# Disclosure of Belief-Dependent Preferences in the Trust Game

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# Psychological Games

- Traditional Game Theory: $\mathbf{u_i = u_i(actions)}$
- *Problem* 1: the motivation of decision makers who are affected by and care for emotions, reciprocity, or social conformity may depend *directly* on beliefs (about choices, beliefs, or information).
- *Extension* 1: Geanakoplos, Pearce and Stacchetti (1989) introduce *belief-dependent motivations*: $\mathbf{u_i = u_i(actions, beliefs_i)}$
  $\mathbf{beliefs_i}$: *initial* (pre-play) beliefs of player $\mathbf{i}$ about strategies and beliefs about beliefs of others.
- *Problem* 2: *conditional* (second-order) beliefs are not considered. Yet they are crucial for applications, and theoretical interpretations of experimental findings.
- *Extension* 2: Battigalli and Dufwenberg (2009) introduce *conditional beliefs*: $\mathbf{u_i(actions, cond.beliefs_i, cond.beliefs_{-i})}$
- *Summary:* In games with belief-dependent motivations there are *two channels* through which beliefs and information affect behavior.

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# Road map

1. Main Features of Psychological Games
   (focusing on Guilt and Reciprocity in a Trust Game)
2. Research Questions
3. Belief-dependent preferences in a Trust Game:
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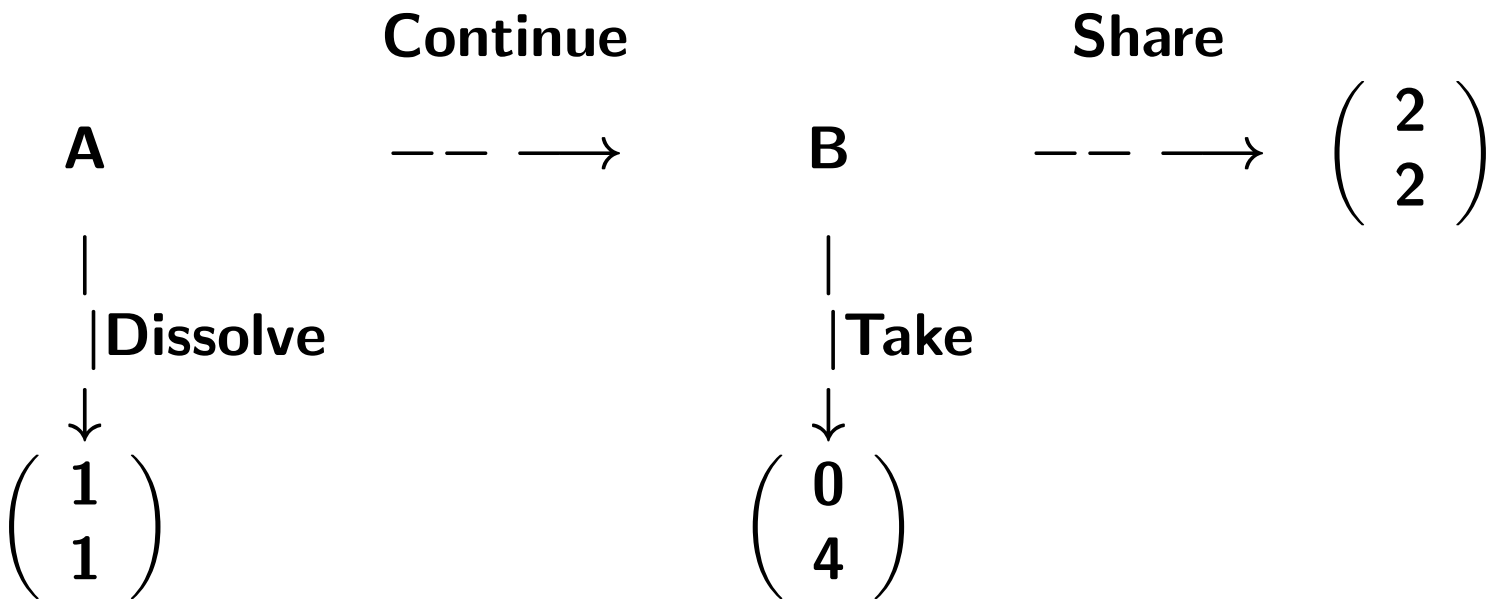
# Main Features of Psychological Games

