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Fairness and intentionality in children's decision-making

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Abstract Few studies have addressed the role of different aspects of the Theory of Mind (ToM) (intentionality and false belief understanding) in decision-making by adults playing strategic games where the importance of fairness is crucial. Even more interesting, this topic has been less investigated with children. The goal of this research was to explore the development of the decisional behavior along with the understanding of fairness, intentions and first- and second-order false belief understanding in children who are just acquiring those abilities. Multiple rounds of the ultimatum game with a human and a non-human partner (child/roulette wheel) were played by 177 children in the age range of 5–10 years, who also completed classic false belief tasks. Results confirm the key role of fairness sensibility across age groups and different degrees of the relevance of ToM according to the variability of children's decisional behavior (stable vs. dynamic).

Keywords Theory of mind · Fairness · Decision-making · Development

JEL Classification D81 · D84

1 Introduction

A person's ability to efficiently and productively adapt to his or her daily social environment is an important challenge that is successfully met due to several fundamental processes that have developed throughout the evolution of our species.

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In this research program, we are particularly interested in two of these processes and how they might operate, in isolation and in concert, to produce appropriate social behavior. Specifically, we are interested in two abilities: (1) the ability to process multiple alternatives and choose an optimal course of action to achieve one's goals in a given situation, typically known as decision-making and (2) the ability to represent, and refer to, mental states of others—intentions, emotions, desires, beliefs—in order to predict and understand behavior, usually known as Theory of Mind (ToM) (Premack and Woodruff 1978).

An interesting contribution regarding this recently appeared in the economic literature. Singer and Fehr (2005) pointed out that objects of research—such as ToM, but also empathy –are classic topics in psychology that may have relevant implications for economics and help us understand the motives that drive human behavior in social interactive games. This was made possible thanks to the advent of a research field known as Neuroeconomics (see the special issue of *Economics and Philosophy* 2008), which investigates the neural circuits underlying the mental processes that drive human behavior in social interactions requiring that a decision be made. In fact, researchers are currently using both standard behavioral paradigms as well as new brain imaging techniques, such as functional magnetic resonance imaging (fMRI), and have discovered that decision-making in social contexts involves the ability to reason about one's own intentions and emotional states as well as those of others (e.g., Camerer 2003; Pillutla and Murnighan 1996; Sanfey et al. 2003). Furthermore, there have been several studies that have directly focused on the role of mind-reading during the decision-making process under strategic game conditions, and they showed that the meta-representation of the mental and emotional states of both players has an effect on how players behave in these scenarios (e.g., Hoffman et al. 2000; Marchetti et al. 2008). For example, Hoffman and coauthors (2000) asked proposers to put themselves in their partners' shoes before making an offer to them and found that thinking about the responders' expectations concerning the offer brought higher offers. Marchetti et al. (2008) provided responders with different levels of descriptions of proposers (no description, physical description, personality description) before they received the offer and reported that the various types of meta-representations of the proposer led to different decisions and emotions although they all made the same fair/unfair offers.

It seems evident then that successful negotiation in the social world involves the ability to accurately represent the mental states of others and examining the developmental trends related to this ability can help illuminate the conditions under which it either flourishes or fails.

The several steps that lead to a full-fledged meta-representation ability have been well documented in the past 20 years. Within the first 2 years of life, a succession of precursors, or early cognitive structures, pave the way to mental competence: the understanding of agency (Battistelli 1995; Mandler 1988, 1992), joint attention and pointing (Baron-Cohen and Ring 1994; Butterworth 1991, 1994), declarative pointing (Camaioni 1993a, b), the understanding of visual perception (Flavell et al. 1981; Flavell 1988; Gopnik et al. 1994; Wimmer et al. 1988) and the understanding of pretense (Leslie 1987). For the purposes of this work, it may be relevant to note

that in ToM development a key step is the understanding of intentions. The capacity to detect the psychological motives that drive the behaviors relies upon the acquisition of basic abilities, such as distinguishing between intentional actions and accidental ones (Behne et al. 2005; Carpenter et al. 1998; Csibra 2003; Gergely et al. 1995; Kuhlmeier et al. 2003; Tomasello et al. 2005).

Following their second birthdays, children progressively develop a more complex understanding of the mind and of the mental states that inhabit it: by 2 years of age, they understand desires (Bartsch and Wellman 1995; Wellman and Bartsch 1994); at 3 years, they understand true beliefs (Wellman 1991; Wellman and Bartsch 1994); by 4 years, they show the understanding of first-order false belief (Wimmer and Perner 1983); and several years later, they understand second-order false belief (Perner and Wimmer 1985). According to the developmental model proposed by Bartsch and Wellman (1995), the understanding of false belief constitutes a watershed in the child's conception of the mind. Prior to 4 years of age, children show an early understanding of non-epistemic mental states, and only after 4 years, do they reach a psychology of beliefs and completely master the ability to handle meta-representation. Of course, ToM development does not stop at 4 years of age, and it continuously undergoes refinement across the lifespan (Freeman 2000; Khun 2000; Massaro and Castelli 2009).

To date, developmental psychologists have studied how children acquire the ability to mentalize (Wellman et al. 2001), which is fundamental for a successful adaptation to one's social life. Instead, children's decisional behavior in social interactions with economic exchanges has been quite neglected for many years since researchers have primarily focused on adults (Rilling and Sanfey 2007). In fact, experts in a subfield of Economics known as Game Theory have offered well-specified models for the investigation of social exchanges. However, much of the decision behavior actually observed in these tasks deviates, often quite substantially, from the predictions of the standard game theoretic model. (For a review, see Camerer 2003). This suggests that psychological approaches, such as insight into mind-reading abilities, may help our comprehension of decisions and judgments.

Bargaining games are a common focus in social interactive decision-making, and those belonging to the family of Dictator Game (DG) and Ultimatum Game (UG) are often used to examine responses related to equality and inequality.[1] It is well known that Game Theory predictions about people's behavior in such games are at

[1] In the DG, one player (the Allocator) decides how much of an endowment to award to the second player (the Recipient). Allocations in this game measure pure altruism, in that the Proposer sacrifices personal gain to share the endowment with their partner. The UG is a variant which examines fairness and more strategic thinking in the context of two-player bargaining. In the UG, the Proposer and Responder are also asked to divide a sum of money, with the Proposer specifying how this sum should be divided between the two. However, in this case, the Responder has the option of accepting or rejecting the offer. If the offer is accepted, the sum is divided as proposed. If it is rejected, neither player receives anything. In either event the game is over, that is, there are no subsequent rounds in which to reach agreement. The decision to reject an unfair offer may be considered a form of altruistic punishment because the Responder chooses to receive no money rather than the amount offered by the Proposer, presumably to punish the Proposer for making a miserly offer. If people are motivated purely by self-interest, the Responder should accept any offer and, knowing this, the Proposer will offer the smallest non-zero amount.

odds with observed behavior, and in most industrialized cultures, low offers of less than 20% of the total amount are rejected about half of the time (Camerer 2003). There are some interesting differences in more traditional cultures, but in general the probability of rejection increases substantially as offers decrease from 50 to 0%. Thus, people's choices in the UG game do not conform to a model in which decisions are driven by self-interest.

