9)	-0.1	0.46
min_share	0.51	(0.2)	0.51	(0.2)	0.0	0.46
# obs	34		34			

Table 3: Treatment Effects - Proposers

Table containing the averages of $E[M]$, $E[l]$, s and $share$ reported by the proposers in each treatment, the difference between both treatments, ΔT, and the corresponding p-value for a one-sided t-test. The figures in parentheses are the associated standard deviations. The stars represent the level of significance associated with the one-sided t-test comparing both treatments; with * being the 10% level, ** 5% and *** 1%.

Result 1b: *The proposers' expectations with regards to their endowment are not significantly different in the CoK than in the ctrl treatment, i.e.* $E[M]_{cok} = E[M]_{ctrl}$.

Result 2b: *The proposers do not choose significantly different offers in the CoK than in the ctrl treatment, i.e.* $s_{cok} = s_{ctrl}$.

Result 4b: *On average, the proposers do not expect significantly different lowest acceptable offers from the respondents in the CoK than in the ctrl treatment, i.e.* $E[l]_{cok} > E[l]_{ctrl}$.

In theory, even though the *CoK* treatment only modifies the respondents' information set, it should affect the proposers as well. Our framework implies that the proposers' expectations regarding their endowment must remain unchanged (Hypothesis 1b) but that their expectations regarding the respondents' strategy as well as their own strategy should differ (hypotheses 2b and 4b).

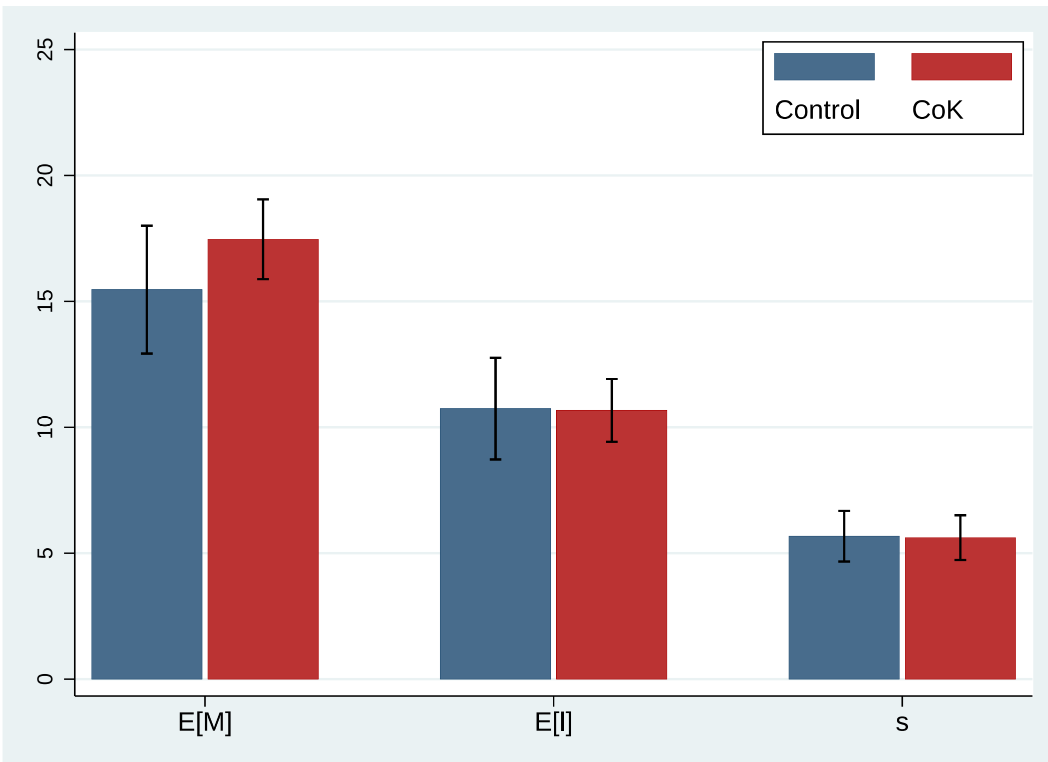


Figure 6: Treatment Comparison - Proposers

Figure showing the averages of $E[M]$, $E[l]$ and s reported by the proposers in each treatment and their associated 95% confidence intervals.