## EXAMPLE: Trust Game with material payoffs



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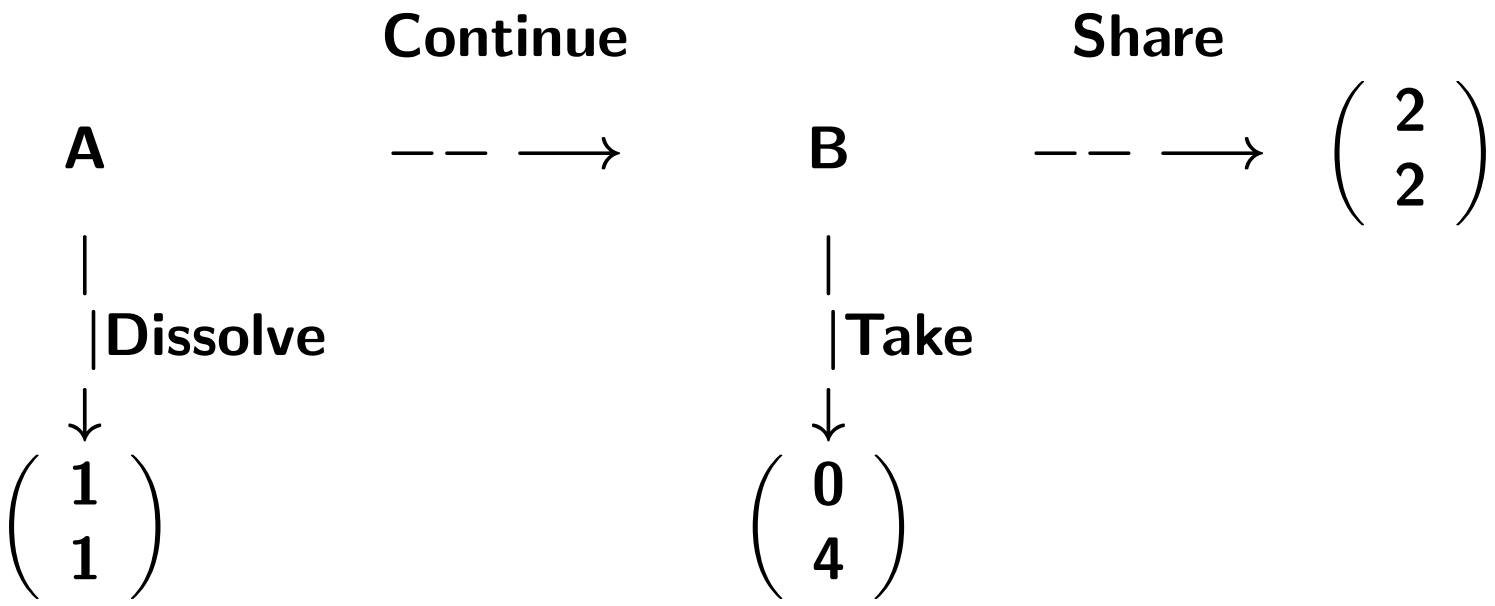