Developmental psychology has paid attention to the acquisition of basic economic concepts in children (Berti and Bombi 1988; Gianinno 1999; Gianinno and Crittenden 2005; Gobbo 1994; Schug 1987; Thompson and Siegler 2000). Some examples of specific research topics in this regard are how children understand the meaning of taxes (Berti and Kirchler 2001; Furnham 2005), their notions about profit (Berti et al. 1986) and market forces (Leiser and Halachmi 2006). However, there are still relatively few studies examining the development of decision-making abilities in children using strategic games that require social interaction (Benenson et al. 2007; Fehr et al. 2008; Gummerum et al. 2008; Güroglu et al. 2009; Harbaugh et al. 2003; Harbaugh et al. 2007; Hoffman and Tee 2006; Murnighan and Saxon 1998; Sally and Hill 2006; Sanfey, Marchetti and Castelli 2007a, b; Sutter 2007; Sutter and Kocher 2007; Takagishi et al. 2010; Takezawa et al. 2006).

The following table sums up the age groups investigated so far, and the interactive games—namely the DG, the UG and the PDG or Prisoner's Dilemma Game—employed in such studies. They are listed in chronological order (Table 1).

These works have provided a first pass regarding children's decision-making in social interactive games, though the findings are still somewhat controversial.

One subject of debate is fairness. A well-established definition of fairness in economics is the one proposed by Rabin (1993): people tend to be fair or altruistic with those who are fair or altruistic and hurt those people who hurt them. Another

Table 1 Overview of the research on children's decision-making using interactive games

Authors	Ages	Games
1. Murnighan and Saxon (1998)	5, 6, 9, 12, 15	UG
2. Harbaugh et al. (2003)	7, 9, 10, 14, 18	DG, UG
3. Hoffman and Tee (2006)	Adolescents, adults	UG
4. Sally and Hill (2006)	6, 8, 10 Typical/atypical (autism)	DG, UG, PDG
5.Takezawa et al. (2006)	11, 13	DG, UG (alone vs. groups)
6. Harbaugh et al. (2007)	8–18	UG
7. Sutter (2007)	7–10; 11–15; 19–33	UG
8. Sutter and Kocher (2007)	8, 12, 16, 22, 32, 68	TG
9. Benenson et al. (2007)	4, 6, 9	DG
10. Gummerum et al. (2008)	9–17	DG (alone vs. groups)
11. Fehr et al. (2008)	3–8	Sharing games
12. Sanfey et al. (2007a, b)	7–9	Base-line fairness regret-disappointment
13. Güroglu et al. (2009)	9–18	Fairness intentionality
14. Takagishi et al. (2010)	5–6	UG

common way of defining what we mean by fairness is via the concept of inequity aversion as outlined by Fehr and Schmidt (1999, p. 819): ". *Inequity aversion means that people resist inequitable outcomes; i.e., they are willing to give up some material payoff to move in the direction of more equitable outcomes.*" Individual differences in this type of explanation are used to understand why certain people decide that 8-2 offers in a UG are unfair and thus reject them, whereas other people have the same reaction to 6-4 offers.

The studies of children have showed that attitudes toward fairness change as one develops. Young children (in both typical and atypical conditions) accept smaller offers than older ones (Harbaugh et al. 2003; Murnighan and Saxon 1998; Sally and Hill 2006). Sutter (2007) found that children and adolescents accept unequal offers less often than adults and discusses this finding from the perspective that fair outcomes are relatively more important than the perception of fair intentions. Recently, Fehr et al. (2008), using various types of sharing games, found that the sensibility of fairness develops strongly between 3 and 8 years of age. Sanfey et al. (2007a) found that the baseline for fairness shifts from an egoistic/egocentric perspective (*"It is fair if it is to my own advantage"*) in 7-year-old children to an equal/multicentric perspective ("*It is fair if it is equal*") in 9-year-old children. Güroglu et al. (2009) found that the ability to understand the intentionality of the proposer increases the ability to evaluate fairness in decision-making about monetary offers.

Few researchers have investigated the connection between fairness and moral reasoning. Takezawa et al. (2006) showed that moral reasoning plays an important role in group discussions of moral issues and undergoes developmental changes. In the younger age groups, altruistic individuals were less influential than egoistic individuals, and the level of moral reasoning was higher in the older age group. Gummerum and coauthors (2008) found that group members with a higher moral reasoning ability were more influential during group negotiations and in influencing group outcomes, but they found no age effect on fairness proposals, and the level of moral reasoning did not predict individual offers.

The use of strategy undergoes developmental changes as well. When playing as proposers, younger children make larger offers than older, according to Murnighan and Saxon (1998). However, Harbaugh and coauthors (2003) found an opposite result (probably due to different aspects of their protocols, such as anonymity and real financial gains), and Harbaugh and coauthors (2007) found that children offer the same 50/50 split as adults. Sally and Hill (2006) observed that young children were more cautious in cooperation and less generous than older ones. Takagishi et al. (2010) found that preschoolers with a high first-order false belief understanding when playing the UG as proposer made higher offers than children who did not pass the first-order false belief task.

Finally, socio-economic status (SES) and gender are also important. High SES children are more altruistic (Benenson et al. 2007), and women are more generous than men (Gummerum et al. 2008; Harbaugh et al. 2003; Murnighan and Saxon 1998), but the latter finding is still controversial. For example, DG offers seem to depend more on P's height (tall children offer less) than on gender (Harbaugh et al. 2003).

Given these findings, our focus here is not only on fairness but also on the development of the decisional behavior along with two relevant abilities for social life, i.e., the understanding of different aspects of ToM (intentionality, first- and second-order false beliefs). To our knowledge, with the exception of the papers by Sally and Hill (2006), Sutter (2007) and Güroglu et al. (2009), these topics have been investigated only in adults.

Blount (1995) was the first to contribute information about the importance of the attribution of intentionality when people have to value different outcomes in bargaining games. Moving from the assumption that humans are perceived as intentional agents, whereas random or natural occurrences are not perceived as intentional, Blount distinguished these two dimensions by using three levels of attribution: "interested party condition," which refers to a human partner who has a stake in the bargaining outcome; "third party condition," which is related to a human partner who does not get a payoff; "random condition," i.e. a non-human proposer—such as a roulette wheel—that removes the perceptions of both intentionality and self-interest. Blount demonstrated that different proposers generate different expectations about the offer, confirming the hypothesis that people have normative expectations regarding other human beings. Under the interested party condition, subjects were less willing to accept unfair offers than subjects in the random condition, whereas players in the third party condition demonstrated preferences halfway between those playing under the interested and random conditions.