Only Hypothesis 1b ($E[M]_p^{cok} = E[M]_p^{ctrl}$) is in line with our findings. Our data do not indicate that the proposers' strategy in the ultimatum game or their expectations regarding the respondents' strategy were affected by the CoK treatment. We cannot reject the null hypotheses that $E[l]_p^{cok} = E[l]_p^{ctrl}$ and that $s_{cok} = s_{ctrl}$. These observations tend to indicate that the proposers are naive with respect to the effect of the curse of knowledge on the respondents' strategies.

4.2.3 Aggregate outcome

The average rate of settlements and profit in the two treatments are reported in Table 4. We have already seen that the respondents' lowest acceptable offers are larger in the CoK treatment and that the proposers' offers are not significantly different. As a result, we observe a lower rate of settlement in the CoK than in the *ctrl* treatment (significant at the 10% confidence level) and a lower average profit, especially of the respondents.

Result 3: *There are fewer settlements reached in the CoK than in the ctrl treatment (with 90% confidence) , i.e.* $settle_{cok} < settle_{ctrl}$

	CoK		$ctrl$		ΔT	$p-val$
$settle$	0.47	(0.5)	0.65	(0.5)	0.18	0.08*
$profit_r$	2.9	(3.5)	4.2	(3.9)	-1.2	0.09*
$profit_p$	3.2	(4.2)	3.5	(3.9)	-0.3	0.38
$profit$	3.1	(3.9)	3.8	(3.9)	-0.7	0.13
# obs	68		65			

Table 4: Outcome of the game

Table containing the average rate of settlement and profits in each treatment, the difference between both treatments and the corresponding p-value for a one-sided t-test. The figures in parentheses are the associated standard deviations. The stars represent the level of significance associated with the one-sided t-test with * being the 10% level, ** 5% and *** 1%.

Due to the curse of knowledge, the respondents are more likely to reject the offers in the CoK treatment and their profit is lower on average. The rate of settlement is 18 percentage points lower in the CoK than in the $ctrl$ treatment. This difference, significant at the 10% level, seems to be the outcome of both the respondents' changes in behaviours and the proposers' naivete regarding the effect of the curse of knowledge. To foresee the effect of the curse on the respondents would have required a high degree of sophistication among the proposers in the CoK treatment. Our results indicate that this is not the case as we do not observe any difference in their strategies between treatments. Therefore, only the number of settlements changes across treatments.

4.3 Quantile analysis

We now go a step further and investigate how the CoK treatment affected the entire distributions of average expectations and strategies in the ultimatum game. Our goal in this section is to extend our analysis to see if the results we have gathered can indicate whether all the respondents are equally affected by the curse of knowledge. We also aim to see if the curse always leads to a change in strategies and if some of the proposers are adapting their strategies as well.

Since our experimental treatments are assigned between subjects we cannot isolate the treatment effect individually. Therefore, we estimate the treatment effect on the different quantiles of the distributions of $E[M]$, $E[s]$ and l for the respondents and $E[M]$, $E[l]$ and s for the proposers. We report the treatment effects on four different quantiles of the distributions in Table 5. Additionally, Figures 7 and 8 illustrate our results by showing for each variable its cumulative distribution function (CDF) as well as the estimated treatment effects on the different quantiles.

	Respondents			Proposers		
Quantile	$E[M]$	$E[s]$	l	$E[M]$	$E[l]$	s
20	1.9***	1.13	1	0.47	1.35	0
40	1.75***	1.52	1	0.41	1.4	0
60	1.69***	3.1*	2	0.35	0.76	0
80	2.5***	5.6*	7***	0.26	-2.2	0

Table 5: Treatment Effects Per Quantile

Table containing the treatment effects on four different quantiles of the distributions (the 20th, 40th, 60th and 80th) for the variables $E[M]$, $E[s]$, l, $E[l]$ and s. The effects are presented for each role, proposer and respondent, separately. The stars represent the level of significance associated with a one-sided t-test against the null hypothesis that no effect is found; with * being the 10% level, ** 5% and *** 1%.