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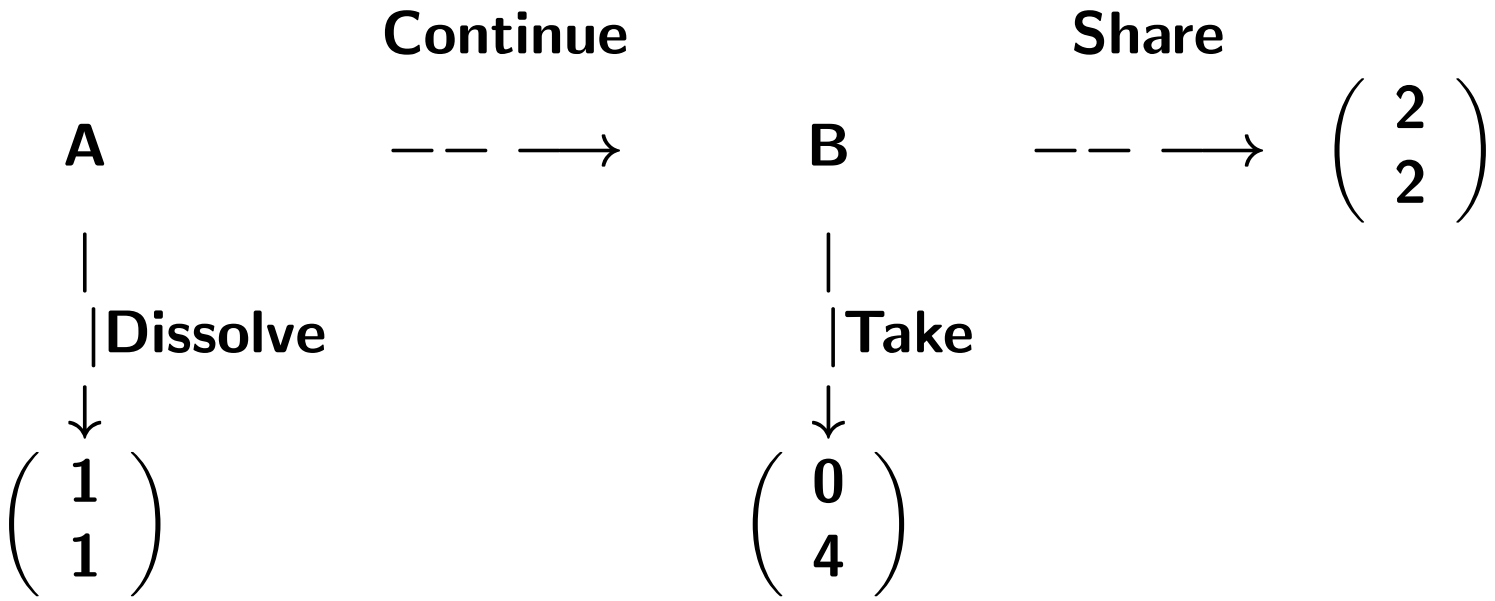


**B** is concerned with *Guilt Aversion* if his expected payoff from playing *Take* after *Continue* depends negatively on his expectation of $\alpha$.

- $-2\alpha =$ how much *A* would feel 'let down' after (*Continue*, *Take*)
- $-2\beta =$ **B**'s expectation of $-2\alpha$, given *Continue*
- **G** := **B**'s sensitivity to *guilt*

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**B** is motivated by *Reciprocity* if his expected payoff from playing *Share* after *Cont.* depends negatively on his expectation of $\alpha$.

- Is *Cont.* a fair action? It depends on *intentions*:
- *Cont.* is kind if $\alpha$ is low. *Cont.* is perceived as kind by *B* if $\beta$ is low
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**R** *commonly known* $\Longrightarrow$ Psy game with *Complete* Info

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   ▶ Can "standard" *trust games* be interpreted as *psychological* games with *Incomplete* info?
   $\rightarrow$ how *feelings sensitivity* (linked to beliefs) can be *elicited.*

2. Complete *vs* Incomplete information:
   ▶ Does "*public information*" of feelings sensitivity change players' behavior and believes with respect to the incomplete info scenario?
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3. "Cross section" analysis:
   ▶ In the "*public information*" framework, do $B$ players with *different feelings sensitivities* lead to a *different behavior* of the pairs they belong to?
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   $\rightarrow$ how *feelings sensitivity transmission* is "*interpreted*" by both players.

# Belief-Dependent Preferences: Psy-Equilibrium Analysis

## Belief-Dependent Preferences in the Trust Game

Consider a trustee (Bob) with material utility function concave in $\mathbf{m_B}$: $\mathbf{(dm_B/dm_A)}$ increasing in $\mathbf{m_B}$, with $\mathbf{u}$ and $\alpha$ constant.

For each material payoff pair $(\mathbf{m_A}, \mathbf{m_B})$, his preferences are affected by:

- *Ann's disappointment* (given that Ann chose *Continue*):

$$\mathbf{D_A}(\alpha, \mathbf{m_A}) = \mathbf{max}(0, 2\alpha - \mathbf{m_A})$$

- *Ann's kindness* (given that Ann chose *Continue*):

$$\mathbf{K_A}(\alpha) = \left(\frac{3}{2} - \alpha\right)$$

Recall that:

- **G :** Bob's sensitivity to Ann's disappointment
- **R :** Bob's sensitivity to reciprocity

Thus, Bob's psychological utility function is:

$$\mathbf{u_B}(\mathbf{m_B}, \mathbf{m_A}, \alpha) = \mathbf{ln}(1 + \mathbf{m_B}) - \frac{\mathbf{G}}{2} \cdot [\mathbf{D_A}(\alpha, \mathbf{m_A})]^2 + \mathbf{R} \cdot \mathbf{K_A}(\alpha) \cdot \mathbf{m_A}$$

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# Belief-Dependent Preferences: Psy-Equilibrium Analysis

## Complete vs Incomplete information about G and R

*Complete Information*

Assume that **G**, **R** and the fact that Ann is self-interested is common knowledge.