Recently, Rilling and coauthors (2004) investigated not only the level of intentionality that the receiver assigns to the proposer—human vs. non-human partner—but also the different neural activations implied in the two conditions. Participants were scanned with fMRI while playing the UG as responders after previously playing some make-believe UG rounds with a human partner and some others with a computer. Under both conditions, the offers were generated by a computer, so what really changed was the attribution of intentionality that subjects made under conditions in which they believed they were playing with a human partner. Behavioral results were very similar to those typically found in UG experiments: participants accepted all fair offers, with decreasing acceptance rates as the offers became less fair. Interestingly, unfair offers of $2 and $1 made by human partners were rejected at a significantly higher rate than the same offers made by a computer. Most important, under both conditions, two of the brain areas discovered to relate to ToM understanding were found to be active—the anterior paracingulate cortex (APC) and the posterior superior temporal sulcus (pSTS)—with a statistically higher activation when subjects believed they were playing with a human partner. The fact that these cortical areas were more active during a game with a human partner supported a neurological hypothesis that mind-reading is implied in decision-making, in this case through the attribution of an *intentional stance* to the other person (see also McCabe et al. 2001; Gallagher et al. 2002). This is particularly true regarding the APC area, which is known to be involved in important psychological functions, such as the prediction of future events, the attribution of intentionality to the behavior and so on.

Similar results were obtained by van't Wout et al. (2006). They asked undergraduate students to play 20 UG rounds (10 with a human partner and 10 with a computer partner) as responders, and they measured players' skin conductance activity during the game. All fair offers were accepted, whereas unfair offers made by a human partner were rejected more than unfair offers made by computers. Skin conductance responses to unfair offers were higher than those to fair offers and, interestingly, this pattern was observed only for offers proposed by human partners but not for offers generated by computers.

Finally, Krach and coauthors (2008) showed that people's decision-making behavior is sensible not only because it adheres to the basic distinction between the attribution of intentionality (human partner) and the lack of attribution of intentionality (PC or roulette) but also because of the increasing degrees of human-likeness in the game partner, going from a PC, to a functional robot, to an anthropomorphic robot, to a human partner.

It is important to underline that we aimed to investigate decision-making and the understanding of ToM (intentionality, first- and second-order false belief understanding) during an age period in which children develop both fairness and ToM. A thorough understanding of the above-mentioned goals can contribute from a developmental point of view to two topics that have been largely debated in the economic literature concerning an explanation of human behavior in social interactive games, i.e., reciprocity and parochialism. Reciprocity is defined as a mutual exchange (see, for example, the special issue of the *International Review of Economics*, 2008) and is not an all-or-nothing phenomenon but a gradual acquisition that occurs during development. Parochialism is favoring the members of one's own social group, and it also undergoes developmental changes (Fehr et al. 2008). As the following section will show in detail, this research may allow conclusions to be drawn regarding both aspects. A social interactive game like UG can elicit a behavior inspired by the reciprocity norms (if the offer is unfair, I am motivated to refuse it, thus reciprocating the unfairness of the proposer). Furthermore, some children played with another child "like them" with regard to gender and age, which can be considered to be parochialism. It is noteworthy that the "like me" recognition is also one of the cornerstones of other minds' understanding largely investigated in Psychology (see, for example, Meltzoff and Moore 1977, 1983).

2 Research methods

2.1 Participants

We recruited 193 children in northern Italy with middle-high SES between 5 and 10 years of age to participate in the research.

In order to create a homogeneous sample with a similar cognitive profile, Raven's Coloured Progressive Matrices (CPM) were used (Raven 1947). Children under the 5th percentile and above the 95th percentile were excluded. The final sample was made up of 177 children, and the group was homogenous with regard to cognitive abilities and gender distribution.

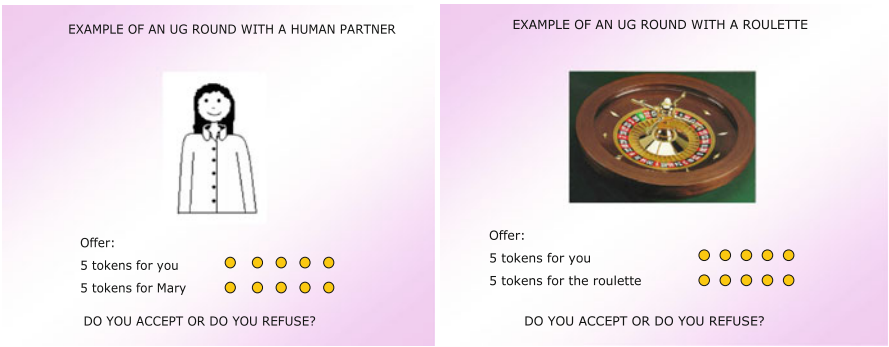

Fig. 1 Example of a UG round with a human partner and with the roulette wheel as partner

2.2 Tasks

Participants completed the following tasks individually in one session in a quiet room at their school.[2]

1. *Ultimatum Game*: each child played 10 UG rounds acting as responder with 10 tokens converted into candies/stickers (5 rounds for each one of two types of proposer). The first type of proposer was a child, depicted on a card as being the same gender and age as the tested child; the second type of proposer was a roulette wheel depicted always on a card. The experimenter told the child playing as responder that he/she was going to play a game with another child or a roulette wheel as partner. The child was informed that the partner was going to propose how to divide ten tokens. The child was asked to express his or her acceptance or refusal of the offer on the same sheet depicting the proposer and the offer (see Fig. 1).The two proposers did the same previously established set of offers: a fair offer and increasingly unfair offers (5-5; 6-4; 7-3; 8-2; 9-1). The order of the type of partner was counterbalanced, and the order of the offers was set with the Latin square.[3] Two control questions were asked to check children's understanding of UG procedure.

   Figure 1 shows an example of a UG round with a child and with the roulette wheel.

2. *First- and second-order false belief task ("look-prediction" version):* this task is adapted from both the Perner and Wimmer (1985) study that was much too difficult for children and another done by Sullivan and coauthors (1994) that was too easy. The child is told a story (with drawings) about two characters (Maria and Gianni) who are playing with a toy. Maria puts the toy in a wardrobe

[2] We are grateful to Camilla Olivero and Sara Carlin for the collection of the data on children and for their coding, and to Camilla Olivero also for the graphic drawing depicting the UG rounds.

[3] Latin square is one of the most convenient and often-used strategies to control the order effect of stimuli and/or research conditions. It consists of the creation of a matrix with a number of rows and columns equal to the number of stimuli/research conditions. No row or column includes the same stimulus/research condition twice (and therefore in the same position). (See, for example, McBurney and White 2007).

and leaves the room, and while she is away Gianni changes the location of the toy, putting it under the bed.