We observe that the CoK treatment had no significant effect on any quantile of the distributions of the proposer's expectations and strategies. As previously mentioned for the average treatment effect, this evidence is in line with Hypothesis 1b ($E[M]_p^{cok} = E[M]_p^{ctrl}$) and at odds with hypotheses 2b and 2c as we cannot reject the null hypotheses that $E[l]_p^{cok} = E[l]_p^{ctrl}$ and that $s^{cok} = s^{ctrl}$ for any quantile of their distribution.

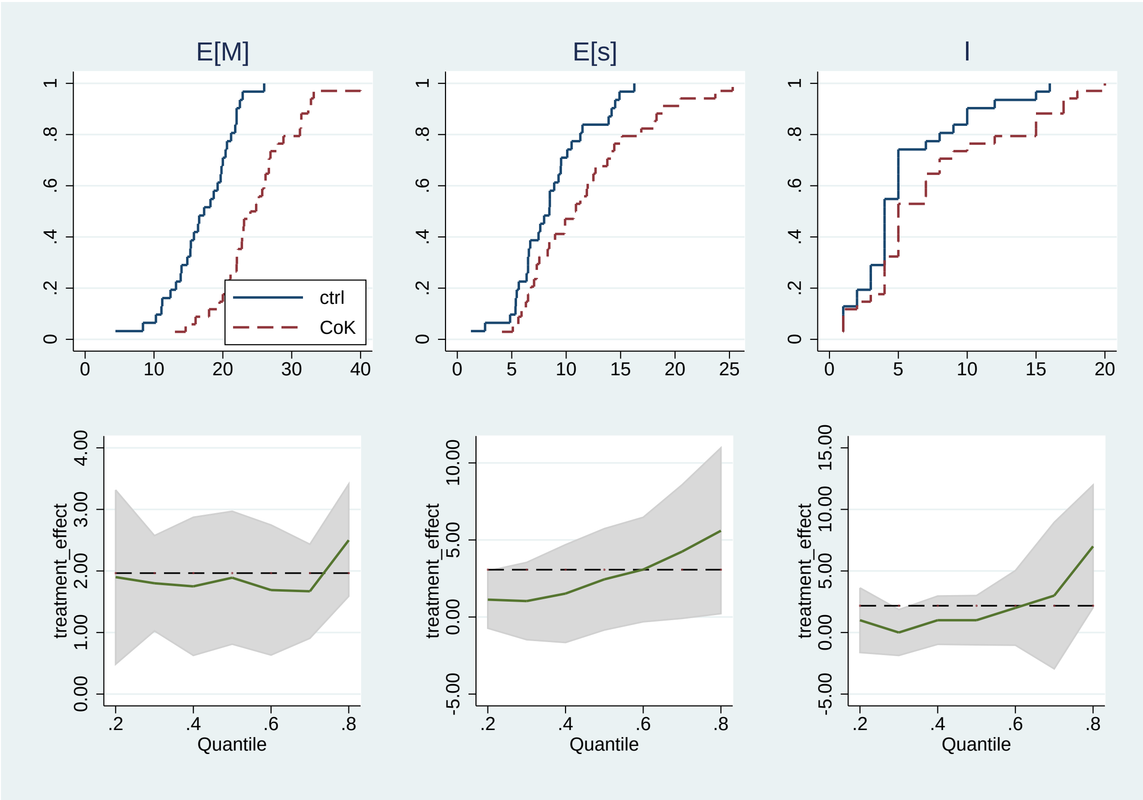


Figure 7: Cumulative Distribution Functions and Treatment Effect per Quantile - Respondents

Figure showing the cumulative distribution function (CDF) as well as the estimated treatment effect on the quantiles of $E[M]$, $E[s]$, l for the respondents. In the top graphs, the full blue line represents the CDF of the *ctrl* treatment and the dashed red line represents the CDF of the *CoK* treatment. In the bottom graphs, the full green line represents the treatment effect on the different quantiles of the distribution while the dashed black line shows the average treatment effect. The grey area is the 95% confidence interval of the quantile effect estimates.