Theoretical analysis, multiple equilibria (under point second-order conditional beliefs):

- if $\alpha = \beta = 0 \implies$ Bob chooses **Take** iff $\mathbf{R} < \mathbf{0.17}$.
- if $\alpha = \beta = 1 \implies$ Bob chooses **Share** iff $\mathbf{2G} + \mathbf{R} > \mathbf{0.51}$.

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Assume that Ann is not informed about the payoff-type of Bob.

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$\rightarrow$ Simplified Bayesian Psychological Game

Qualitative prediction: average behavior is intermediate (less extreme behavior).

*Main goal of the experiment*: measure the impact of making Bob's (belief-dependent) preferences public information among the co-players, assuming that one can at least approximate such a condition in the lab.

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# Belief-Dependent Preferences: Experimental Elicitation

## Hypothetical History

Consider the Trust Game with material payoff between $A$ ($A$nn) and $B$ ($B$ob) described above.

We let subjects focus on history **(Continue, Take)**.

$$
\begin{tikzcd}
\mathbf{A} \arrow[r, dashed, "\textbf{Continue}"] \arrow[d, "\textit{Dissolve}"] & \mathbf{B} \arrow[r, dashed, "\textit{Share}"] \arrow[d, "\textbf{Take}"] & \begin{pmatrix} 2 \\ 2 \end{pmatrix} \\
\begin{pmatrix} 1 \\ 1 \end{pmatrix} & \begin{pmatrix} \mathbf{0} \\ \mathbf{4} \end{pmatrix} &
\end{tikzcd}
$$

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\begin{pmatrix} 1 \\ 1 \end{pmatrix} & & \begin{pmatrix} \mathbf{0} \\ \mathbf{4} \end{pmatrix} & &
\end{array}
$$

# Belief-Dependent Preferences: Experimental Elicitation

## Hypothetical Pay-Back Scheme (HPS)

Assume that $B$ sincerely answers the following question:

"Suppose $A$ chose *Continue* and you have chosen *Take*, hence getting 4, but now you can give $\mathbf{x}$ to $A$.
How much would you give, if Ann expected you to *Share* with probability $\alpha$?"

# Belief-Dependent Preferences: Experimental Elicitation

## Hypothetical Pay-Back Scheme (HPS)

$B$ answers the question filling the following questionnaire:

| $A$'s possible assessments of *Share* $(\alpha)$ | Your reimbursement $(\mathbf{x})$ |
|---|---|
| 0% | between 0.00 and 4.00 |
| 10% | between 0.00 and 4.00 |
| 20% | between 0.00 and 4.00 |
| 30% | between 0.00 and 4.00 |
| 40% | between 0.00 and 4.00 |
| 50% | between 0.00 and 4.00 |
| 60% | between 0.00 and 4.00 |
| 70% | between 0.00 and 4.00 |
| 80% | between 0.00 and 4.00 |
| 90% | between 0.00 and 4.00 |
| 100% | between 0.00 and 4.00 |

*Hypothetical Pay back Scheme* (*HPS*)

**Two among all possible types**

| *A*'s possible assessments of *Share* ($\alpha$) | Guilt Averse | Reciprocity |
|---|---|---|
| 0% | 0.00 | 2.00 |
| 10% | 0.20 | 1.80 |
| 20% | 0.40 | 1.60 |
| 30% | 0.60 | 1.40 |
| 40% | 0.80 | 1.20 |
| 50% | 1.00 | 1.00 |
| 60% | 1.20 | 0.80 |
| 70% | 1.40 | 0.60 |
| 80% | 1.60 | 0.40 |
| 90% | 1.80 | 0.20 |
| 100% | 2.00 | 0.00 |

# Belief-Dependent Preferences: Experimental Elicitation

## Best-Reply to the Hypothetical Pay-Back Scheme

Bob has belief-dependent preferences represented *ex-ante* by

$$\mathbf{u_B(m_B, m_A, \alpha) = \ln(1 + m_B) - \frac{G}{2} \cdot [D_A(\alpha, m_A)]^2 + R \cdot K_A(\alpha) \cdot m_A}$$

