The role of theory of mind in economic decision making

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Abstract

Theory of mind (ToM) is a concept that is not often considered in economic decision making. However, it could be of importance. This literature review focuses on ToM in economic decision making by answering the following research question: "What role does ToM play in economic decision making?" Specifically it focuses on game theory, looking at the ultimatum game, the dictator game and the prisoner's dilemma. It is unclear whether ToM plays a role in every form of economic decision making, but in general people with a more developed ToM seem to be better at making strategic decisions, both as proposer in the ultimatum game and in the prisoner's dilemma, probably because people with a well-developed ToM have a better understanding of how other people think and react, and can take this into account when making a decision. On the responder side of the ultimatum game it is again unclear whether ToM plays a role, but if it does this is probably because people with a more developed ToM have a greater sense of fairness. In the dictator game ToM may play a role, because people with a more developed ToM have a better understanding of other people's disappointment and have a better idea of how their decisions can affect other people's view of the person. Examples are given of how the findings from these simple games can be important for more complicated economic decisions.

Economics and psychology are often thought of as two completely separate fields of research. Economist have traditionally used the rational, self-interested *homo economicus* as a model of the human being in their research for many years, completely ignoring the fact that real-life human beings are not necessarily rational and do in fact take the feelings of others into account (Thaler, 2000). More recently, however, the relevance of psychological findings for economics has received more attention, and a field of research that combines

psychological insights and economic theory has developed. This field is known as "behavioural economics".

Even though several topics that combine psychological and economic theory have recently received more research attention, there is one topic that, surprisingly, has received relatively little attention. This topic is the role that theory of mind (ToM), the awareness of one's own mental processes and the mental processes of others (Santrock, 2004), including the ability to form a psychological theory about others (Verhofstadt-Denève, Van Geert & Vyt, 1999) plays in economic decision making.

Economic decision making in general has been thoroughly researched. In particular, game theory, the study of strategic decision making, has received a lot of attention. Game theory is relevant in decision-making situations with interdependence. That is, situations in which a decision made by one person or team influences the decision made by another person or team, and vice versa. This implies that each person or team will theorise about the other person's or team's decision, and it is usually assumed that the other person or team will act rationally. These situations occur in various fields of economics, e.g. in bidding in financial economics or in setting interest rates in macroeconomics.

Game theory is also applicable in many other fields, e.g. politics, sociology and sports (Wilson, 2008). A game consists of a set of players, the strategies available to each player, and payoffs to the player. The set of players may include nature or chance. An example of available strategies is the number of moves available to each player. The payoffs arise from the particular combination of strategies that a player chooses. Games can be analysed to determine equilibria. In the case of an equilibrium, none of the players can profit from changing their strategy when none of the other players do. If all players have adequate levels of knowledge, self-interest and coherent decision making they should arrive at an equilibrium (Hill & Sally, 2004). While some games are so easy that almost anyone can arrive at the equilibrium, others are more complicated and may therefore require mentalising. This is where ToM may be of interest.

How ToM influences decision making will be the focus of this thesis. In order to provide more insight into this topic this literature research will answer the following research question: "What role does ToM play in economic decision making?" It will focus on three economic games; the ultimatum game, the dictator game and the prisoner's dilemma. First the concept of ToM will be explained, then the role of ToM in the three previously mentioned games will be described.

Theory of mind

Theory of mind (ToM) is the awareness of one's own mental processes and the mental processes of others (Santrock, 2004), and includes the ability to form a psychological theory about others (Verhofstadt-Denève et al., 1999). It is a broad concept that is linked to the understanding of the difference between physical and mental acts, but also to the understanding of specific mental states, such as desire or belief (Bukatko & Daehler, 2001). It also includes the awareness that people can have different perceptions, thoughts and feelings about the same event (Berk, 2000) and the awareness that there is a distinction between the public and private aspects of self (Shaffer, 1999). ToM is often referred to as the ability to mentalise (Hill & Sally, 2004).

