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# SOCIAL PREFERENCES AND PERCEIVED INTENTIONS. AN EXPERIMENT WITH NORMALLY DEVELOPING AND AUTISTIC SPECTRUM DISORDERS SUBJECTS

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# Social Preferences and Perceived Intentions. An experiment with Normally Developing and Autistic Spectrum Disorders Subjects

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**Abstract**[*]
Models of social preferences explain departures from pure self-interest as a consequence of either outcome-based or intention-based other-regarding motives. Various experimental studies lend support to the conclusion that subjects behave *as if* they conditioned their behaviour on the perceived intentions of others. We present a new experiment that explores this *as if* clause by making the ability to detect intentions a treatment variable. We compare normally developing children with autistic children – typically unable to perceive intentions – and find differences consistent with the hypothesis that behaviour responds to intentions, especially if unkind.

**Keywords**: Social Preferences, Theory of Mind, Intentionality, Autism.
**Jel classification:** C72, C91

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## 1. Introduction

Standard game theoretical analyses of strategic behaviour are based on the assumption that the behaviour of rational players is exclusively guided by concerns about their own final payoff. The payoffs to other players and the motives behind their actions are deemed irrelevant, and excluded from the analysis. This assumption, however, rarely holds in practice. There is now a large body of experimental evidence showing that a player's own payoff is not all that matters. Their behaviour deviates from the predictions of self-interest in a way that indicates that the perceived motives of other players, and/or their final payoffs, also matter (e.g. Camerer, 2003).

These forms of other-regarding behaviour have led economists to relax the assumption of self-interest in favour of some form of *social preferences*, in which an agent's utility is allowed to depend on aspects of the interaction that pertain to the other players. Several models of social preferences have been proposed in the last two decades. Some of these models can be said to be *outcome-based*, for they incorporate concerns for others by allowing the utility that agents derive from a particular outcome to depend not only on their own payoffs, but also on the payoffs to other players (e.g. Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). Other models can be said to be *intention-based*, for they assume that the utility that agents derive from a particular outcome does not only depend on their own payoff, but also on the perceived intentions that led other players to choose the sequence of moves leading to that particular outcome (e.g. Rabin, 1993; Bacharach et al., 2007; Dufwenberg and Kirchsteiger, 2004; Battigalli and Dufwenberg, 2007; Pelligra, 2010).

Both classes of models have received empirical support (e.g. Camerer, 2003; Henrich et al. 2004, Fehr et al., 2008). It has also been found that the motives they incorporate are not mutually exclusive. The same individuals can *simultaneously* respond to the final distribution of payoffs *and* to the perceived intentions of other players (e.g. Charness and Rabin, 2002; Nelson, 2002; McCabe et al., 2003; Falk et al., 2003, 2008). Models incorporating this feature of preferences have already appeared (e.g. Falk and Fischbacher, 2006).

Most of this empirical support comes from studies that adopt the same basic investigative strategy. The strategy consists in designing games in which a particular deviation from self-interested behaviour can be interpreted as evidence in favour of a particular other-regarding motive. A variant of this strategy is also adopted by studies that report evidence for both classes of motives (e.g. McCabe et al., 2003; Falk et al., 2003). These studies compare games in which, *if* intentions matter, they are expected to affect behaviour in a particular way, with games in which intentions should play no role. Deviations from self-interest in the latter games are regarded as evidence that outcome-based motives matter. A different behavioural pattern in the former games is attributed to intention-based motives.

As far as the other-regarding motive(s) of interest are concerned, however, this evidence in only *indirect*. That is, the observed behavioural pattern is *consistent with*, but not necessarily *implied by*, the supposed causal mechanism. In principle, other totally different, yet unidentified, mechanisms can produce exactly the same pattern.

In this paper, we propose an alternative investigative strategy potentially able to substantially strengthen the causal inferences to be drawn from these experimental results. We focus on the role of intention-based motives. Rather than just using the common strategy of comparing games in which intentions can affect behaviour with games in which this possibility is disallowed, we add an extra level to the analysis by testing whether the patterns arising from such a comparison persist in a sample of individuals that lack the ability to detect intentions. We achieve this by using a unique sample of children affected by the Autism Spectrum Disorders (ASD). If the behavioural patterns usually attributed to intention-based motives do not persist in this unique sample, while they appear in a sample of individuals who are able to detect the intentions of others, we have stronger evidence in favour of the causal role of motives that presuppose intention detection. In short, our results are broadly consistent this causal role, especially for motives that involve negative perceived intentions.

The remainder of the paper is organised as follows. In Section 2, we present two simple classes of games that have been used to isolate the role of outcome-based and intention-based motives. In Section 3, we discuss the relationship between ASD and the ability to detect intentions, which motivates our experimental design. We describe our experimental procedures in Section 4, and present our results in Section 5. We discuss our findings and offer some concluding remarks in Section 6.

## 2. Intention-based and outcome-based motives in experimental games

In this Section, we present some of the experimental games that have been used in the literature to explore the role of intention-based and outcome-based other-regarding motives, following the general strategy described in the previous Section. We use these games to illustrate the implications of some of these motives, and to show how our extra treatments can better isolate the role of intention detection.

In both outcome-based and intention-based models, various mechanisms have been proposed to make the relationship between other-regarding motives and behaviour more explicit. For instance, outcome-based motives have been formalised either in terms of *altruism* (e.g Becker, 1976), or *inequality aversion* (e.g. Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). Intentions have been incorporated in the form of *reciprocity* (e.g. Rabin, 1993; Dufwenberg and Kirchsteiger, 2004), *trust responsiveness* (e.g. Bacharach et al., 2001; Pelligra, 2010), or *guilt aversion* (Battigalli and Dufwenberg, 2007). For the main purpose of our analysis, the specific form of other-regarding behaviour is of secondary interest. The key aspect is whether or not the ability to detect the intentions of others, which distinguishes the two classes of models, is required for the mechanism to work.

We focus our attention on the *mini ultimatum games* (mini UG) used by Falk et al. (2003) – henceforth, FFF – and on the *voluntary trust game* (VTG) and *involuntary trust game* (ITG) used by McCabe et al. (2003) – henceforth, MRS. As we shall see, *if* the perceived intentions of others play a role in strategic interactions, subjects should behave in a systematically different way in the various versions of the mini UG on the one hand, and in the VTG and ITG on the other.

The mini UG (Bolton and Zwick, 1995) is a variant of the ultimatum game, first proposed by Guth et al. (1982). In the mini UG there are two players, a proposer (P) and a respondent (R). P is endowed with 10 experimental points, and can offer R either 2 ('Left') or X points ('Right'), keeping either 8 or (10 – X) points for themselves. R, in turn, can either 'Accept' or 'Reject' P's offer. If they accept, the payoff distribution resulting from P's offer is implemented. If they reject, both get nothing. In the four variants considered by FFF, X takes the values 5, 8, 2, and 0, respectively. These games are represented in Figure 1 a)–d). In the Figure, the top number indicates P's payoff, while the bottom number indicates R's payoff.