For the respondents, the *CoK* treatment produces a curse of knowledge that can be measured over the entire distribution of expectations. The CDF of $E[M]$ is shifted towards the left and all the quantile effects are close to 2€ which corresponds to the average treatment effect. Nonetheless, the treatment effect on the expected proposals and on the lowest acceptable offer are different across quantiles. Only the high quantiles of these two distributions are significantly shifted towards higher values by the treatment. The lower quantiles remain unaffected.

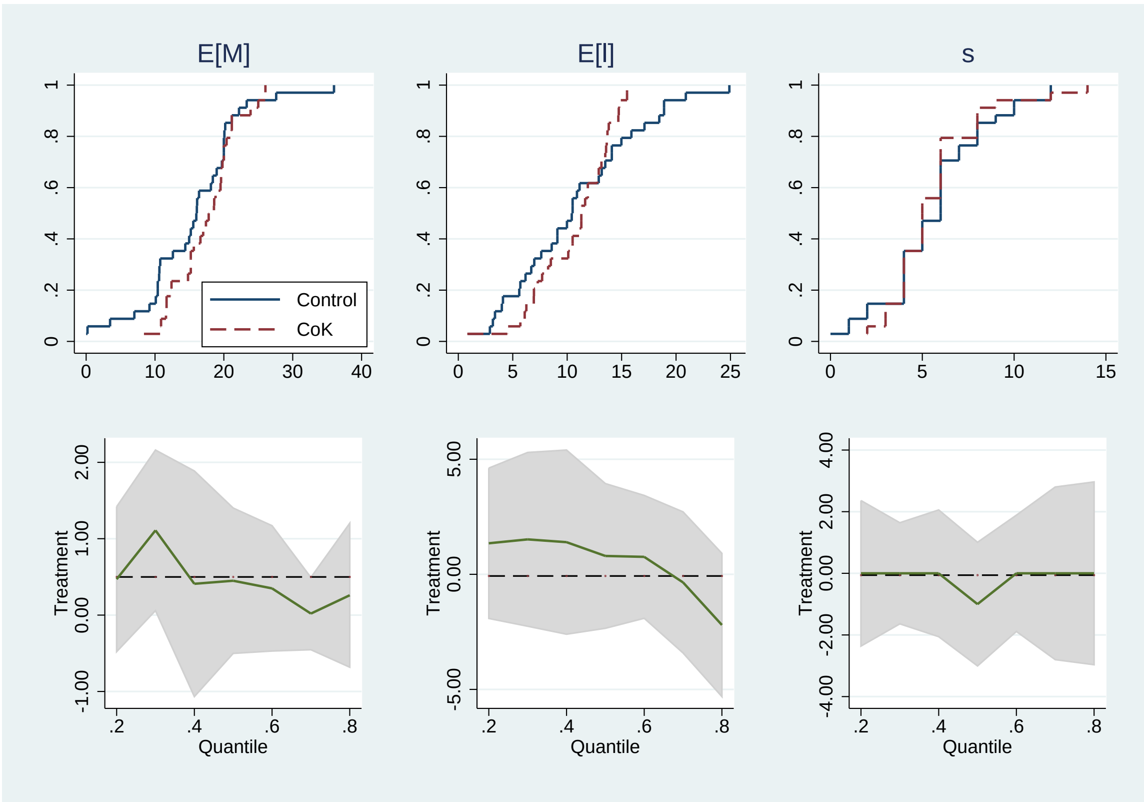


Figure 8: Cumulative Distribution Functions and Treatment Effect per Quantile - Proposers

Figure showing the cumulative distribution function (CDF) as well as the estimated treatment effect on the quantiles of $E[M]$, $E[l]$, s for the proposers. In the top graphs, the full blue line represents the CDF of the *ctrl* treatment and the dashed red line represents the CDF of the *CoK* treatment. In the bottom graphs, the full green line represents the treatment effect on the different quantiles of the distribution while the dashed black line shows the average treatment effect. The grey area is the 95% confidence interval of the quantile effect estimates.