ToM develops with age, and various stages in this development can be recognised. By 2 to 3 years of age children begin to understand three mental states (Santrock, 2004). The first mental state to be recognised by the child is perception; the child realises that another person sees what is in front of his or her own eyes and that this is not necessarily the same as the child sees in front of his or her eyes. The second mental state to be recognised is emotion; the child can distinguish between positive and negative emotions. For example they can distinguish between disgust and happiness when another person reacts to the taste of food that he or she respectively likes or dislikes (Repacholi & Gopnik, 1997). A third is desire; the child now understands that if a person wants something he or she will try to get it (Santrock, 2004). For example, when a child had previously seen a person express disgust to crackers and happiness to broccoli the child understood that the person would rather have the broccoli than the crackers even if the child would prefer the crackers (Repacholi & Gopnik, 1997). By the age of 3 years, children are also able to distinguish between physical and mental entities (Bukatko & Daehler, 2001). Wellman and Estes (1986), for example, found that 3-year-olds were able to answer questions about subjective and corresponding objective experiences correctly. When asked for example whether a boy imagining a cookie and a boy who actually had a cookie could eat the cookie and whether the cookie could be seen by others, 3-year-olds answered these questions correctly at a rate that was significantly higher than that predicted by chance. By 28 months, children are also able to interpret "make-believe" activity correctly. This was shown in the research by Harris, Kavanaugh and Wellman (1993); children aged 25–38 months were introduced to a hand puppet named Duck who then performed a sequence of pretend actions, for example pouring cereal from an empty box into a bowl and then pretending to feed a toy horse. When asked questions such as "What did Duck do?" or "What

did the horse eat?" the majority of children gave answers that showed that the children understood the "make-believe" sequence of activities.

Though 2–3-year-olds have a basic understanding of desires, they have difficulty distinguishing these desires from beliefs. They tend to think that people act in a certain way because of their desires and do not understand that actions could also be influenced by beliefs (Santrock, 2004). They often think that beliefs are accurate views of reality that everyone holds and do not yet understand that people's beliefs differ because they are merely interpretations of reality and may be incorrect (Shaffer, 1999). Consider, for example, a situation in which a boy puts chocolate in a blue cupboard and goes out to play. When he is gone his mother moves the chocolate to a green cupboard. When children are asked where the boy will look for his chocolate when he returns, 2- or 3-year-olds will be inclined to say he will look in the green cupboard as they expect the boy to know what they know. By the time children are 4 or 5 years old they learn to understand the difference between beliefs and desires. In the previous example of the chocolate in the cupboard, they will say the boy will look in the blue cupboard as they understand that the boy still believes the chocolate will be in the cupboard he left it in. This understanding that beliefs are merely mental representations of reality and are not necessarily accurate is called a belief–desire ToM (Shaffer, 1999). This way of thinking closely resembles that of adults (Berk, 2000).

Between the ages of 6 and 10 years, children develop an understanding of the mind as an active entity that is separate from the self (Bukatko & Daehler, 2001). Hickling and Wellman (2001) researched this development by using a metaphor comprehension task that consisted of metaphors about the mind, i.e. "my mind is racing", "my mind tricked me". While 6-year-olds had a limited understanding of these metaphors and tended to interpret them literally, 8-year-olds already understood more of the metaphors. All of the 10-year-old subjects gave a correct non-literal interpretation of the metaphors concerning the mind.

By the age of 10 years children understand that some mental states like "wanting" and "fearing" are more difficult to control than others (Bukatko & Daehler, 2001). Flavell and Green (1999) asked a group of 7-year-olds, a group of 10-year-olds and a group of adults to judge whether ten different mental states were easy to change or hard to control. The 10-year-olds and the adults were significantly better than 7-year-olds at distinguishing easy-to-control mental states, such as imagining and looking, from hard-to-control mental states, such as fearing and liking.

Various views are held on how ToM develops. The first view is that humans are biologically prepared for, and motivated to acquire, information about mental states (Shaffer,

1999). In other words, a young child has the same ToM as an adult. Fodor (1992) believed this idea to be true. He said the only reason why younger children perform less well on tasks testing ToM is because they do not yet have the computational ability to make full use of their ToM. In the case of the false belief task, this would mean a child does know when an initial presumption was wrong; however, he just does not have the capacity to further use this information. For example, when a child is shown a sponge that looks like a rock and is asked what it is he will answer: "a rock". When he then touches the object and is asked the same question, he will say: "a sponge". He will change his answer because he now knows his first answer was wrong. However, he does not have the computational ability to keep in mind his first answer *and* the new information, and will therefore incorrectly give the answer "a sponge" when asked "What does it look like?". A second view is that ToM develops from social interactions, both with other children and with parents and other family members (Shaffer, 1999). Research shows that children with more than one older sibling do better on false belief tasks than children with only one older sibling (Ruffman, Perner, Naito, Parker & Clements, 1998). The reason for this could be that they have more interactions that teach them the effect of beliefs, for example through trickery, teasing and make-believe play. Other research has shown that daily contact with adults or older children also correlates with better performance on false belief tasks (Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996). A third view on the development of ToM is that cultural influence is important. It is possible that a culture's customs determine when and if ToM develops. Vinden (1996) for example found that Junín Quecha children (members of South American indigenous ethnic group) perform worse at false belief tasks than children from other countries. An explanation for this is that ToM does not develop as well, because these people do not talk about mental states and their language does not have words to describe mental states. However, other researchers point at the considerable similarities between cultures when it comes to the development of ToM (Bukatko & Daehler, 2001).