*[Figure 1 about here]*

The different implications of outcome-based and intention-based models can be seen by considering R's reaction to the [8, 2] offer in these games. It is easy to see that a self-interested R should never reject the [8, 2] split, on the grounds that any positive number of points is better than nothing. Therefore, behaviour should not differ in the four mini UGs. The rejection rate of the [8, 2] offer should be zero in all cases. When Rs care about the final distribution of payoffs, and in particular when they are *inequality averse* – that is, when they dislike favourable and unfavourable unequal splits – rejection rates for the [8, 2] offer are expected to be positive, but crucially, they should be the same in all four mini UGs, for the inequality associated with the [8, 2] split is not affected by the value of X.

If Rs care about the intentions of Ps, as signalled by Ps' choice between [8, 2] and the [10 – X, X] alternative, however, behaviour should differ in the four mini UGs. In the [5, 5]-UG (in which X = 5), an [8, 2] choice by P signals a negative intention. P could offer R a better outcome, but did not. Relative to the [8, 2]-UG (with X = 2), in which P has in fact no choice, the reaction of Rs to these perceived intentions takes the form of *negative reciprocity* – that is, Rs are prepared to bear a cost in order to punish Bs' unkind action – and leads to expect a higher rejection rate for the [8, 2] split. Similarly in the [2, 8]-UG. Here, the rejection rate of the [8, 2] offer is also expected to be higher than in the [8, 2]-UG, but lower than in the [5, 5]- UG, because in order to offer an advantageous split for R, P should accept a disadvantageous split for themselves, and some R can anticipate that some Ps would not do that. Finally, in the [10, 0]-UG (in which X = 0) the rejection rate of the [8, 2] offer should be lower than in the [8, 2]-UG, because an [8, 2] offer signals a positive intention. P could have offered zero, but chose to offer two. This resembles *positive reciprocity*, but is also consistent with self-interest, as accepting [8, 2] is Rs' payoff maximising strategy, and does not incur them any cost.

FFF report that the percentage of subjects who reject the [8, 2] offer is 44.4%, 26.7%, 18% and 8.9% in the [5, 5]-, [2, 8]-, [8, 2]-, and [10, 0]-UG respectively. They interpret this evidence as suggesting that individuals do not only care about the final outcome resulting from a particular combination of strategies (as indicated by the positive rejection rate of the [8, 2] offer when the alternative is identical, as in the

[8, 2]-UG), but also about the intentions signalled by the alternatives that have not been chosen.

In Study 1, we extend FFF's design by adding a comparison between individuals who possess the ability to detect others' intentions and individuals who lack this ability. We say more about how we do this in Sections 3 and 4. This leads us to the following:

**Prediction 1 (mini UGs).** If observed behaviour in mini UGs is intention-driven, individuals who are able to detect intentions are expected to behave according to the pattern observed by FFF, while individuals unable to detect intentions are expected to behave in the same way in the four mini UGs.

In Study 2, we adopt the same strategy in relation to the VTG and ITG studied by MRS. These games are represented in Figure 2 a)–b). In both games there are two players, labelled A and B. The top numbers in the Figure indicate A's payoffs, while the bottom numbers indicate B's payoffs. In the VTG, player A can choose between 'Right' and 'Down'. If they choose 'Right', A and B get 20 points each. If they choose 'Down', it is B's turn to choose. If they choose 'Right', both players get 25 points. If they choose 'Down', they get 30 points and player A gets 15 points. The ITG is exactly the same, except that A's choice stage is removed.

*[Figure 2 about here]*

Using backward induction, it can immediately be seen that a self-interested B would choose Down in the VTG. Anticipating this, A would choose Right. If Bs are inequality averse, however, a proportion of them would choose Right, justifying the choice of Down of some As. If Bs behave reciprocally – that is, if they are ready to sacrifice part of their material payoff in order to reward kind actions or punish unkind actions – they are also expected to choose Right when their decision node is reached. Since A choosing down conveys a kind intention, *positive reciprocity* leads to expect that a proportion of Bs would choose Right. Therefore, observing deviations from self-interest in the VTG is consistent with both outcome-based and intention-based motives. This is not the case in the ITG. Since A's decision node has been removed, B's choice cannot be influenced by B's perception of A's intentions, but only by B's concerns about the distribution of payoffs.

MRS find that 64.7% of their 17 Bs choose Right in the VTG, while only 33.3% of their 27 Bs do so in the ITG. This evidence is consistent with the possibility that players' decisions in these games are affected by both outcome-based and intention-based motives. In Study 2, we further explore the role of the latter motives by comparing subjects who are able to detect intentions and subjects who lack this ability. This leads us to the following:

**Prediction 2 (trust games).** If the seemingly positively reciprocal behaviour observed by MRS is a result of intention detection, we should replicate MRS's pattern when the VTG and ITG are played by individuals who are able to detect the intentions of others, while we should observe no differences between the two games with individuals who lack this ability.

## 3. Autism and intention detection

The ability of accurately predicting the behaviour other players is essential in playing any interactive game. In human beings, this is done through a process known as *mentalising*, which consists in ascribing thoughts, beliefs, desires and intentions to other individuals (Firth and Firth, 2003). There are different theories about how this process works, collectively known as *theories of mind* (ToM). These can be broadly divided into two groups, the *theories of theory of mind*, also known as *Theory-Theory* and the *Simulation Theories*. In the Theory-Theory approach, agents are assumed to predict the behaviour of others by means of the so-called *folk psychology* (Carruthers and Smith, 1996), that is, by using simple explanatory laws to link the (unobservable) determinants of behaviour (desires, beliefs and intentions) to external (observable) stimuli in order to predict other people's actions. This attribution process works on the basis of theoretical reasoning that involves (tacitly) shared causal laws. In the Simulation Theories, the attribution of mental states to others works through mental representations. Agents are assumed to simulate the reasoning process of others, by putting themselves in the 'mental shoes' of the agents whose behaviour they observe or want to predict (Davis and Stone, 1995).

For the purposes of this study, how mentalising actually works is of secondary importance. However, since we intend to use intention detection as a treatment variable, it is important that mentalising abilities are somehow measurable, and that there is variation in the extent to which various individuals possess them. In order to evaluate the ability of individuals to mentalise, psychologists have developed what they call the *second-order false belief tests* (see the next Section and the Appendix for details). For our purposes, subjects passing this test will be treated as possessing high ToM abilities, i.e. being able to detect the intention of others (the *High ToM* group), while those who fail will be treated as having low ToM abilities (the *Low ToM* group). If behaviour really is guided by intention detection as assumed by intention-based models, then the behavioural patterns observed by FFF and MRS should appear in the High ToM group, but not in the Low ToM group.