Given that *A* chose *Continue* and he chose *Take*, in answering the previous question, he also takes into account *ex-post negative feelings mitigation*, represented by parameter $\mathbf{p} \in [0, +\infty)$.
So, he solves the problem

$$\max_{0 \le x \le 4} \bar{u}_B(4 - x, x, \alpha), \quad \text{with}$$

$$\bar{u}_B := \quad \log(5 - x) - \frac{G}{2}[\max(0, p + 2\alpha - x)]^2 + R\left(p + \frac{3}{2} - \alpha\right) x.$$

Let $\bar{U}_{G,R,p}(x; \alpha)$ denote utility of type $(G, R, p)$ as funct. of $x$ and $\alpha$,

$$\bar{\xi}(\alpha; G, R, p) = \arg\max_{0 \le x \le 4} \bar{U}_{G,R,p}(x; \alpha)$$

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# Belief-Dependent Preferences: Experimental Elicitation

## Best-Reply to the Hypothetical Pay-Back Scheme

The FOC leads to $\bar{\xi}(\alpha; \mathbf{G}, \mathbf{R}, \mathbf{p}) =$

$$\begin{cases} 0 & \text{if} \quad R\left(p + \frac{3}{2} - \alpha\right) \in \left[0, \frac{1}{5} - G\left(p + 2\alpha\right)\right] \\ \bar{\xi}_G & \text{if} \quad R\left(p + \frac{3}{2} - \alpha\right) \in \left(\frac{1}{5} - G\left(p + 2\alpha\right), \frac{1}{5-p-2\alpha}\right] \\ \bar{\xi}_{noG} & \text{if} \quad R\left(p + \frac{3}{2} - \alpha\right) \in \left(\frac{1}{5-p-2\alpha}, 1\right] \\ 4 & \text{if} \quad R\left(p + \frac{3}{2} - \alpha\right) \in (1, +\infty) \end{cases}$$

with

$$\bar{\xi}_G = \frac{G(5+p+2\alpha)+R\left(p+\frac{3}{2}-\alpha\right)-\sqrt{\left[G(5-p-2\alpha)-R\left(p+\frac{3}{2}-\alpha\right)\right]^2+4G}}{2G}$$

$$\bar{\xi}_{noG} = 5 - \frac{2}{R(3+2(p-\alpha))}$$

# Belief-Dependent Preferences: Experimental Elicitation

## Best-Reply to the Hypothetical Pay-Back Scheme

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# Belief-Dependent Preferences: Experimental Elicitation

## Experimental Design

| **Stages** | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | 1-shot game | *Questionnaire* | **1-*shot*** game | Final Questionnaire |
| **Tr. 1: *NoQ*** | **Decision Task 1** with beliefs elicitation but no results told | New random matching and ***no*** Feelings Elicitation | **Decision Task 2** with beliefs elicitation but no results told | Feelings Elicitation *without* Transmission |
| **Tr. 2: *QNoT*** | **Decision Task 1** with beliefs elicitation but no results told | New random matching and ***B***'s Feelings Elicitation ***without*** Transmission | **Decision Task 2** with beliefs elicitation but no results told | Feelings Elicitation *without* Transmission |
| **Tr. 3: *QT*** | **Decision Task 1** with beliefs elicitation but no results told | New random matching and ***B***'s Feelings Elicitation ***with*** Transmission | **Decision Task 2** with beliefs elicitation but no results told | Feelings Elicitation *without* Transmission |

Beliefs Elicitation close to Charness and Dufwenberg (2006).
No. of pairs: 40 in **NoQ** and **QnoT**; 80 in **QT**.
Subjects pool: undergraduates of Bocconi University (1st - 2nd year).

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| **Tr. 3:** ***QT*** | **Decision Task 1** with beliefs elicitation but no results told | New random matching and ***B***'s Feelings Elicitation ***with*** Transmission | **Decision Task 2** with beliefs elicitation but no results told | Feelings Elicitation *without* Transmission |

Beliefs Elicitation close to Charness and Dufwenberg (2006).

No. of pairs: 40 in **NoQ** and **QnoT**; 80 in **QT**.

Subjects pool: undergraduates of Bocconi University (1st - 2nd year).