When researchers want to compare subjects with a well-developed ToM with subjects with a less developed ToM they have different options, The first is to compare younger children with older children; as has been explained in this section, ToM develops with age.

Another possibility is to use knowledge about mental disorders and ToM, and to compare subjects with a mental disorder with those without a mental disorder. One population that has a less developed ToM is people with autism. It has been concluded that autistic children lack ToM and this lack of ToM is specific to autism and is not just a consequence of mental retardation (Baron-Cohen, Leslie & Frith, 1985). Although people with Asperger

Syndrome, who can be considered as high-functioning, are able to pass false belief tasks, they have difficulty on tasks that require more complex mentalising processes and have unusual explanations of how they came to certain conclusions (Hill & Sally, 2004). Autistic children's inability to interact socially may be caused by a lack of ToM. This lack of ToM leads to an inability to understand the minds of others, which, in turn, can cause problems in social interaction and communication (Bukatko & Daehler, 2001). A second mental disorder that may be related to impaired ToM is schizophrenia. However, Frith and Corcoran (1996) concluded that impaired ToM was only seen in schizophrenic patients with positive symptoms. In schizophrenics with negative symptoms, poor results on tests of ToM were related to memory impairment, and patients in remission performed as well as controls. It is, therefore, questionable how useful schizophrenic patients are in research into the effects of impaired ToM in decision making, but this patient group has been used in this field of research (Agay, Kron, Carmel, Mendlovic & Levkovits, 2008), as we will see later.

The role of ToM in the ultimatum game

Ultimatum games are bargaining games that involve two people. For instance, a predetermined amount of money can be divided between these two people. One person, the proposer, proposes an amount that the other person can receive. The second person, the responder, either accepts or rejects this proposal. If the responder accepts the proposed amount the responder receives that amount and the proposer receives the total available amount minus this proposed amount. If the responder rejects the proposed amount they both get nothing.

The basic form of this game is too simple to resemble real life situations but it does offer insight into the concept of fairness. If responses were based on pure self-interest the proposer would propose the lowest amount possible and the responder would accept any amount. However, this is not the case. In practice, the proposer often offers a larger amount, sometimes even 50% of the total amount, and the responder does not accept an amount if it is very low. This can be explained by taking people's notion of fairness into account. When a responder thinks an offer is too low he or she will think this is unfair. He or she is, therefore, willing to punish the proposer at cost to him or her and reject the proposal, leaving both parties with nothing. The proposer wants to avoid this situation, and will offer more than the minimum amount (Wilkinson, 2008). In order to increase the chance that an offer will be accepted a proposer has to think about what the responder will think is a fair offer (Frith &

Singer, 2008). This thinking about the way other people think (second-order mentalising) requires a developed ToM.

On the other hand ToM may help the responder think about how the proposer thinks about him or her. If a proposer makes a low offer this may be a sign for the responder that the proposer thinks he or she is gullible or does not care about what the responder gets. The responder will punish the proposer for this behaviour by rejecting the offer (Hill & Sally, 2004).

ToM of the proposer

From the previous description it becomes clear that there are two sides to the ultimatum game in which ToM could be important. Firstly, the role of ToM is considered for the proposer. ToM has an influence on strategies for proposals; people with a lower ToM make less-strategic proposals. Autistic people (with a lower ToM) picked one of two strategies: either offering the other person nothing or splitting the amount in half. Non-autistic people, however, tried taking one or two points extra for themselves (Hill & Sally, 2004). So people with a higher ToM are more able to consider what the other person will still consider a fair enough proposal to accept, and use this to their advantage and keep slightly more than half for themselves. Children who passed the second-order belief task were more likely to offer half the points in the ultimatum game, whereas children who did not pass were more likely to offer nothing (Hill & Sally, 2004). Again this is proof that ToM helps in making a reasonable offer that is likely to be accepted by the responder.

In a study by Agay et al. (2008) 49 subjects with a DSM-IV diagnosis of schizophrenia were compared with 52 healthy controls in a two-phase version of the ultimatum game. The controls' offers were divided more or less evenly between fair (offering half the amount) and unfair (offering less than half the amount), and none were hyperfair (offering more than half the amount). The schizophrenic subjects proposed a fair offer in about half the cases, too, but the rest were divided between unfair and hyperfair. The fact that the schizophrenic subjects made hyperfair proposals is again proof that people with a lower ToM make less strategic decisions. There is no need to offer the responder more than half the amount to make sure the responder accepts the offer so it is, therefore, not a strategically logical offer. When an offer was rejected in the first round, both schizophrenic subjects and controls raised their offers in the next round, but schizophrenic subjects raised their offers more. When an offer was accepted, healthy controls tended to lower their offer in the next round in an attempt to maximise profits. Schizophrenic subjects ,however, did not try to do so.