In order to ensure that our sample includes both individuals with high and individuals with low ToM abilities, we use subjects affected by ASD.[1] Evidence suggests that in Normally Developing (ND) subjects the ability to mentalise is already fully developed at the age of four (Feinfeld et al. 1999; Baird and Moses, 2001; Schult, 2002). This is not true for ASD subjects, who usually show *mind blindness*, that is, a specific and long-lasting inability to empathise with others (Baron-Cohen et al. 2002; Cohen and Volkmar 1997; Gillberg 1992, 1999), and a deficit in ascribing mental states, like goals, beliefs, and intentions, to other individuals. By including ASD subjects in our sample, we can achieve the variability in mentalising abilities essential to our study of the role of intention detection in strategic games.

Although high-functioning autism produces a lack of social competences and a failure in affective attunement, it does not necessarily compromise the development of other cognitive abilities (Baron-Cohen, 2000). By restricting our attention to ASD and ND *children*, we can achieve the variation in ToM abilities we need, while keeping other mental skills comparable. Since the interactive games and second-order false belief tasks we use require cognitive abilities that develop in children only at a relatively late stage, we restrict our attention to ten-year-old ND children and ASD children of comparable mental age, as measured by their IQ score and other metrics (see below for details).

For some of the games we are interested in, and for some of the issues we consider, there is some evidence that the behaviour of children is very similar to that of adults. For instance, Sutter (2007) shows that children's behaviour in mini UGs is qualitatively very similar to that of university students. Fehr et al. (2008), report that inequality aversion strongly develops in (ND) children between the ages of three and eight. With respect to the mini UG, these findings lead us to believe that the

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[1] ASD subjects are also studied by Sally and Hill (2006) who compare their behaviour with that of ND subjects in Prisoner's Dilemma and Ultimatum games.

relatively young age of our sample should not be problematic. We have all reasons to believe that our unique sample should allow us to better isolate the role of intentions. There is less evidence concerning the VTG and ITG. To the best of our knowledge, no study has looked at the behaviour of children in these games. The closest to such an investigation is the study of children's behaviour in the investment game (Harbaugh et al., 2005; Sutter and Kocher, 2007), which can be regarded as a generalisation of the VTG. The evidence suggests that children of an age comparable to that of our sample do not appear to be prone to positive reciprocity.[2] Therefore, with respect to the trust games, our investigation extends the existing literature in two ways. First, it allows us to check the robustness of Harbaugh et al.'s and Sutter's findings in a simplified variant of the games they study. This aspect is important because, as Harbaugh et al. also recognise, the wide strategy space of the investment game, combined with the use of the strategy method, can make the experimental environment too complex for children. Second, and depending on whether ND children behave as MRS found for adults, it allows us to look into whether this seemingly reciprocal behaviour is related to subjects' perception of the intentions of others.

## 4. Experimental procedures

We recruited a total of 42 ND children and 23 ASD children of comparable mental age.[3] The ND children were recruited from three primary schools, while the ASD children were contacted through the Centre for Pervasive Developmental Disorders of the "Brotzu" Hospital. The participants were all males, considering the higher

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[2] A similar finding is reported in an early study by Fishbein and Kaminski (1985), who use a slightly different game to investigate the role of intentional donations in eliciting reciprocal responses.

[3] The average chronological age of the ND children at the time of the experiment was 10 (equivalent to 5th grade primary school). ND children are assumed to have normal IQ levels (an IQ score greater than 90 is very good; an IQ between 89 and 70 is normal; an IQ of less than 70 denotes a cognitive deficit). The average chronological age of ASD children was 15.69 (max. 20 – min. 11), corresponding to an average mental age of 10. Mental age is determined for each subject as the results of a series of psychological tests and is expressed as the age at which that particular result is typically attained. The average IQ of the ASD children in our sample was normal (83.84).

prevalence of ASD in this gender. The experimental sessions took place in Cagliari (Italy) between May and September 2008.[4]

Each individual in our sample took part in both Studies. Thus, each individual played a total of six games in a randomised sequence. At the end of the experiment, one of these was selected at random to determine the subject's earnings.

In Study 1, each individual played the four mini-ultimatum games used by FFF, either in the role of P, or in the role of R. Whether the [8, 2] option was shown to the left or to the right was varied across subjects. Since our main interest rests in how individuals with different mentalising abilities respond to the [8, 2] offer for different [10 – X, X] alternatives, all the ASD subjects were assigned the role of R. Of the 42 ND children, 22 played as P and 20 played as R. Having some subjects playing as P allows us to carry out an important consistency check in our data. The decisions of Ps in FFF's data show that subjects behave as if they anticipate the reciprocal motives of Rs. The percentage of individuals offering the [8, 2] split in the [5, 5]-UG is roughly 30%, rising to about 70% in the [2, 8]-UG, and 100% in the [10, 0]-UG (the data of the [8, 2]-UG cannot be unambiguously interpreted). A similar pattern is observed by Sutter (2007) with children. By assigning some of our ND subjects the role of P, we can check whether our sample conforms to the findings reported in the literature with respect to the pattern of [8, 2] offers.[5] If the pattern is the same, we are reassured that the test we carry out on the behaviour of Rs is picking up the desired effects and is not the result of other, unobservable features of our sample.

In Study 2, each individual played the VTG and ITG presented in Figure 3. Since we rewarded our subjects based on only one of the six games they played, we changed the payoffs used by MRS in order to make their absolute magnitude comparable to that of our mini UGs. Because our main interest lies on the perceived intentions of Bs, in the VTG and ITG games, we made all our subjects play this role, which also allowed us to maximise the number of observations at our disposal.

[4] Before the experiment was conducted, we received the written consent of the parents of both ND and ASD children.

[5] In principle, carrying out such a test would also be interesting for ASD subjects. However, since these individuals are hard to find, and having the same subjects playing both roles is undesirable for other reasons, we opted for assigning all of them the R role.

*[Figure 3 about here]*

In both Studies, we used the *strategy method*. In the mini UGs, we asked Rs to decide whether they would accept or reject each of the possible offers (in each game, 2 and X respectively). In the VTG, we asked Bs to choose either 'Right' or 'Down' without knowing whether their decision node would be reached. Relative to sequential play, the strategy method has the advantage of producing a larger number of observations, which is of particular importance given the rarity of ASD subjects. It also simplifies the implementation of the random lottery incentive scheme. We acknowledge that its use may somewhat weaken the effects of reciprocal behaviour that would be possible in a sequential implementation, but we judged that the benefits in terms of sample size were worth this risk.[6] Since our main interest rests on how the behaviour of Low ToM individuals compares with that of High ToM individuals and the strategy method is kept constant across groups, its use should not affect our qualitative conclusions.