The story is stopped at this point and the child is asked where Maria will look for the toy once she returns to the room (first-order false belief question). The child is then asked to justify the response and is further given two memory control questions to assess the understanding of the story. Once these answers are obtained, the story is resumed, with Maria returning to the room. From the open door, she sees Gianni as he is moving the toy under the bed, though Gianni does not see Maria. The child is then asked where Gianni thinks Maria will look for the toy once she is back in the room (second-order false belief question). Again, the child must justify this response and is asked two last memory control questions.[4]

The tasks used in this research are taken from the research done in the fields of Economics and in Psychology. In fact, the UG is one of the most frequently employed games in studies of decision-making in Economics, whereas the false belief task is very common in explorations of ToM development in Psychology. The procedure was largely adopted from the research in economics (see, for example, Hertwig and Ortmann 2001). Participants were presented with information from a precisely defined "script." Children were rewarded for their performance with candies. Children were not deceived, and the minimum accepted offer criterion (MAO) was adopted to identify participants who behaved like a Homo Oeconomicus, as predicted by the standard economic view. However, some specific procedural strategies came from the psychological field. In fact, the repetition of trials was avoided because of the well-known negative effect of repeated questioning on children's performance. The history of repeated questioning in developmental psychology can be traced back to Piaget (1926). In order to be sure that children mastered the concept under investigation, he asked the same question twice or contradicted the children's answers, offering them a counter-suggestion, which was a productive of cognitive improvement. More recent studies (Siegal 1997) have shown that children often change their answer not because of a poor mastery of the investigated concept but in response to the violation of the Quantity Rule in conversation (Grice 1975). This also might happen as a consequence of their desire to please the adult, given the asymmetric roles implied in the experimental situation. We are aware that adopting a double set of methodological criteria (from Economics as well as from Psychology) represents only an approximation of the real-life situation in which people usually decide. We tried to create an ecological setting (particularly relevant in studies with children) in order to improve the

[4] To score their performance, correct answers received 1 point, and incorrect answers scored 0. The two justification questions were scored on a three-point scale: 0 points for a wrong answer (reference to wrong information or irrelevant facts, such as: *"Because toys always stay in the wardrobe"* or *"Because I always do the same"*); 1 point for a correct answer referring to the behavioral domain (for example: *"Because she had put them in the wardrobe"*); 2 points for a correct answer referring to the mentalistic domain (for example: *"Because she does not know that he has changed the location of the toy"* or *"Because she thinks/believes that the toy is still in the wardrobe"* as the justification for the first-order false belief question; *"Because he does not know that she knows that he changed the location of the toy"* or *"Because he thinks/believes that she does not know that he changed the location of the toy"* for the justification pf the second-order false belief question). The scores for all of the tasks could range from 0 to 8 (if all questions received 1 point) or from 0 to 10 (if both justifications received 2 points).

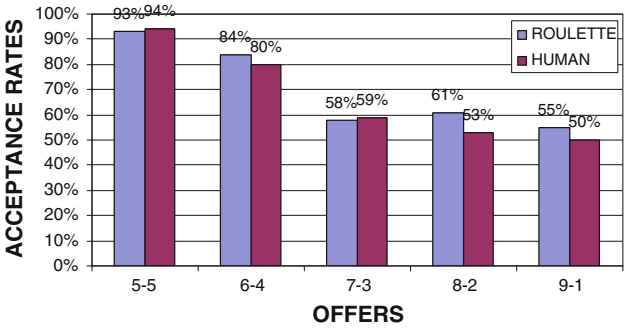

Fig. 2 Acceptance rates of each offer from human and roulette wheel in the whole sample

external validity of our results. In accordance with Davis and Durham (2001), we also believe that the exclusive use of prescriptive methodologies "*while useful in economics, may obfuscate important psychological phenomena*" (p. 406).

3 Results

Figure 2 provides an overview of the acceptance rates of fair and unfair offers from the roulette and the human partner in the whole sample.

Not surprisingly, the acceptance rates of the fair offer are close to 100% irrespective of the type of proposer, and they decrease as the offers became less fair. This decreasing pattern is in line with the one found by Rilling et al. (2004) and Sanfey et al. (2003), but there are slightly different rates. Identical to their results is the perfect analogy of the acceptance rates in the 7-3 offer between human and non-human partner: 95% in Rilling et al. (2004) and Sanfey et al. (2003), 59 and 58% in this study.

The two age groups were created after considering the distribution of ages in months (younger: $N = 87$, age range 50–104, mean = 78,9, SD = 17,131; older: $N = 90$, age range 76–130, mean = 109,14, SD = 16,380). The UG performance was coded as follows: the acceptance rate of rounds 5-5 and 6-4 on one side and the acceptance rate of rounds 7-3, 8-2, 9-1 on the other side were totaled to obtain a fair/unfair score, respectively; these two scores were normalized. The two ToM variables demonstrate high and low levels of ToM reasoning. These two levels were obtained by combining the first-order false belief test question and its justification question and combining the second-order false belief test question and its justification question, as follows:

1st ORDER ToM—LOW LEVEL	Absence of ToM
1st ORDER ToM—HIGH LEVEL	Presence of 1st order ToM
2nd ORDER ToM—LOW LEVEL	Presence of 1st order ToM only
2nd ORDER ToM—HIGH LEVEL	Presence of 2nd order ToM

A General Linear Model was run for the whole sample to determine whether the subject's choice to accept or reject the offers (dependent variable) could be affected

by the fairness of the offers themselves (fair and unfair offers) and by the proposer typology (child and roulette partners). Fairness and proposer typology were within subjects independent variables. The effect of gender, age, high–low first-order ToM, high–low second-order ToM (between-participants independent variables) was also verified.

The GLM showed the following significant effects for:

fairness ($F_{(169,1)} = 33.46$, $p < .001$): fair offers are accepted more often than unfair ones;
interaction between fairness and first-order ToM ($F_{(169,1)} = 9.13$, $p < .01$): children with high first-order ToM reasoning accept unfair offers less often than children with low first-order ToM reasoning;
no age, no proposer typology, no gender effects.

In order to evaluate the acceptance rates of each round with respect to all the independent variables (age, gender, first- and second-order false belief, fairness and proposer typology) a series of Chi-square tests was carried out for each offer made by each type of proposer. With the human partner, there was a significant association between the acceptance rate and the first-order false belief in the 9-1 round ($\chi^2 = 7{,}14$, df $= 1$, $p < .01$; see Fig. 3) and between the acceptance rate and the second-order false belief in the 7-3 round ($\chi^2 = 73{,}83$, df $= 1$, $p < .05$; see Fig. 4).