These findings indicate that the curse of knowledge shifts the beliefs of the respondents independently of their preferences for fairness but that only the respondents who are averse to inequality react to this change. This interpretation is in line with our theory. Indeed, if we derive from the functional form describing the choice of the lowest acceptable offer, $l = \frac{\alpha_r}{1+2\alpha_r}E[M]$, the following expression:

$$\Delta l \;=\; \frac{\alpha_r}{1+2\alpha_r}(E[M]_r^{cok} - E[M]_r^{ctrl})$$

where Δl is the difference in the lowest acceptable offer stated by the respondents between the control and the treatment condition. We can observe that the impact of the curse of knowledge on the expectations and the fairness preference parameter α influence the optimal strategy of the respondents in a multiplicative way. This means that the respondents with a high α, i.e. who are more averse to inequality, both choose a high lowest acceptable offer and are more affected by the CoK treatment than those with a low α.

This scenario fits both our data and our theoretical conjectures but is not formally tested by our design. Further research involving a within-subjects design that let us observe individual effects would be needed to draw final conclusions regarding the combined effect of preferences for fairness and the curse of knowledge.

5 Summary and conclusions

In this article we present experimental evidence demonstrating the causal effect of the curse of knowledge on negotiation strategies in a bargaining situation. We conduct a laboratory experiment in which the ultimatum game is used to create a stylised negotiation setting. A change-detection task determines the proposer's endowment in the game. In one of the two treatments, we provide the respondents of the ultimatum game with private information about the solution of the change-detection task and thus induce the curse of knowledge. This manipulation shifts the respondents' beliefs regarding the endowment's size without modifying any feature of the game. Hence, the treatments allow us to observe the causal effect of the curse of knowledge on our subjects' expectations and behaviour.

We find that providing additional information to the respondents impairs their ability to judge the task's difficulty. As a result they expect a larger endowment for the proposers and choose a higher lowest acceptable offer in the ultimatum game. In our experiment, the effect of the curse of knowledge on the respondents is substantial. It increases their expected endowment and their lowest acceptable offer by respectively 47% and 42% on average. The respondents maintain a minimum accepted share of 31% of the expected endowment across treatments which corresponds to the existing findings in the ultimatum game literature. The proposers do not foresee the effect of the curse on the respondents' strategies. They report similar expectations and choose the same offers across treatments. This absence of effect on the proposers' strategy combined with the difference in respondents' choices leads to a higher rate of rejection and a smaller profit for subjects in the *CoK* than in the *ctrl* treatment. We observe a higher rate of bargaining impasse when the respondents receive private information regarding the solution of the change-detection task.

This treatment variation was designed to show that the curse of knowledge can partly explain observed bargaining impasses. We selected a setting in which different estimations of the endowment create a mismatch between the respondents' expectations and the proposers' offers. Of course, the impact of information asymmetry through the curse of knowledge may be different depending on the information structure as well as context-specific features of the negotiation. For example, in a scenario where the information regarding the task is provided to the proposers instead of the respondents, it could lead to higher offers from the proposers to be matched with relatively low exigence from the respondents, which would increase the rate of settlement.

Even though our experimental framework is specific, our results demonstrate that cognitive biases such as the curse of knowledge may generally impact the strategies of players in bargaining contexts where fairness preferences play a role. We even provide suggestive evidence of a larger treatment effect on the subjects who have strong preferences for equality. These findings are important for the interpretations of scientific evidence related to bargaining with information asymmetry and are also relevant for policy issues. Indeed, we see that better information does not necessarily lead to more desirable outcomes.

In contrast to previous research where individuals may consciously change their behaviours under different information settings for personal motives, in our environment it is their cognitive limitations that prevent them from choosing what would likely have been their favourite strategy with less information. Therefore, the settlement, or the impasse, reached due to the curse of knowledge can be considered suboptimal and results in a net utility loss for the bargainers. This would mean, for example, that certain transparency policies that are generally considered beneficial when individuals behave rationally may in fact have certain costs that must be taken into account. Especially when these policies target only part of the population.

Appendices

Appendix 1 : Instructions

Page 1

Welcome to our experiment!

During the experiment you are not allowed to use electronic devices or to communicate with other participants.

Please use only the programmes and functions provided for the experiment. Please do not talk to other participants.

If you have a question please raise your hand. We will come over and answer your question in private. Please do not ask questions loudly in front of all the other participants. If the question is relevant for all participants, we will repeat it and answer it in front of everyone.

If you do not comply with the rules, you will be excluded from the experiment and from the remuneration.