Given the age of our participants, we did not reward them using money, but with *trading cards* (Yu-Ghi-Oh, see the Appendix for details). The partner's decision in the selected game was randomly determined by an anonymous confederate, who stayed in another room, communicated through a computer network, and could not be seen from the participants at any stage during the experiment. The structure, the rules and the incentive scheme of the game were explained to the children at the beginning of the session.[7] All children made their decisions in the presence of an experimenter. ASD children were also accompanied by their personal tutor who helped ensuring their understanding of the rules of the games.

A key aspect of our design consists in how we assign individuals to the High ToM and Low ToM groups. We do this with the aid of the second-order false belief test, which measures subjects' mentalising

[6] The strategy method was also employed by FFF and Sutter (2007), who find clear evidence of reciprocal behaviour. MRS implemented full sequential play in their trust games. Recent evidence shows that, while in public good games the use of the strategy method seems not to be problematic (Fischbacher and Gaechter, 2009), it can significantly lower observed rates of trustworthiness (Casari and Cason, 2009).

[7] In order to preserve reciprocal behaviour as much as possible, the participants were not told that the other person made choices at random. A translation of the experimental protocol is reported in the Appendix.

abilities. Since ND subjects normally pass the test by the age of six or seven (Perner and Wimmer, 1985), we only needed to administer it to the ASD subjects, who took it after completing the experimental games.[8] In a typical *first-order* false belief test, the experimenter reads a short story and then asks the subject a series of questions that require them to make inferences about the character's (possibly) false belief about a certain fact ("A thinks that..."). The *second-order* false belief test requires the subject to be able to represent the (possibly) false belief of another person about what a second person thinks about a certain fact ("B thinks that A thinks that…"). Therefore, this task requires the ability of making inferences about the character's attribution of (possibly) false beliefs. The subject is assigned a score of 1 when their answer is incorrect for whatever reason, 2 when it is correct but for the wrong reason, and 3 when both their answer and their inferential reasoning are correct. An example of the test is reported in the Appendix.

As noted in Section 1, ASD subjects are also characterised by the inability to empathise with others, which might affect their behaviour in interactive games like the ones we study. To investigate the effect of this lack of empathy, in addition to the second-order false belief test, we also measured the empathy level of our subjects by means of the Cambridge Empathy Quotient Questionnaire (Baron-Cohen et al. 2001; Baron-Cohen and Wheelwright, 2004).[9] By collecting this information, we can check whether our subjects' empathy level correlates with their behaviour in experimental games in any important ways.

## 5. Results

The centrepiece of our design is the ability to distinguish between the High ToM group and the Low ToM group. This distinction is based on the second-order false belief test taken by our ASD subjects. 11 out of

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[8] We took the extra precaution of asking some of our ND children to take the test. The results confirm the usual finding: the test is passed by all the ND children who took it. We avoided doing this for all children, because the experiment was conducted during the teaching hours, and taking the test would have made the sessions unnecessarily long.

[9] The complete questionnaire, both in English and in the Italian translation used in our study, can be found at http://www.autismresearchcentre.com/tests/eq-sq_child.asp.

the 23 ASD children failed to pass the test, and were therefore assigned to the Low ToM group. The remaining 12 ASD children and the ND children were assigned to the High ToM group.[10] This leaves us with somewhat unbalanced sample sizes (11 Low ToM subjects versus the 32 High ToM subjects of Study 1 and the 54 High ToM subjects of Study 2), but given the low incidence of ASD in the population of children, these sizes could have hardly been better.[11]

We start with the results of Study 1. Before discussing our main results, we consider the behaviour of Ps. As explained in the previous Section, we can compare the offers of these ND children to those reported in the literature as a way of checking the appropriateness of our sample. The relevant data are reported in panel A of Table 1. The proportion of subjects offering the [8, 2] split rather than the [10 – X, X] alternative is 18.18% in the [5, 5]-UG, 77.27% in the [2, 8]-UG, and 90.91% in the [10, 0]-UG. As indicated by the non-parametric statistical tests reported in panel B of Table 1, the rejection rate in the [5, 5]-UG differs significantly from those of the other two games. These figures are remarkably similar to the results reported by FFF for adults and by Sutter (2007) for children. We take this as an indication of the appropriateness of our sample for the purposes of Study 1.

We are now ready to turn to our main research question. Is the rejection pattern for the [8, 2] offer due to subjects' reaction to perceived intentions? In order to answer this question, we look at the data presented in Table 2. For each game, panels A and C of the table report – for the High ToM and Low ToM groups respectively – the absolute number of individuals rejecting the [8, 2] offer and the [10 – X, X] alternative and, more interestingly, the corresponding percentages. The remaining panels report our statistical tests.

We consider the High ToM group first. If subjects' ability to perceive the intentions of others matters, this group's behaviour should resemble the pattern observed by FFF. Even a first glance at the figures

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[10] One of the ASD children did not complete the test, and has been assigned to the Low ToM group. The results of our statistical analysis do not depend on this.

[11] We considered the possibility of extending the sample size of the Low ToM group by recruiting ASD subjects from other centres, but given the heterogeneity in the way the syndrome is diagnosed and treated, we discarded this possibility as we feared that it would have introduced some extra, and much more difficult to control, sources of variability in our data.

shows that this is definitely the case. The rate of [8, 2] rejections decreases from 81.25% in the [5, 5]-UG, to 75% in the [2, 8]-UG, dropping to 34.38% and 15.63% in the [8, 2]-UG and [10, 0]-UG respectively. Qualitatively speaking, this is the same pattern reported by FFF. As shown by the non-parametric statistical tests reported under the main diagonal of panel B of Table 2, all pairwise comparisons, with the exception of the comparison between the [5, 5]-UG and the [2, 8]-UG, show that the rejection rates are statistically different.[12]

If intention detection is driving this behaviour, then the Low ToM group – whose members lack the ability to detect intentions – should behave differently. The data reported in panel C of Table 2 lend some support to this hypothesis. The rejection rates show a much flatter trend, decreasing from 90.91%, to 72.73%, to 63.64% to 54.55% for the [5, 5]-, [2, 8]-, [8, 2]- and [10, 0]-UG respectively. The statistical tests reported under the main diagonal of panel D, show that all the differences in rejection rates (except for the comparison between the [5, 5]-UG and the [8, 2]-UG, which is significant at the 10% level) are not statistically significant. Given the differences in proportions, the lack of statistical significance may seem surprising. However, if one looks at the absolute numbers, it can be easily seen that the difference between the [5, 5]-UG and the [2, 8]-UG (i.e. between 91% and 73%) is just two rejections, while all other differences between adjacent games only involve one observation. This is an unavoidable side effect of our relatively small sample size. Although we cannot firmly conclude that the rejection rate of the [8, 2] offer is the same across games as one would expect if individuals in our Low ToM group *completely* lacked the ability to detect the intentions of others, we can assert quite confidently that the pattern we observe suggests that conclusion.[13]

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[12] The rejection rates for the [10 – X, X] alternative are in line with expectations, except maybe for the somewhat high rejection rate (12.5%) for the [5, 5]-UG. The statistical tests reported above the main diagonal of panel B of Table 2 show that the rejection rate of [10 – X, X] is significantly higher in the [10, 0]-UG. Again, this does not surprise us, for an offer of zero looks quite unkind when offering two is possible.