This means the schizophrenic subjects perform less well in strategic thinking. There were also significantly more non-strategic responses in the schizophrenic group; these non-strategic responses were raising an offer in the second round when the first offer has been accepted, or lowering an offer when the first has been rejected. The fact that schizophrenic subjects were worse at making strategic decisions could be caused by a limited understanding of how others would react to a proposal, which could be caused by a deficit in ToM. However, in this study ToM was not determined for either the schizophrenic subjects or the healthy controls and therefore no definite conclusions about a link can be drawn. This could be a subject of future research. Takagishi, Kameshima, Schug, Koizumi, and Yamagishi (2010) conducted an experiment among healthy children. They tested 68 preschool children with ages ranging from 47 months to 73 months. These children each played a version of the ultimatum game with sweets instead of monetary reward once, either as proposer or responder. Their ability for mentalising was also tested using the Sally-Ann false belief task. The group of children who did pass the false belief task was compared with the group that did not. Results showed that children who passed the false belief task proposed to share a significantly higher amount of sweets than the children who did not pass the false belief task, with children who had passed the task offering a mean of 4.70 sweets and children who did not pass offering a mean of 2.64 sweets. Interestingly, the age of the proposer had no significant effect on the amount of sweets offered, showing that it is not age but the development of ToM that has an effect on offers made. The fact that children who did pass the false belief task offered more sweets suggests that ToM has an effect on children's sense of fairness.

So, to summarise, people with a lower ToM seem to perform less well at making strategic decisions than people with a higher ToM. Whereas people with a developed ToM tend to offer half the amount or a bit under half, people with less developed ToM tend to offer nothing or are hyperfair and offer more than half (Hill & Sally, 2004; Agay et al., 2008; Takagishi et al., 2010). They also tend to make illogical decisions in versions of the ultimatum game with several rounds (Agay et al., 2008). For example, offering less when the previous offer had been rejected or more when the previous offer had been accepted. This means that a limited understanding of others' mental processes can lead to less sensible offers, where the responder is either likely to reject the offer or the proposer gives the responder more than necessary.

ToM of the responder

ToM may have some effect on the amounts that are accepted by the responder. When looking at which offers were rejected it was clear that there was a developmental trend, with younger subjects accepting lower offers than older subjects. This may be a sign that ToM offers the ability to understand the other person's intentions and that, because of this, older people are more offended by these intentions and therefore less likely to accept low offers (Hill & Sally, 2004). Blount (1995) conducted an experiment in which subjects stated what the minimum acceptable bid was in an ultimatum game when the proposer was another person and when the available amount was divided by a computer simulation of a roulette wheel. It was found that the lowest acceptable amount was significantly lower in the second case. In this case ToM plays no role as the subjects do not have to think about the mental states of the other person. It is clear that amounts that are viewed as acceptable are lower when ToM does not play a role. Güroğlu, Van den Bos, Rombouts and Crone (2010) measured the brain activity of 23 responders in an adapted version of the ultimatum game. In this version the proposer could choose between two alternatives. One alternative was always an unfair, 8/2 division. The other option differed and was either fair (a 5/5 division) or hyper-fair (a 2/8 condition), or the only option was an unfair 8/2 division. Higher brain activity in the right temporoparietal junction (TPJ) and the medial prefrontal cortex (PFC) an anterior cingulated cortex (ACC) was observed for rejection of unfair proposals in the no-alternative condition than in the fair or hyper-fair condition. Higher activation in these brain regions was associated with lower rejection levels in the no-alternative condition. The TPJ and medial PFC and ACC are associated with ToM. The no-alternative condition requires the highest level of mentalising about the other person's intentions, as rejecting an unfair offer cannot be justified, whereas it is more easily justified when the proposer had a fair or hyper-fair alternative. As higher levels of activation were associated with lower rejection levels it can be argued that using ToM more leads to a better understanding of the fact that the proposer had no choice, and because of this understanding of the proposer's intentionality there is no reason to reject the proposal.

There are however also signs that ToM does not play a role in accepting or rejecting offers. There were no differences in mean offers rejected between autistic and normal adults and autistic and normal children. When comparing performance on ToM tasks and offers rejected no relationship was found between the two. Therefore, mentalising probably does not play a role in rejection of offers, but the offence generated internally is enough for a subject to reject low offers (Hill & Sally, 2004). There were no significant differences in rejection rates

between schizophrenic and control-group responders. However, it must be noted that overall rejection rates were low in this study, which may be the cause of this lack of differences between groups (Agay et al., 2008).