# Belief-Dependent Preferences: Experimental Elicitation

## Experimental Design

| Stages | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | 1-shot game | *Questionnaire* | **1-*shot*** game | Final Questionnaire |
| **Tr. 1:** ***NoQ*** | **Decision Task 1** with beliefs elicitation but no results told | New random matching and ***no*** Feelings Elicitation | **Decision Task 2** with beliefs elicitation but no results told | Feelings Elicitation *without* Transmission |
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# Belief-Dependent Preferences: Experimental Elicitation

## Experimental Results: Grid Estimation with step 0.05

**B**'s feelings (types) according to the **HPS** (**Grid Estimation**)

| **Category** | | **Treatment** | | | |
|---|---|---|---|---|---|
| | | **NoQ** | **QnoT** | **NoQnoT** | **QT** |
| (More) Guilt | **HPS** $\nearrow$ in $\alpha$ | 55% | 45% | **50%** | **53%** |
| (More) Recipr. | **HPS** $\searrow$ in $\alpha$ | 13% | 13% | **13%** | **13%** |
| Mixture G-R | **HPS** $\searrow \nearrow$ in $\alpha$ | 7% | 5% | **6%** | **5%** |
| Fairness | **HPS** — in $\alpha$ | 3% | 3% | **3%** | **8%** |
| Self Interest | **G, R** close to 0 | 10% | 22% | **16%** | **14%** |
| | | | | | |
| Unclassified | | 12% | 12% | **12%** | **7%** |

Notice that:

- average pay-back is 0.77, 0.75 and 0.77, for **NoQ, QnoT** and **QT**;
- distribution of types in **NoQnoT** and in **QT** not significantly different.

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## Experimental Results: Grid Estimation with step 0.05

Let us split the sample of **B** players in two groups:

- Payoff types with $\mathbf{2G + R > 0.51}$, who should choose **Share** in **QT**:

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# Belief-Dependent Preferences: Experimental Elicitation

## Theoretical Insights about B's choice and second-order belief

Let's check whether (coherently with the theory),
for *Guilt Averse B*s with $\mathbf{2G + R > 0.51}$ (*High Guilt Averse*):

B.1 positive correlation between *Share* and 2nd-order beliefs of *Share*;

B.2 their 2nd-order beliefs about *Share* increases after questionnaire transmission in **QT**;

B.3 both in **NoQnoT** and **QT**, they choose *Share* more than all other types.

B.4 the frequency of *Share* is higher in **QT** than in **NoQnoT**.