This experiment will last 30-40 minutes (instructions included). All of your decisions are completely anonymous, neither the experimenter nor the other participants will know about them.

Your remuneration for the experiment depends on your decisions and on chance. You will at least earn 8€.

Page 2

In the experiment, there are **three roles**: **participant A**, **participant B** and **participant C**.

All participants are divided into groups of three. In each group there is one participant A, one participant B and one participant C.

The participants C have participated in an earlier sessions. In this session of the experiment, only participants A and participants B are taking part. The roles, either participant A or participant B, will be randomly assigned. You will be told what your role is at the end of the instructions.

In a prior session of the experiment, participant C worked on the following task:

Participant C had to find the difference between two images which were shown alternately on their screen 6 times during approximately one second each.

After 15 seconds the first image remains on the screen together with a red circle. Participant C was given 30 seconds to move the circle to the place where the difference between the two pictures was located. The red circle could be moved by clicking on the picture.

Every time when participant C found the difference, he/she earned 4€. Participant C had to find the difference in 10 pairs of pictures. Thus, he/she could earn between 0 and 40€.

On the following page, you will see an example of participant Cs task. In this example the difference between the two pictures is marked in a blue rectangle to demonstrate the task.

Beware! The blue mark only appears in the example. During the experiment, participant C was not shown the difference marked in a blue rectangle.

Please click on Next to see an example.

Page 3

Contained an example of the change detection task.

Page 4

In today's experiment, participant A and participant B have to accomplish three tasks.

First, participant A and participant B will see the task that participant C had to accomplish. Participant A and participant B will be shown the exact same pair of images for the same amount of time as participant C. [11]

The task of Participant A and participant B will be to estimate how many correct answers participant C has given.

In other words, **for each possible number of correct answers, participant A and B will have to determine, how probable it is (between 0 and 100%) that participant C has answered exactly this number of difference-detection tasks correctly.**

[11] In the instructions of the treated group, the following sentences are added to this paragraph: *Moreover, participant B will be shown the difference between the two pictures in a blue rectangle. This difference is never shown to participant A or C.* These two sentences are the only differences between the instructions for the two groups.

Example: If participant A or B name 15% as a probability for “2 correct answers”, it means that in his/her opinion 15 out of 100 people in the role of participant C have given this number of correct answers.

On the left, an example of the table that you will have to fill in later is displayed. The probabilities have to add up to 100%.

Your remuneration for this task is 1,50€.

Page 5

Afterwards participant A receives the same sum of money as participant C in the previous session. Then participant A can make an offer to participant B, which the latter can accept or refuse.

Participant A proposes a sum between 0 and 40€ to participant B. Participant A can propose 0, 2€, 3€ etc. up to 40€, but no more than he/she has received (the same sum that participant C has earned in the difference-detection task).

At the same time, participant B decides on the minimal offer that he/she is willing to accept.

After participant A has made his/her offer and after his/her attributed participant B has named his lowest acceptable offer, the experiment is over. The remuneration is calculated from the offer of participant A and the corresponding answer of participant B for this offer (acceptance or rejection).

If the offer made by participant A is greater or equal to participant B’s lowest acceptable offer, it means that the offer has been accepted by participant B. In this case, the sum attributed to participant A will be split between participant A and participant B, according to participant

As offer.

Example: Participant C has answered 5 questions correctly and thus, participant A has 20€ (5 x 4€) at his disposal. If participant A makes an offer of 5€ and participant Bs lowest acceptable offer is 3€, then the final split will be:

Participant B receives 5€ and participant A receives 15€.

If participant As offer is lower than the lowest acceptable offer named by participant B, this means that the offer has been rejected by participant B. In this case, both participants earn 0€ for this task.

Page 6

During the experiment a third task must be completed: participant A and participant B must give their expectations regarding the how the other participant in their group will behave during the experiment.

In every round Participant A has to estimate for each interval (0€, 1-4€; 5-8€; 9-12€; 13-16€; 17-20€; 21-24€; 25- 28€; more than 28€) how probable it is that participant B's lowest acceptable offer falls into this interval.

Example: If participant A gives an estimate of 20% for the interval of "1-4€", this means that he/she thinks, that there is a 20 percent chance that participant B will determine either 1€, 2€or 3€ as his/her lowest acceptable offer.