[13] The rejection rates for the [10 – X, X] alternative are broadly similar to those of the High ToM group. The only remarkable exception is represented by the [8, 2]-UG. This may be surprising at first, but is less so if one compares it with the corresponding rejection rate for the [8, 2] offer. Since the two alternatives are the same in this case, one would expect similar rejection rates, and, in fact,

The above analysis has shown that, consistently with our conjecture, the High ToM and Low ToM groups show different *within-group* patterns. Since our main treatment variable is the ability to detect intentions, the crucial test is to consider whether there are important *between-group* differences. This comparison is presented Figure 4, in which the rejection rates for the [8, 2] offer in the four games are shown next to each other. Although the rates are very similar for the [5, 5]-UG and the [2, 8]-UG, they differ substantially for the [8, 2]-UG and the [10, 0]-UG. As shown in panel E of Table 2, the proportions of [8, 2] rejections are significantly different for these latter games. We can summarise these findings as follows.

**Result 1 (mini UGs).** The differences between the *High ToM* and *Low ToM* groups in the mini UGs are consistent with the hypothesis that observed differences in the rates of [8, 2] rejections are the result of subjects' responses to perceived *unkind* intentions.

A natural interpretation of these between-group differences can be given in terms of inequality aversion. Recall that, since in the [8, 2]-UG P has no real decision to make, the rejection rate in this game can be interpreted as a measure of the pure aversion to unequal splits in each sample. Therefore, our Low ToM sample seems to be much more averse to inequality than our High ToM sample. It could be that, for some reason, ASD individuals are more sensitive to unequal divisions. However, since they usually have difficulties in empathising with others, if anything, one would expect the reverse. Our Empathy Quotient data can shed some tentative light on this issue. The average score of our ND Rs is 38.7, while the average of the 23 ASD children is 32.3. The average in the High ToM and Low ToM groups is 36.5 and 31.8 respectively. Although not statistically significant ($p > 0.1$ in the Mann-Whitney test), the direction of this difference is in line with expectation, and contrary to the hypothesis that differences in inequality aversion are due to empathising abilities. Why ASD children seem to be particularly averse to unequal divisions is an interesting issue to be pursued in future research.

We now turn to the results of Study 2. This Study seeks to find evidence that the positively reciprocal behaviour found by MRS is indeed related to the reaction of Bs to the perceived kind intentions of As, by

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this is the case for both groups. Then, it is the underlying behaviour in the [8, 2]-UG that differs significantly between the two groups. We say more about this issue in the remainder of this Section.

comparing behaviour in the VTG and ITG in the High ToM and Low ToM groups. The results of Study 2 are reported in Table 3.

Contrary to Study 1, for which we could rely on the already existing evidence that ND children's behaviour is analogous to the behaviour of adults, we have a much weaker evidential base for Study 2. The few studies that look at children's behaviour in similar games (Fishbein and Kaminski, 1985; Harbaugh et al., 2005; Sutter and Kocher, 2007), find no evidence of positively reciprocal behaviour. This finding is confirmed in our data. As shown in panel A of Table 3, the proportion of High ToM children choosing 'Right' is 50% in the VTG and 48.15% in the ITG. These proportions are not statistically different. Not surprisingly, this lack of sensitivity to intentions also appears in the Low ToM group. Panel B of Table 3 shows that the corresponding proportions are 63.64% and 72.73% for the VTG and ITG respectively. As for the High ToM group, these figures are not statistically different. Therefore, both groups fail to respond to behaviour that might signal kind intentions. The between-subject tests reported in the last two columns of panel A of Table 3 show that, for both games, the percentages of children choosing 'Right' do not differ significantly between the two groups. We can summarise these findings as follows.

**Result 2 (trust games).** The behaviour of the *High ToM* and *Low ToM* groups does not differ significantly in the VTG and ITG games. Both groups do not respond to behaviour that may signal *kind* intentions.

Taken as a whole, Results 1 and 2 seem to indicate that, while High ToM *children* behave as adults in the mini-UGs, they behave differently in the VTG and ITG. If perceived intentions do indeed affect their behaviour, it seems that they do react to *unkind* intentions, but they fail to react to *kind* intentions. While it is possible that this is a side effect of the use of the strategy method, which can have greater influence in trust games than in mini UGs (Casari and Cason, 2009), it is conceivable that negative reciprocity develops in children at an earlier stage than positive reciprocity. And the evidence from related games is also consistent with this possibility. We come back to this point in our discussion.

There is an interesting parallel between the results of Study 1 and those of Study 2. In Study 1, we find that the proportion of rejections of the *unequal* [8, 2] split in the [8, 2]-UG, which can be regarded as a rough measure of the level of inequality aversion, is higher in the Low ToM sample than in the High ToM sample. Similarly, in Study

2 the proportions of Bs' *inequality-minimising* choices (i.e. choosing 'Right' in the two trust games), are higher (although not significantly so) in the Low ToM group than in the High ToM group. We cannot rule out the possibility that the same factor is responsible for both findings. The identification of such factor(s) lies behind the scope of this paper, but appears to be worthy of further attention in future research.

## 6. Discussion and conclusion

Research in the area of social preferences has identified two mechanisms able to explain why behaviour deviates from the mere pursuit of self-interest often assumed in standard game theoretic investigations. These mechanisms assume that individuals respond to unequal payoff distributions (as in outcome-based models) or to the perceived intentions of others (as in intention-based models). Both classes of models are supported by empirical evidence showing that individuals behave *as if* the alleged causal mechanisms were at work.

Our study makes a further step in the investigation of the causal mechanism embedded in intention-based models, by substantially weakening this *as if* clause. The use of an atypical sample made of ASD children allows us to make the ability to detect the intentions of others a *treatment* variable. Since ASD children often lack the ability to mentalise, that is, to ascribe others with mental states (including intentions), comparing their behaviour with that of ND children should allow us to conduct a controlled test of the causal mechanism assumed in intention-based models. We do this by adapting FFF's experimental protocol involving mini-UGs, in which intention-driven behaviour mainly takes the form of *negative* reciprocity, and MRS's comparison of the VTG and ITG, in which perceived intentions can feed into behaviour in the form of *positive* reciprocity.

Our mini-UG results provide support for the role of negative reciprocity. We find that children with a deficit in their mentalising abilities are much less sensitive to what may be perceived as unkind offers than subjects with normal mentalising skills. Our trust game results, on the other hand, fail to produce evidence of positive reciprocity, even in children with normal mentalising abilities. To the best to our knowledge, our Study 2 represents the first investigation of the VTG and ITG in a sample of children. Our results, together with the finding that children of a similar age do not behave in a positively reciprocal way in the investment game, suggest that this may be due to the fact that children learn to punish unkind actions earlier than they learn to reward kind actions.[14] For instance, it may reflect a tendency for punishments to have greater salience than rewards in children's memory, or simply the prevalence of punishments over rewards in children's experience. This is an interesting issue, but unfortunately we cannot address it with the data at our disposal.