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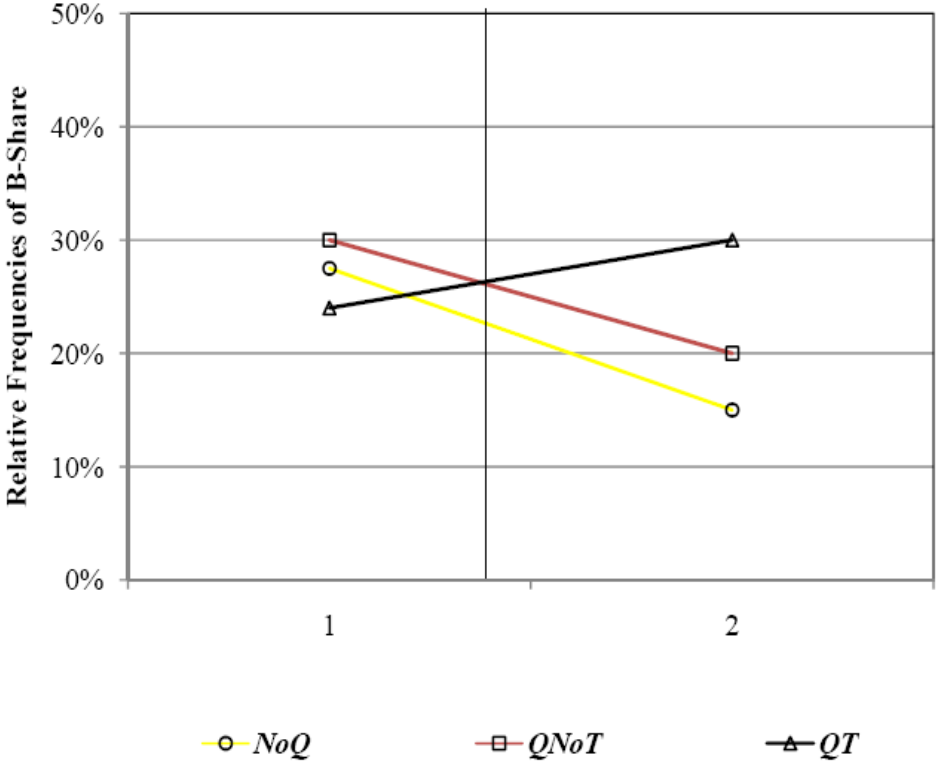
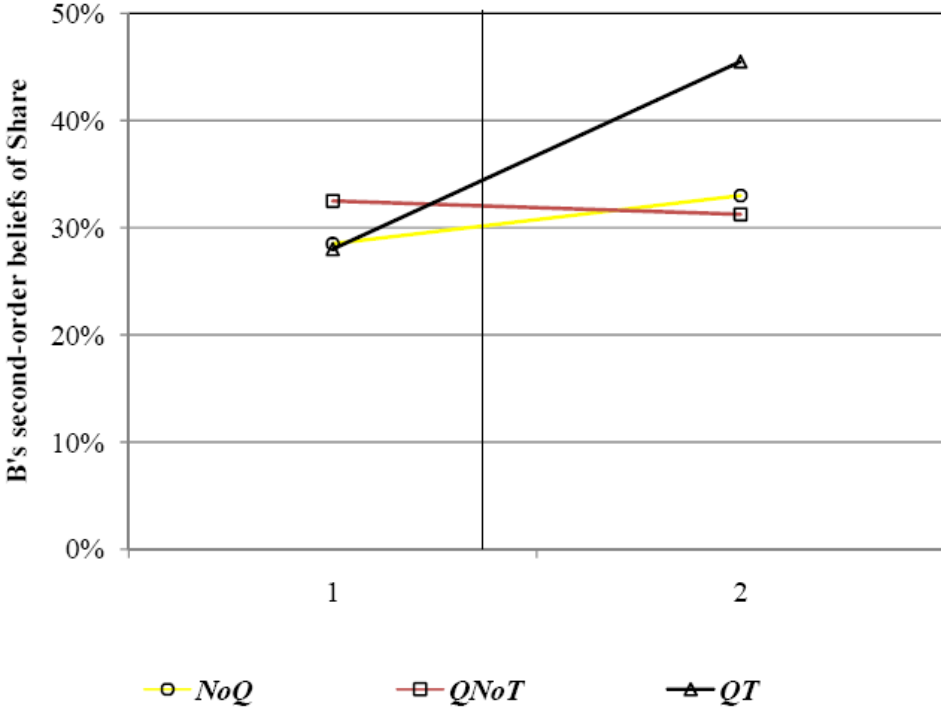
# Belief-Dependent Preferences: Experimental Elicitation

## Bs actions and 2nd-order beliefs not disentangled by type

Actions




Beliefs



# Belief-Dependent Preferences: Experimental Elicitation

## Bs actions and 2nd-order beliefs (disentangled by type)

**% of *B* Share**

| | *NoQnoT* | | | *QT* | |
|---|---|---|---|---|---|
| | **High Guilt Averse** | **Other Feelings** | | **High Guilt Averse** | **Other Feelings** |
| Stage 1 | 43% | 20% | Stage 1 | 42% | 17% |
| Stage 2 | 27% | 12% | Stage 2 | 58% | 17% |

***B* 's 2nd-order beliefs of Share**

| | *NoQnoT* | | | *QT* | |
|---|---|---|---|---|---|
| | **High Guilt Averse** | **Other Feelings** | | **High Guilt Averse** | **Other Feelings** |
| Stage 1 | 33% | 29% | Stage 1 | 36% | 25% |
| Stage 2 | 33% | 32% | Stage 2 | 54% | 30% |

# Belief-Dependent Preferences: Experimental Elicitation

## Theoretical Insights about B's choice and second-order belief

Let's check whether (coherently with the theory),
for *A*s "facing" a *Guilt Averse B*s with $\mathbf{2R + G > 0.51}$ (*High*) in **QT**:

A.1 - they choose *Share* more than *A*s "facing" a *B* with *Other Feelings*;