To deepen the observed effects, we implemented a logistic regression model for binary repeated measures that showed the predictive effect of fairness (Waild $X^2 = 78.05$, df $= 4$, $p = .001$) and of the interaction between fairness and first-order ToM (Waild $X^2 = 24.71$, df $= 5$, $p = .001$). In particular, we found a significant effect of the 5-5 ($\text{Exp}(\beta) = 1.65$), 6-4, ($\text{Exp}(\beta) = 1.44$) and 7-3 ($\text{Exp}(\beta) = 1.11$) offer conditions as well as of the interaction between the group of children with a low first-order ToM performance and 8-2 ($\text{Exp}(\beta) = 1.45$) and 9-1 ($\text{Exp}(\beta) = 1.33$) offer conditions. Fairness seems to be a strong predictor for the

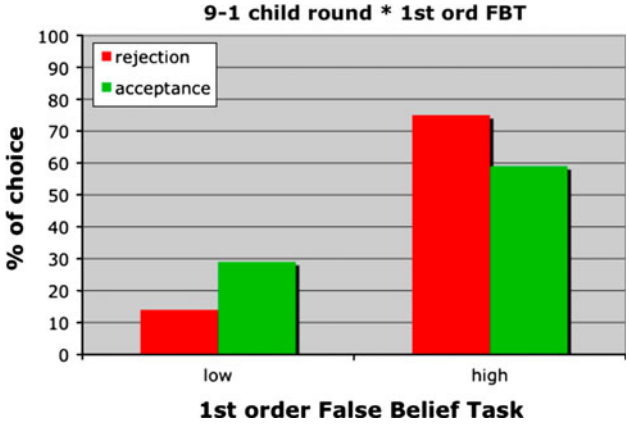

Fig. 3 Association between the acceptance rate and the first-order false belief in the 9–1 round with the human partner

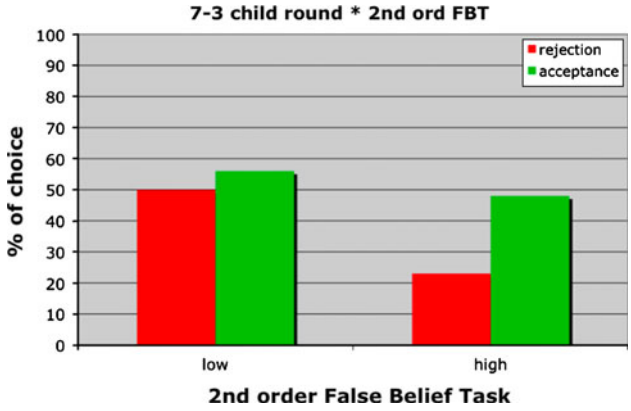

Fig. 4 Association between the acceptance rate and the second-order false belief in the 7–3 round with the human partner

acceptance of the offer; the results show that the 7-3 offer condition is the threshold to exclude the casuality of the choice. The children with a low performance in first-order ToM showed a higher probability to accept the offers when they were very unfair (8-2, 9-1).

In order to better understand children's decision-making, we applied a filter for the variability of children's decisional behavior. On the basis of the pattern of acceptances, a minimum acceptable offer (MAO) was identified for each child. Therefore, children with a stable pattern of acceptances (for example, they refused an 8-2 offer and also refused a 9-1 offer) were placed in the "stable" category, whereas children with an unstable pattern of acceptances (for example, they refused an 8-2 offer and then accepted a 9-1 offer) were placed in the "dynamic" category.

The "stable" group ($N = 47$; $M = 28$; $F = 19$) consisted of 23 young children (6, 5 years) and 24 older children (9 years). First-order false belief was overcome by 61% of children in this group, and second-order false belief was overcome by 36%. Figure 5 provides an overview of the acceptance rates among those in the stable group.

As Fig. 5 shows, the MAO is set at a quite high level (9-1), irrespective of the type of proposer. In fact, no significant results were provided by the GLM set-up. The "stable" group of children was strongly insensitive to the fairness of the offer, given that there was a rejection rate of less than 10% only in the 9-1 round. It is worth noting that with regards to the age range considered, "stability" in decision-making is strongly associated with a tendency toward maximization of the outcome.

The "dynamic" group ($N = 130$; $M = 81$; $F = 49$) was made up of 64 young children (6, 5 years) and 66 older children (9 years). First-order false beliefs were overcome by 80% of children in this group, and second-order false beliefs were overcome by 41%. Figure 6 provides an overview of the acceptance rates among members of this group.

Similar to the whole sample (see Fig. 2), the acceptance rates of the fair offer were close to 100%, irrespective of the type of proposer, and then they decreased as

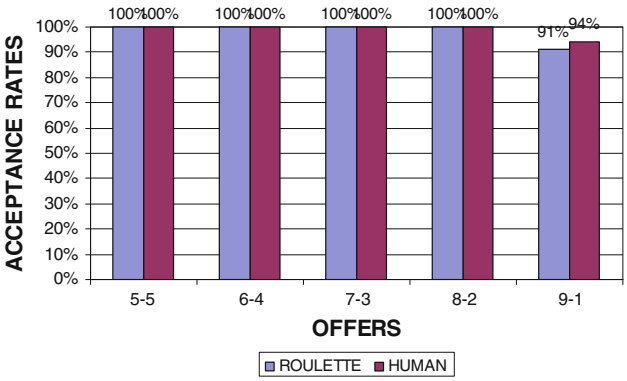

Fig. 5 Acceptance rates of each offer from human and roulette wheel among children in the "stable" group

the offers became less fair**.** The GLM, with the same design used in the two previous groups, was also used in this one, showing the following significant results:

- fairness ($F_{(122,1)} = 50.09$, $p < .001$): fair offers are accepted more than unfair ones;
- interaction between fairness and age ($F_{(122,1)} = 6.15$, $p < .05$): young children accept unfair offers more than older ones.

Furthermore, there was a significant tendency related to fairness, age and first-order false belief ($F_{(122,1)} = 3.31$, $p = .07$): young children with a high level of first-order ToM reasoning accepted unfair offers less often than children with a low level of first-order ToM reasoning. In the group of older children, ToM made no difference since they all rejected unfair offers (see Fig. 7).

Finally, to evaluate the acceptance rates of each round with respect to all the independent variables (age, gender, first- and second-order false beliefs), a series of Chi-square tests was carried out for each offer made by each type of proposer. Significant associations between the acceptance rates and second-order ToM were

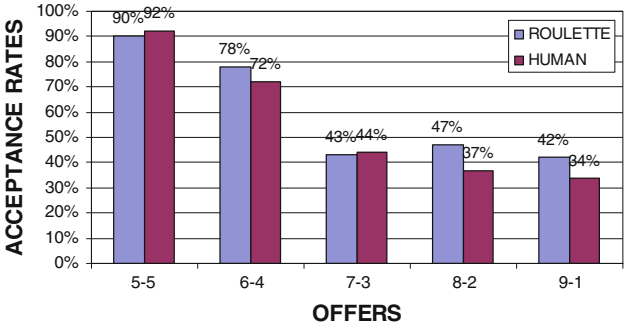

Fig. 6 Acceptance rates of each offer from human and roulette wheel among members of the "dynamic" group

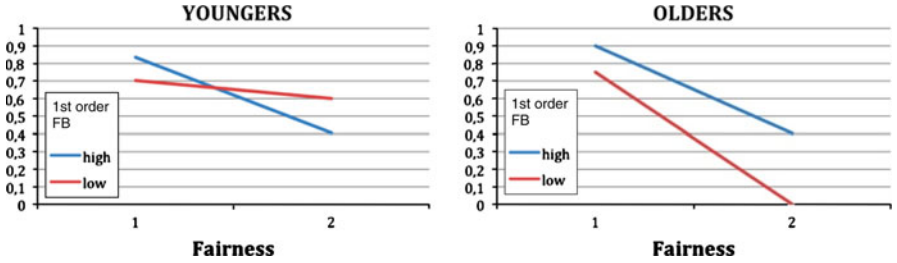

Fig. 7 Interaction among fairness, age and first-order false beliefs in the "dynamic" group

found in the 8-2 and 7-3 rounds with a human proposer ($\chi^2 = 3{,}48$, df $= 1$, $p < .05$; $\chi^2 = 6{,}90$, df $= 1$, $p < .01$): children with a high level of ToM reasoning had a higher acceptance rate.