We also point out two interesting aspects of our mini-UG results. The first is that, as noted in Section 5, the behaviour of subjects with lower mentalising skills appears to be much more averse to inequality than that of normal subjects. This has a parallel in the larger proportion of inequality-minimising choices that Low ToM subjects make in the VTG and ITG, and cannot be explained by differences in empathy levels. The second aspect is that the rejection rates we observe for children appear to be substantially higher, in absolute terms, than those FFF observe for adults. Similarly high rejection rates are also found by Sutter (2007), in a comparison of adults and children with monetary rewards. Although we use non-monetary rewards (trading cards), the similarity of these results leads us to speculate that, given their relative size, the incentives used in this type of experiments may be more *salient* for children than for adults.[15] Alternatively, the pattern could be related to other factors which are subject to change with age.

Overall, our study has found moderate support in favour of the causal mechanism posited by intention-based models. Since outcome-based motives have also been found to be important, a natural extension of our research consists in making more explicit the causal mechanism underlying the sensitivity to payoff distributions, such as altruism and inequality aversion. Our finding that differences in what can be interpreted as a consequence of pure inequality aversion cannot be explained by differences in the ability of subjects to empathise with others suggests that the search for appropriate controls could be more difficult in this case. But if the models of social preferences are to be extended in the direction suggested by Falk and Fischbacher (2006), such

[14] In principle, the lack of responsiveness to intentions in the trust games could be a side effect of the strategy method, which was not used by MRS, but since we do observe reaction to intentions in the mini UGs, it could be related to other factors.

[15] Sutter tries to control for this by using different conversion rates for children and for adults, but the difference is rather small (0.2 euro/point for children versus 0.3 euro/point for adults).

a search, perhaps combined with further studies that use the traditional *indirect* strategy of comparing behaviour that would be observed under the *as if* condition, appears to be a worthwhile endeavour.

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**Tables and Figures**

**Table 1 – Mini UG: Proposers' Decisions**

| *A) Proposers (N = 22):* | [5, 5]-UG | | [2, 8]-UG | | [10, 0]-UG | |
|---|---|---|---|---|---|---|
| | Obs. | % | Obs. | % | Obs. | % |
| Offers [8, 2] | 4 | 18.18% | 17 | 77.27% | 20 | 90.91% |

| *B) Statistical tests*[a] | [5, 5]-UG | | [2, 8]-UG | |
|---|---|---|---|---|
| | $\chi^2$ | Sig. | $\chi^2$ | Sig. |
| [2, 8]-UG | 13.00 | *** | | |
| [10, 0]-UG | 14.22 | *** | 1.80 | |

a – McNemar test of difference in proportions. Significance levels are as follows: *** = 1%; ** = 5%; * = 10%.

**Table 2 – Mini UG: Respondents' Decisions**

| *A) High ToM (N = 32):* | [5, 5]-UG | | [2, 8]-UG | | [8, 2]-UG | | [10, 0]-UG | |
|---|---|---|---|---|---|---|---|---|
| | Obs. | % | Obs. | % | Obs. | % | Obs. | % |
| Rejects [8, 2] | 26 | 81.25% | 24 | 75.00% | 11 | 34.38% | 5 | 15.63% |
| Rejects [10 – X, X] | 4 | 12.50% | 4 | 12.50% | 7 | 21.88% | 21 | 65.63% |

| *B) Statistical tests (High ToM):*[a, b] | [5, 5]-UG | | [2, 8]-UG | | [8, 2]-UG | | [10, 0]-UG | |
|---|---|---|---|---|---|---|---|---|
| | $\chi^2$ | Sig. | $\chi^2$ | Sig. | $\chi^2$ | Sig. | $\chi^2$ | Sig. |
| [5, 5]-UG | -- | -- | *0.00* | | *1.29* | | *13.76* | *** |
| [2, 8]-UG | 0.67 | | -- | -- | *1.80* | | *15.21* | *** |
| [8, 2]-UG | 13.24 | *** | 13.00 | *** | -- | -- | *12.25* | *** |
| [10, 0]-UG | 21.00 | *** | 19.00 | *** | 4.50 | ** | -- | -- |

| *C) Low ToM (N = 11):* | [5, 5]-UG | | [2, 8]-UG | | [8, 2]-UG | | [10, 0]-UG | |
|---|---|---|---|---|---|---|---|---|
| | Obs. | % | Obs. | % | Obs. | % | Obs. | % |
| Rejects [8, 2] | 10 | 90.91% | 8 | 72.73% | 7 | 63.64% | 6 | 54.55% |
| Rejects [10 – X, X] | 2 | 18.18% | 2 | 18.18% | 7 | 63.64% | 9 | 81.82% |

| *D) Statistical tests (Low ToM):*[a, b] | [5, 5]-UG | | [2, 8]-UG | | [8, 2]-UG | | [10, 0]-UG | |
|---|---|---|---|---|---|---|---|---|
| | $\chi^2$ | Sig. | $\chi^2$ | Sig. | $\chi^2$ | Sig. | $\chi^2$ | Sig. |
| [5, 5]-UG | -- | -- | *0.00* | | *5.00* | ** | *5.44* | ** |
| [2, 8]-UG | 2.00 | | -- | -- | *3.57* | * | *7.00* | *** |
| [8, 2]-UG | 3.00 | * | 0.20 | | -- | -- | *0.67* | |
| [10, 0]-UG | 2.67 | | 0.67 | | 0.20 | | -- | -- |

| *E) High ToM vs. Low ToM:*[c] | [5, 5]-UG | | [2, 8]-UG | | [8, 2]-UG | | [10, 0]-UG | |
|---|---|---|---|---|---|---|---|---|
| | Z | Sig. | Z | Sig. | Z | Sig. | Z | Sig. |
| [8, 2] rejection rates | 0.75 | | –0.15 | | 1.7 | * | 2.55 | ** |
| [10 – X, X] rejection rates | 0.47 | | 0.47 | | 2.55 | ** | 1.01 | |

a – McNemar test of difference in proportions. Significance levels are as follows: *** = 1%; ** = 5%; * = 10%.

b – $\chi^2$ values and significance levels below the main diagonal refer to comparisons of [8, 2] rejection rates. $\chi^2$ values and significance values above the main diagonal refer to comparisons of [10 – X, X] rejection rates.

c – Test of proportions based on the binomial distribution. Significance levels as in a.