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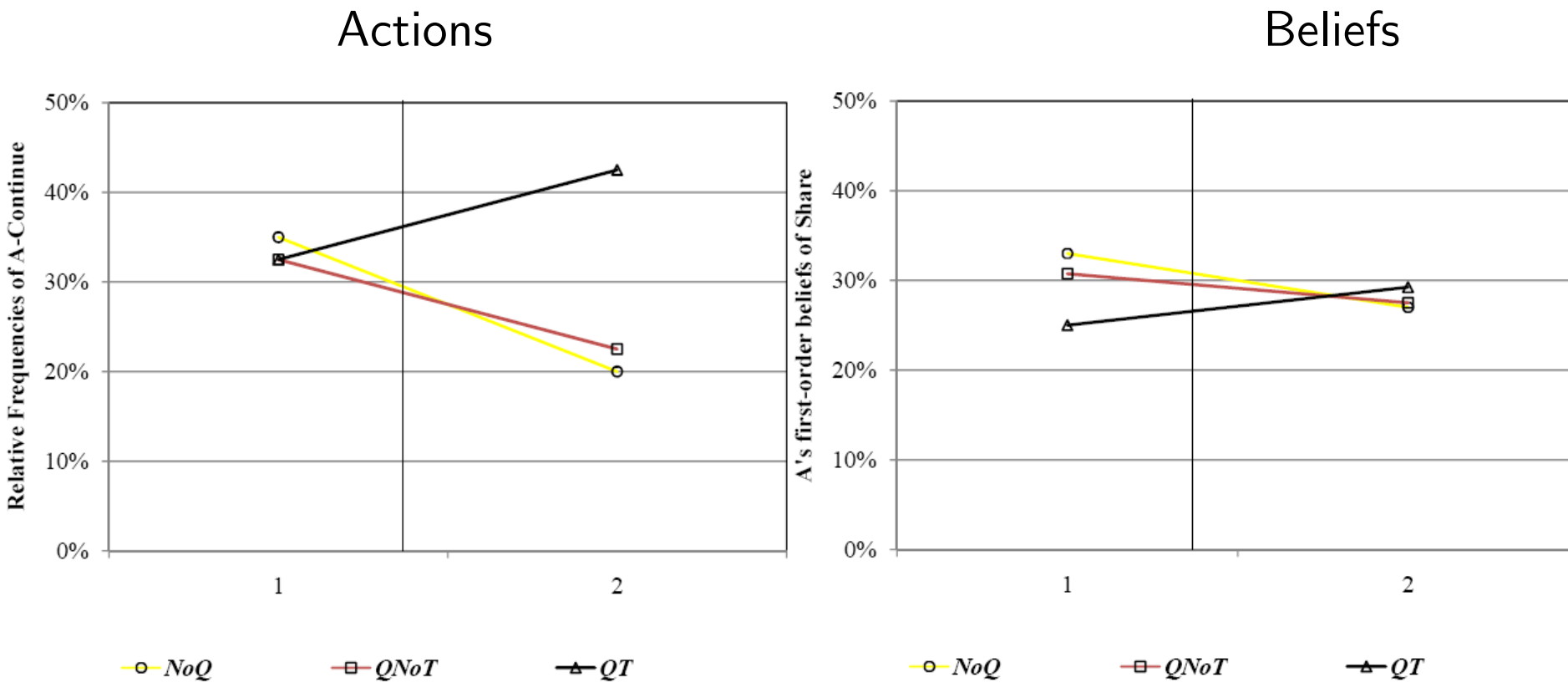
As actions and 1st-order beliefs (not disentangled by type)



# Belief-Dependent Preferences: Experimental Elicitation

## As actions and beliefs in QT (disentangled by type)

| % of *A* Continue | | |
|---|---|---|
| | Facing a | |
| | **High Guilt Averse** | **Other Feelings** |
| Stage 1 | 36% | 34% |
| Stage 2 | 70% | 26% |

| *A* 's 1st-order beliefs of Share | | |
|---|---|---|
| | Facing a | |
| | **High Guilt Averse** | **Other Feelings** |
| Stage 1 | 28% | 27% |
| Stage 2 | 48% | 24% |

# Conclusions

1. We have built a **design** to test **one − stage psychological games :**
   - we elicit feelings sensitivities through a very structured questionnaire;
   - our transmission procedure allows to make public information a trustee's particular feeling sensitivity.

2. **Public information** of trustee's feelings sensitivity enhances players' trust and cooperation.

3. Public information of trustee's **Guilt Aversion** leads to trust and cooperation within the pair. Public information of trustee's (*intention-based*) **Reciprocity** does not.

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