Chi-square analyses showed no significant associations between the variability of children's decisional behavior and gender, age, proposer typology, and ToM performance.

In this case, to deepen the observed effects, we implemented a logistic regression model for binary repeated measures that showed that only fairness has a predictive effect on the choice (Waild $X^2 = 268.72$, df $= 4$, $p = .001$). More specifically, we found a significant effect of the 5-5 (Exp(β) $= 1.88$) and 6-4 (Exp(β) $= 1.53$) offer conditions.

4 Discussion

The first result that can be noticed from the general linear model on the whole sample is the significant effect of fairness, with fair offers accepted more than unfair ones. The logistic regression confirms and extends this evidence, underlining the predictive effect of fairness on the children's choice. This appears to be in line with studies outlined in the literature review on the development of decision-making that was presented in the introduction, showing that fairness is a key component of social decision-making not only in adulthood but also in those who are developing (Fehr et al. 2008; Harbaugh et al. 2003; Murnighan and Saxon 1998; Sally and Hill 2006).

A second interesting finding from the general linear model is the significant interaction between fairness and ToM reasoning: a high first-order ToM level makes children more prone to refuse unfair offers, thus strengthening an already present sensibility to fairness. The logistic regression points out the predictive effect of low first-order ToM performance for the acceptance of the more unfair offers. It may be worth noting that the Chi-square tests show significant associations between the acceptance rates and ToM reasoning only in child-child interactions, more specifically in the 9-1 round where children with high first-order ToM reasoning refused the offer more often and in the 7-3 round in which children with high second-order ToM reasoning accepted the offer more often. Therefore, it seems that a first-order ToM ability is sufficient to make a child sensitive to a strong unfair

offer. In other words, a child need not have a high ToM in order to understand that a proposer, who should offer an equal split for a perfect reciprocity, may not consider you to be an equal, if he/she offers only 1. A child who reasons that *"I (receiver) think that you (proposer) have a bad opinion about me since you are offering me only 1"* is more likely to refuse the offer compared to a child who may not use the same level of reasoning, given his/her lower ToM. Mentalizing stands out as a component that enhances the tendency to refuse the most unfair among the offers. A second-order ToM ability seems necessary to put oneself in someone else's shoes in order to understand that 7-3 is not so unfair, since the partner could also have offered less. The fact that the children who accept more often in this round are those who have a higher ToM may suggest that those children recognize that the offer of the proposer depends on his/her capacity to understand that the receiver may understand his/her mental state, following a thread of reasoning like this: *"I (receiver) think that you (proposer) think that I (receiver) may think that a 7-3 offer is still an acceptable option, given the rules of the game"*. With regard to the remaining cases, we can hypothesize that fairness *per se* is a sufficient condition to decide about the offer, as shown, in particular, by the absence of an association between second-order ToM and the acceptance rate of 5-5 and 6-4.

As for the "stable" group, the absence of any significant effect from the GLM can be interpreted as a result of a purely maximizing motivation in decision-making for these subjects, who showed no sensitivity to fairness or to the proposer typology. In the group of "dynamic" children, the importance of fairness is once again confirmed by the general linear model and by the logistic regression. Furthermore, only the GLM shows a significant interaction between fairness and age, with young children accepting unfair offers more often than older ones. This is in line with the results of Harbaugh et al. (2003), Murnighan and Saxon (1998) and Sally and Hill (2006). We can speculate about the tendency toward an interaction between fairness, age and first-order ToM reasoning (young children with a high-ToM level accept unfair offers less often). When using first-order ToM in deciding to refuse unfair offers from the roulette wheel and from the human partner, the child may apply ToM to his/herself and to the experimenter in the first case and to his/herself in relation to the experimenter and to the other child in the second case. In the first situation, the child may use recursive thinking to consider his/her own mental states (*"I feel so disappointed/unlucky to receive such an offer from a machine"*) and to think about the experimenter's mental states (*"What will the experimenter think about me if I accept everything?"*). In the second situation, the child may use not only the same recursive thinking about him/herself and the experimenter but also about the mental states of the proposer (*"Why does he/she offer me this little amount? What does he/she think about me? What will he/she think if I accept?"*).

Therefore, among "dynamic" children, ToM reasoning about one's own and another person's mental states may be applied not only to decide what to do but also to preserve one's own attitude about his or her reputation, the human proposer and the experimenter who observes the situation. This speculation, which may deserve further study in the future, seems to be supported by the significant associations between second-order ToM and the acceptance rates in the 8-2 and 7-3 rounds with a human proposer, with high-ToM children having a higher acceptance rate.

Probably these children were able to deal with a complex recursive reasoning, such as "*I think that you think that I may understand that 2/3 is better than nothing, so I do not punish you and I accept it.*". In this case, as in the whole sample, fairness could be the main factor that affected decision-making in the remaining rounds.

Finally, there was an interesting result regarding the lack of differentiation in choices depending on the type of proposer. Contrary to the findings of Rilling et al. (2004) and Sanfey et al. (2003) who studied adults, the presence of different proposers did not play a major role in our sample. We can give two explanations for these results. We can argue that children failed to recognize intentionality in the human proposer or that they misattributed intentionality to the non-human one. Although our data do not offer a conclusive answer to this problem, it is worth noting that a large proportion of the literature seems to disprove the first interpretation, showing that children are able to detect intentionality in human beings before they are 5-years old (that is, before they reach the age of our youngest participants). Instead, the second explanation is supported by Piaget's concept of "animism" in childhood (Piaget 1926). It is the tendency to attribute feelings, intentions and emotions to animals and things. This tendency could have driven the children to evaluate the offers from the non-human partner in the same way they did with the human one and considering only the fairness component of the offer before making a decision.

5 Conclusions and directions for future research

A first conclusion is the partial involvement of ToM in social decision-making. In fact, although fairness is probably confirmed as one of the stronger aspect implied in this kind of activity, in our study ToM is involved as well in different ways and degrees depending on the various combinations between level of recursive thinking, age, type of partner and entity of the offer.

This confirms on one side, Astington's (2003) general statement about the role of ToM in social life, i.e. *"ToM is sometimes necessary, never sufficient"*; on the other side, Sally and Hill's (2006) conclusions about ToM involvement in various decision-making games in children. More specifically, they found that children's mentalizing abilities tested with classical false belief tasks explain intentional and strategic behavior in the PDG and the avoidance of unfair offers in the UG. This last result has been also confirmed by our results, as we found that a first-order ToM ability is sufficient to be sensible to a strong unfair offer (children with high first-order ToM reasoning refuse the 9-1 offer more).