**Table 3 – Trust Games**

| *A) High ToM (N = 54):* | VTG | | ITG | | $\chi^2$ | Sig.[a] |
|---|---|---|---|---|---|---|
| | Obs. | % | Obs. | % | | |
| Right [5, 5] | 27 | 50.00% | 26 | 48.15% | 0.04 | |
| Down [0, 8] | 27 | 50.00% | 28 | 51.85% | | |

| *B) Low ToM (N = 11):* | VTG | | ITG | | $\chi^2$ | Sig.[a] |
|---|---|---|---|---|---|---|
| | Obs. | % | Obs. | % | | |
| Right [5, 5] | 7 | 63.64% | 8 | 72.73% | 0.20 | |
| Down [0, 8] | 4 | 36.36% | 3 | 27.27% | | |

| *C) High ToM vs. Low ToM:*[b] | VTG | | ITG | |
|---|---|---|---|---|
| | Z | Sig. | Z | Sig. |
| Right [5, 5] | 0.83 | | 1.49 | |

a – McNemar test of difference in proportions. Significance levels are as follows: *** = 1%; ** = 5%; * = 10%.
b – Test of proportions based on the binomial distribution. Significance levels as in a.

**Figure 1 – FFF's mini UG**

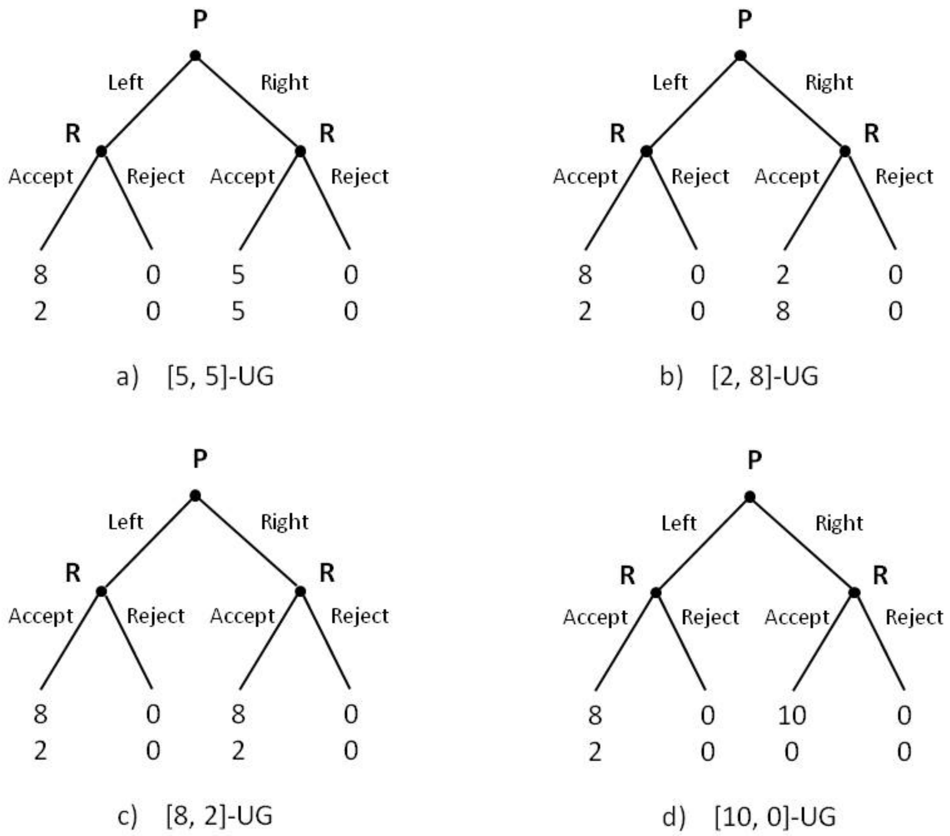
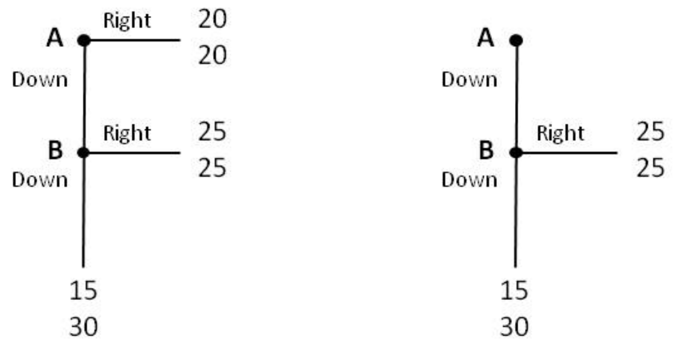
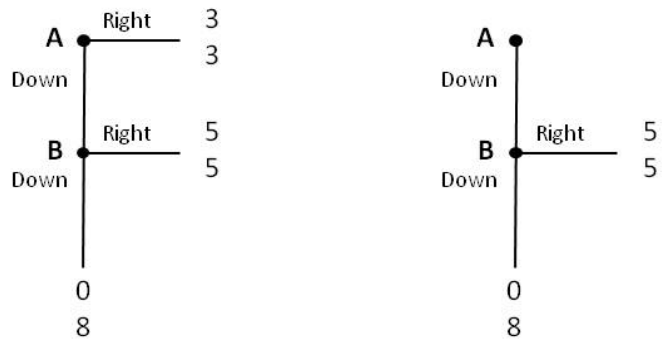