In every round participant B has to estimate for each interval (0€, 1-4€; 5-8€; 9-12€; 13-16€; 17-20 €; 21-24€; 25- 28€; more than 28€) how probable it is that participant A makes such an offer.

Example: If participant B gives an estimate of 100% for the interval of “13-16€”, this means that he/she thinks, that there is a 100 percent chance that participant A will offer propose him/her either 13€, 14€, 15€or 16€.

On the right, an example of the table that you will have to fill in later is displayed. The probabilities have to add up to 100%.

Your remuneration for this task is 1,5€.

Page 7

The experiment will be conducted as follows: First you will see participant C’s task. Then you have to give your estimation for every possible number of correct answers, how probable it is (between 0% and 100%) that participant C has answered exactly this number of questions correctly.

Then participant A and participant B will give their expectations about the other participant’s behaviour during the experiment: Participant A has to estimate for each interval how probable it is that participant B’s lowest acceptable offer falls into this interval. Participant B has to estimate for each interval how probable it is that participant A makes such an offer.

Then participant A offers a sum between 0 and 40 euros to participant B. Simultaneously, participant B decides what the lowest offer is, that he is willing to accept. After participant A has made his/her offer and his/her assigned participant B has named his/her lowest acceptable offer the experiment is over. At the end of the experiment your remuneration is determined by your own decisions and the decisions of the other participant assigned to you. Additionally, you will receive 5€ for your participation and 1,50€ for the two other tasks.

Page 8

You have been assigned the role of **participant A (B)**.

You can consult the instructions throughout the whole experiment by clicking on "Instructions". If you have questions, please raise your hands. We will come and answer them.

If you do not have any questions, you can click on "Start". The experiment will start when all participants are ready.

Appendix 2 : Results including outliers

This appendix contains the treatment effects measured on the beliefs and the strategies of the respondents as well as the effects on the outcome of the ultimatum game, i.e. the rate of settlement and the profit made by the players. We do not report any new results regarding the proposers' behaviour since no outliers were detected among them. Table 6 is the equivalent of Table 2 and Table 7 is the equivalent of Table 4.

The three outliers where all participating in the control treatment. We can see that adding them to the sample increases substantially the lowest acceptable offers in this treatment and renders the minimal share accepted very high (70%) with a large standard deviation (180%). These observations indicate that the three subjects behaved in a strange manner that was very different from all the others. Nevertheless, the impact of the outliers on our analysis is not substantial. Taking them into account does not change the direction of the main results. It only dampens the treatment effect on the lowest acceptable offers.

	CoK		$ctrl$		ΔT	$p-val$
$E[M]$	24.8	(5.7)	16.2	(5.5)	8.6	0.00***
$E[s]$	11.6	(5.4)	9.1	(3.9)	2.5	0.01***
l	7.5	(5.4)	6.5	(5.3)	1.0	0.22
min_share	0.31	(0.2)	0.71	(1.8)	-40.0	0.11
# obs	34		31			

Table 6: Treatment Effects - Respondents

Table containing the averages of $E[M]$, $E[s]$, l and min_share reported by the respondents in each treatment, the difference between both treatment, ΔT, and the corresponding p-value for a one sided t-test. The figures in parenthesis are the associated standard deviations. The stars represent the level of significance associated with the one sided t-test comparing both treatments; with * being the 10% level, ** 5% and *** 1%.

	CoK		$ctrl$		ΔT	$p-val$
$settle$	0.47	(0.5)	0.59	(0.5)	0.12	0.17
$profit_r$	2.9	(3.5)	4.2	(3.9)	-1.2	0.09*
$profit_p$	3.2	(4.2)	3.5	(3.9)	-0.3	0.38
$profit$	3.1	(3.9)	3.6	(3.9)	-0.6	0.19
# obs	34		34			

Table 7: Outcome of the game

Table containing the average rate of settlement and profits in each treatment, the difference between both treatment and the corresponding p-value for a one sided t-test. The figures in parenthesis are the associated standard deviations. The stars represent the level of significance associated with the one-sided t-test with * being the 10% level, ** 5% and *** 1%.

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