A second conclusion concerns the importance of detecting the intentionality of the partner to accept or refuse an offer. So, our data do not show differentiation on the basis of the proposer typology; however, since the specific age of our sample allows to suppose that the ability to recognize intentionality should be developed, this fact could be explained in terms of Piaget's animism: children would be driven by the proclivity to attribute intentions, emotions etc. also to material things. For the future, it may be useful to adopt a more continuous series of intentional devices, like Krach et al. (2008) did with adults, as well as to extend the age range, in order to see

if there is a turning-point where children begin to differentiate between human and non-human thus differentiating their decisional behavior.

A third and final conclusion that can be derived from this study is that given the same cognitive abilities in the age range here considered, children differ as regards the variability of their decisional style. The fact that we did not find any association between the decisional pattern (stable vs. dynamic) and age, gender, proposer typology and ToM performance suggest as future lines of investigation the analysis of other variables pertaining subjects, for example, personality traits, socio-affective dimensions (style of attachment, trust) or other kinds of structural ones as family size, birth order.

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References

Astington JW (2003) Sometimes necessary, never sufficient: false-belief understanding and social competence. In: Repacholi B, Slaughter V (eds) Individual differences in theory of mind: implications for typical and atypical development. Psychology Press, New York, pp 13–38

Baron-Cohen S, Ring H (1994) A model of the mindreading system: neuropsychological and neurobiological perspectives. In: Lewis C, Mitchell P (eds) Children's early understanding of mind: origins and development. Lawrence Erlbaum Associates, Hillsdale, pp 183–207

Bartsch K, Wellman HM (1995) Children talk about the mind. Oxford University Press, London

Battistelli P (ed) (1995) Io penso che tu pensi…le origini della comprensione della mente. Franco Angeli, Milan

Behne T, Carpenter M, Call J, Tomasello M (2005) Unwilling versus unable: infants' understanding of intentional action. Dev Psychol 41:328–337

Benenson JF, Pascoe J, Radmore N (2007) Children's altruistic behaviour in the dictator game. Evol Hum Behav 28:168–175

Berti AE, Bombi AS (1988) The child's construction of economics. Cambridge University Press, Cambridge

Berti C, Kirchler E (2001) Contributions and contributors: research on representations of the fiscal system. Giornale Italiano di Psicologia 38:595–607

Berti AE, Bombi AS, De Beni R (1986) Acquiring economic notions: profit. Int J Behav Dev 9:15–29

Blount S (1995) When social outcomes are not fair: the effects of causal attributions on preferences. Organ Behav Hum Decis Process 63(2):131–144

Butterworth G (1991) The ontogeny and phylogeny of joint visual attention. In: Whiten A (ed) Natural theories of mind: evolution, development and simulation of everyday mindreading. Basil Blackwell, Cambridge, pp 223–232

Butterworth G (1994) Theory of mind and the facts of embodiment. In: Lewis C, Mitchell P (eds) Children's early understanding of mind: origins and development. Lawrence Erlbaum Associates, Hillsdale, pp 115–132

Camaioni L (1993a) Lo sviluppo della ToM e dei suoi precursori. Età Evolutiva 45:61–72

Camaioni L (1993b) The development of intentional communication: a re-analysis. In: Nadel J, Camaioni L (eds) New perspectives in early communicative development. Routledge, London, pp 82–96

Camerer CF (2003) Behavioral game theory. Russell Sage Foundation, New York

Carpenter M, Nagell K, Tomasello M (1998) Social cognition, joint attention, and communicative competence from 9 to 15 months of age. Monogr Soc Res Child Dev 63(4):1–174
Csibra G (2003) Teleological and referential understanding of action in infancy. Phil Trans R Soc Lond B 358:447–458
Davis HP, Durham RL (2001) Economic and psychological experimental methodology: separating the wheat from the chaff. Behav Brain Sci 24(3):405–406
Fehr E, Schmidt KM (1999) A theory of fairness, competition, and cooperation. Q J Econ 114(3):817–868
Fehr E, Bernhard H, Rockenbach B (2008) Egalitarianism in young children. Nature 454:1079–1083
Flavell JH (1988) The development of children's knowledge about the mind: from cognitive connections to mental representations. In: Astington JW, Harris PL (eds) Developing theories of mind. Cambridge University Press, New York, pp 244–267
Flavell JH et al (1981) Young children's knowledge about visual perception: further evidence for the level 1-level 2 distinction. Dev Psychol 17(1):99–103
Freeman NH (2000) Communication and representation: why mentalistic reasoning is a lifelong endeavour. In: Mitchell P, Riggs KJ (eds) Children's reasoning and the mind. Psychology Press, Hove, pp 349–366
Furnham A (2005) Understanding the meaning of tax: young peoples' knowledge of the principles of taxation. J Soc Econ 34(5):703–713
Gallagher HL, Jack AI, Roepstorff A, Frith CD (2002) Imaging the intentional stance in a competitive game. Neuroimage 16(3 Pt 1):814–821
Gergely G, Nadasdy Z, Csibra G, Bıro S (1995) Taking the intentional stance at 12 months of age. Cognition 56:165–193
Gianinno LJ (1999) Children's understanding of everyday economic practices (transactions). Dissertation Abstracts International: Section B: The Sciences and Engineering 60 (6-B): 29–83
Gianinno LJ, Crittenden VL (2005) Assessing shared understanding of economic exchange among children and adults. Psychol Mark 22(7):551–576
Gobbo C (1994) On children's understanding of an economic concept: the role of graphics in evaluation. In: Schnotz W, Kulhavy RW (eds) Comprehension of graphics. Advances in psychology. North-Holland/Elsevier Science Publishers, Amsterdam, pp 227–249
Gopnik A, Slaughter V, Meltzoff A (1994) Changing your views: how understanding visual perception can lead to a new theory of the mind. In: Lewis C, Mitchell P (eds) Children's early understanding of mind: origins and development. Lawrence Erlbaum Associates, Hillsdale, pp 157–181
Grice HP (1975) Logic and conversation. In: Cole P, Morgan JL (eds) Syntax and semantics, vol III, Speech Acts. Academic Press, New York, pp 41–58
Gummerum M, Keller M, Takezawa M, Mata J (2008) To give or not to give: children's and adolescents' sharing and moral negotiations in economic decision situations. Child Dev 79(3):562–576
Güroglu B, van den Bos W, Crone EA (2009) Fairness considerations: increasing understanding of intentionality during adolescence. J Exp Child Psychol 104:398–409
Harbaugh WT, Krause K, Liday SG (2003) Bargaining by children. http://econpapers.repec.org/paper/oreuoecwp/2002-04.htm. Accessed 13 July 2009
Harbaugh WT, Krause K, Vesterlund L (2007) Learning to bargain. J Econ Psychol 28:127–142
Hertwig R, Ortmann A (2001) Experimental practices in economics: a methodological challenge for psychologists? Behav Brain Sci 24(3):83–451
Hoffman R, Tee JY (2006) Adolescent-adult interactions and culture in the ultimatum game. J Econ Psychol 27:98–116
Hoffman E, McCabe K, Smith V (2000) The impact of exchange context on the activation of equity in ultimatum games. Exp Econ 3:5–9
Khun D (2000) Theory of mind, metacognition and reasoning: a life-span perspective. In: Mitchell P, Riggs KJ (eds) Children's reasoning and the mind. Psychology Press, Hove, pp 301–326
Krach S et al (2008) Can machines think? Interaction and perspective taking with robots investigated via fMRI. PLoS ONE 3:e2597. doi:10.1371/journal.pone.0002597
Kuhlmeier V, Wynn K, Bloom P (2003) Attribution of dispositional states by 12-month olds. Psychol Sci 14:402–408
Leiser D, Halachmi RB (2006) Children's understanding of market forces. J Econ Psychol 27:6–19
Leslie AM (1987) Pretense and representation: the origins of "Theory of Mind". Psychol Rev 4:412–426
Mandler JM (1988) How to build a baby: on the development of an accessible representational system. Cogn Dev 3(2):113–136
Mandler JM (1992) How to build a baby: II. Conceptual primitives. Psychol Rev 99(4):587–604