**Figure 2 – MRS's Trust Games**



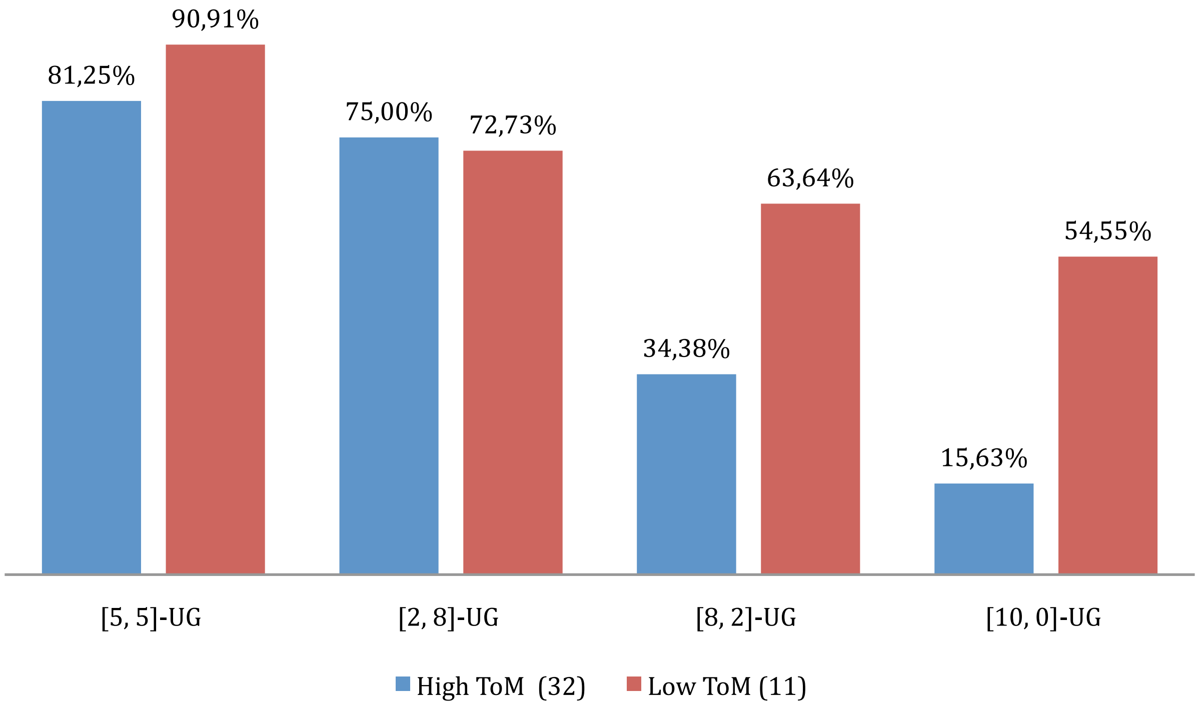

a) Voluntary Trust Game b) Involuntary Trust Game

**Figure 3 – Study 2 Trust Games**




a) Voluntary Trust Game b) Involuntary Trust Game

**Figure 4 – Rejection rates in the four mini-ultimatum games**



**Appendix**

**The "Ice-Cream Van Task" (Second order false belief test. Perner & Wimmer, 1985).**
This is John and this is Mary. They live in this village. Here they are together in the park (Fig.1). Along comes the ice-cream man. John would like to buy an ice-cream, but he has left his money at home (Fig.2). He is very sad. "Don't worry", says the ice-cream man, "you can go home and get your money and buy some ice-cream later. I'll be here in the park all the afternoon". "Oh good", says John, "I'll be back in the afternoon to buy some ice-cream".
Where did the ice-cream man say to John he would be all afternoon?
(REALITY QUESTION) Park
So John goes home...he lives in this house. Now, the ice cream man says "I'm going to drive my van to the church to see if I can sell my ice-creams outside there".
Where did the ice cream man say he was going?
(REALITY QUESTION) Church
Did John hear that?
(REALITY QUESTION) No
So the ice-cream man drives over the church. On his way he passes John's house, John sees him and says "Where are you going?". The ice-cream man says "I'm going to sell some ice-cream outside the church" (Fig.3). So off he drives to the church (Fig.4).
Where did the ice-cream man tell John he was going?
(REALITY QUESTION) Church
Does Mary know that the ice-cream man has talked to John? No
(REALITY QUESTION)
Now Mary goes home. She lives in this house. Then she goes to John's house – she knocks on the door and says "Is John in?". "No", says John's mother. "He has gone out to buy an ice-cream".
Where does Mary think that John has gone to buy and ice-cream? Park
(SECOND ORDER THEORY OF MIND QUESTION)
Why?
Where did John really go to buy his ice-cream? Church
(REALITY QUESTION)

Fig. 1

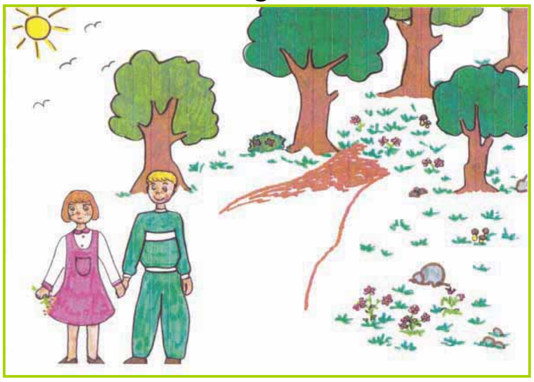
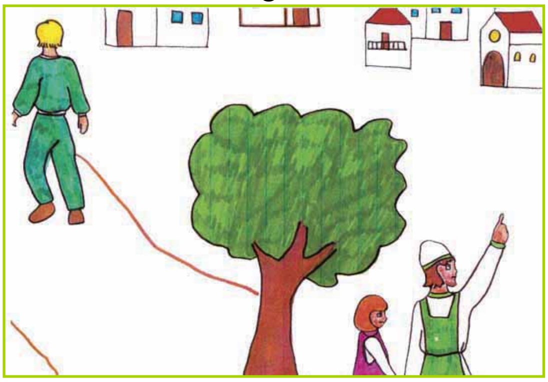


Fig. 2

Fig. 3


Fig. 4



**Instructions**

**Experimental protocol for Receivers (A players in the trust games)**
The experimental subject is taken to room A by one of the experimenters (Exp. A hereafter). Another experimenter (Exp. B) stays in room B.

Exp. A explains the games to the subject, by reading the following text (in bold). Insertions in square brackets are instructions for Exp. A.

**We are now going to play a series of games in which you have the opportunity to win some Yu-Gi-Ho cards. The number of cards that you win will depend on your decisions and on the decisions of another person, who is now in another room. We will communicate with the other person via a computer. You will never know who is in the other room.**

*For the Mini UGs*

**This is an example of how this game works. The person in the other room has been given 10 cards like these.**

[Display cards on the table]

**They have to decide how to divide these 10 trading cards between them and you. For example,** [take example game] **they could have these two options:**

- **Keep 6 cards for themselves and give 4 to you;**
- **Or keep 9 cards for themselves and give 1 to you.**

**Let us assume that they keep 6 cards and give 4 to you.**

**You can now decide if you accept their offer or not. If you accept, they win 6 cards and you win 4. If you reject, none of you wins any cards.**

**Do you accept or reject?**
[Keep in mind subject's response.]

**There are four of these games.**

*For the VTG*

**This is an example of how this other game works. The person in the other room has been given a certain number of Yu-Gi-Ho cards.**

**They have two alternatives: they can either give 3 cards to you and keep 3 for themselves or let you decide. In this latter case you can choose between 8 cards for you and no card to them, or 5 cards for you and 5 for them.**
**Suppose now that they let you decide. What would you do?**

[Keep in mind subject's response.]

**How many cards did you win?**

*For the ITG*

**This is an example of how this other game works. You now have a certain number of Yu-Gi-Ho cards.**

**you can choose between 8 cards for you and no card to them, or 5 cards for you and 5 for them.**

**What you do?**

[Keep in mind subject's response.]

**How many cards did you win?**

**There is a sequence of six of these games.**

**We will play them all, and then you will draw a dice to select one at random to be played for real. If the game for real were the first we played, in which the other person chose to keep 6 cards for themselves and give 4 to you,**

[if child accepted:]

**You would win 4 cards and they 6, because you accepted their offer.**

[If subject rejected:]

**Nobody would win anything because you rejected their offer.**

**Similarly for the two other games.**

**Are you ready to start? Have you got any questions?**

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