Marchetti A, Castelli I, Sanfey AG (2008) Teoria della Mente e decisione in ambito economico: un contributo empirico. In: Antonietti A, Balconi M (eds) Mente ed economia. Come psicologia e neuroscienze spiegano il comportamento economico. Il Mulino, Bologna, pp 191–207

Massaro D, Castelli I (2009) Mentalizing in communicative and socio-relational interactions: considerations about a theory-of-mind modelling. Stud Commun Sci 1:103–130

McBurney DH, White TL (2007) Research methods. Wadsworth, Belmont, CA

McCabe K, Houser D, Ryan L, Smith V, Trouard T (2001) A functional imaging study of cooperation in two-person reciprocal exchange. Proc Natl Acad Sci USA 98:11832–11835

Meltzoff AN, Moore MK (1977) Imitation of facial and manual gestures by human neonates. Science 198:75–78

Meltzoff AN, Moore MK (1983) Newborn infants imitate adult facial gestures. Child Dev 54:702–709

Murnighan JK, Saxon MS (1998) Ultimatum bargaining by children and adults. J Econ Psychol 19:415–445

Perner J, Wimmer H (1985) 'John thinks that Mary thinks that…': attribution of second-order false beliefs by 5- to 10-year-old children. J Exp Child Psychol 39(9):437–471

Piaget J (1926) La raprésentation du monde chez l'enfant. Alcan, Paris

Pillutla MM, Murnighan JK (1996) Unfairness, anger, and spite: emotional rejections of ultimatum offers. Organ Behav Hum Decis Process 68(3):208–224

Premack D, Woodruff G (1978) Does the chimpanzee have a theory of mind? Behav Brain Sci 1:515–526

Rabin M (1993) Incorporating fairness into game theory and economics. Am Econ Rev 83(5):1281–1302

Raven JC (1947) Progressive matrices: Séries A, Ab, B. Editions scientifiques et psychotechniques, Clamart Seine

Rilling JK, Sanfey AG (2007) Decision-making and neuroeconomics: social interactions. In: Squire L et al (eds) The new encyclopedia of neuroscience. Elsevier, Amsterdam

Rilling JK, Sanfey AG, Aronson JA, Nystrom LE, Cohen JD (2004) The neural correlates of theory of mind within interpersonal interactions. Neuroimage 22:1694–1703

Sally D, Hill E (2006) The development of interpersonal strategy: Autism, Theory of Mind, cooperation and fairness. J Econ Psychol 27:73–97

Sanfey AG, Rilling JK, Aronson JA, Nystrom LE, Cohen JD (2003) The neural basis of economic decision-making in the ultimatum game. Science 300:1755–1758

Sanfey AG, Marchetti A, Castelli I (2007a) What is fair for you? The concept of fairness in school-age children. Oral communication presented to the Conference "Reciprocity: Theories and Facts". University of Milano Bicocca, Milano, 22–24 Feb 2007 (book of the abstracts: p. 60)

Sanfey AG, Marchetti A, Castelli I (2007b) Equality and regret: theory of mind and emotions in children's understanding of economic concepts. Oral communication presented to the 37th Annual Meeting of the Jean Piaget Society: Society for the Study of Knowledge & Development, on "Developmental Social Cognitive Neuroscience". Amsterdam, 31 May–2 June 2007 (book of the acts: p. 12)

Schug MC (1987) Children's understanding of economics. Elem Sch J 87(5):507–518

Siegal M (1997) Knowing children. Experiments in conversation and cognition, 2nd edn. Erlbaum, Hove

Singer T, Fehr E (2005) The neuroeconomics of mind reading and empathy. Am Econ Rev 95(2):340–345

Sullivan K, Zaitchik D, Tager-Flusberg H (1994) Preschoolers can attribute second-order beliefs. Dev Psychol 30:395–402

Sutter M (2007) Outcomes versus intentions: on the nature of fair behavior and its development with age. J Econ Psychol 28:69–78

Sutter M, Kocher MG (2007) Trust and trustworthiness across different age groups. Games Econ Behav 59:364–382

Takagishi H, Kameshima S, Schug J, Koizumi M, Yamagishi T (2010) Theory of mind enhances preference for fairness. J Exp Child Psychol 105:130–137

Takezawa M, Gummerum M, Keller M (2006) A stage for the rational tail of the emotional dog: roles of moral reasoning in group decision making. J Econ Psychol 27:117–139

Thompson DR, Siegler RS (2000) Buy low, sell high: the development of an informal theory of economics. Child Dev 71(3):660–677

Tomasello M, Carpenter M, Call J, Behne T, Moll H (2005) Understanding and sharing intentions: the origins of cultural cognition. Behav Brain Sci 28:675–735

van' t Wout M, Kahn RS, Sanfey AG, Aleman A (2006) Affective state and decision-making in the ultimatum game. Exp Brain Res 169:564–568

Wellman HM (1991) From desires to beliefs: acquisition of a theory of mind. In: Withen A (ed) Natural theories of mind. Evolution, development and simulation of everyday mindreading. Basil Blackwell, Oxford, pp 39–50

Wellman HM, Bartsch K (1994) Before belief: children's early psychological theory. In: Lewis C, Mitchell P (eds) Origins of an understanding of mind. Erlbaum, Hillsdale, pp 331–354

Wellman HM, Cross D, Watson J (2001) Meta-analysis of theory of mind development: the truth about false belief. Child Dev 72:655–684

Wimmer H, Perner J (1983) Beliefs about beliefs: representation and constraining function of wrong beliefs in young children's understanding of deception. Cognition 13:103–128

Wimmer H, Hogrefe J, Sodian B (1988) A second stage in children's conception of mental life: understanding informational accesses as origins of knowledge and belief. In: Astington JW, Harris PL (eds) Developing theories of mind. Cambridge University Press, New York, pp 173–192