In the study by Takagishi et al. (2010) that was described in the section on ToM of the proposer, results showed that none of the fair or hyperfair offers, i.e. offers of at least five sweets, were rejected. Six out of eleven unfair offers were, however, rejected. Once again, the children who passed the false belief task were compared with the children who did not. Results showed that there was no significant effect of ToM on the rejection of unfair offers. This suggests that the sense of fairness that develops with ToM has less effect on this side of the ultimatum game.

To summarise, it is unclear what the effect of ToM on reactions of the responder is. On the one hand some studies have found that more developed ToM leads to a more developed sense of fairness, and because of this people with a less developed ToM accept lower offers than people with a more developed ToM (Hill & Sally, 2004) and people accept lower offers in situations in which ToM does not play a role (Blount, 1995; Güroğlu et al., 2010). On the other hand, ToM may not influence the decision of the responder (Takagishi et al., 2010).

The role of ToM in dictator games

In dictator games, similarly to the ultimatum game, a proposer decides what proportion of a total amount another player gets and how much the proposer keeps. However, the other player does not have the possibility to reject this proposal and will have to accept whatever offer the proposer makes. The proposer does not have to think strategically to avoid a situation in which an offer is rejected. Therefore, any positive offer made by the proposer is likely to be altruistic, particularly when the proposer stays anonymous (Wilkinson, 2008).

In the dictator game a proposer does not have to think about what the other person thinks is a fair proposal. However ToM may still play a role. Proposers hardly ever offer nothing. A reason for this, as is supported by the fact that proposers offer less in case of total anonymity, is that people care about their reputation. This is a form of second-order mentalising, as it requires people to think about what others think of them (Frith & Singer, 2008). This in turn requires ToM. Another way in which ToM may play a role in higher-than-nothing offers in the dictator game is that it helps the dictator understand the other players' disappointment in case he or she gets nothing and therefore inclines the proposer to be generous (Hill & Sally, 2004).

Some studies show ToM does not influence offers made in the dictator game. There are no differences in amounts offered by children or adults or in amounts offered by autistic and non-autistic subjects (Hill & Sally, 2004). Therefore, it can be concluded that there are no differences in core generosity between people with higher and lower ToM.

There is also research that suggests that there are differences in offers made depending on age. In an experiment by Gummerum, Hanoch, Keller, Parsons and Hummel (2010) twenty-six 3-year-olds, thirty 4-year-olds and twenty-one 5-year-olds played a dictator game in which they could decide how ten stickers were to be divided between them and another unknown child. No significant differences were found between age groups for the mean amount of stickers proposed. However 3- and 4-year-olds most often offered no stickers whereas 5-year-olds most often offered five. This could be attributed to a growing ToM, with the 5-year-olds being better at understanding others needs and perspectives. However, in the research by Gummerum et al. (2010) an explanation is offered based on moral attribution. They found that predictions of how one would feel after a moral violation predicted the offers in the dictator game. Children who predicted they would feel good after achieving a goal by doing something morally wrong (as was more often the case for 3- and 4-year-olds) made lower offers in the dictator game; therefore, not thinking about others desires but the child's own emotions influenced offers. Benenson, Pascoe and Radmore (2006) asked a total of 360 children divided evenly across three age groups, 4-, 6- and 9-year-olds, to propose how many of the ten stickers that they picked from a larger selection of stickers they wanted to give to a classmate. Results showed that though even the youngest children behaved altruistically (donating at least one sticker), children's altruistic behaviour increased with age. The 9-year-old children donated significantly more stickers to their classmates than 4-year-old children, and 6-year-olds donated an intermediate amount. In this study, researchers attributed this growing altruism to socialisation practices, but it may also be related to development of ToM, as the older children may be better at anticipating the other child's disappointment when he or she does not get any stickers and understands that the amount of stickers offered may influence what the other child thinks of the proposer. As these two aspects require second-order mentalising a more developed ToM will help this.

So, to summarise, some studies show that ToM does not influence offers made in the dictator game (Hill & Sally, 2004). Other studies, however, show that offers made depend on age (Gummerum et al., 2010; Benenson et al., 2006), which could mean that when ToM develops children become better at understanding other people's disappointment and understanding how their decision influences what other think of them.

The role of ToM in the prisoner's dilemma

The classic prisoner's dilemma involves two prisoners. They are held in separate police cells and cannot communicate with each other. They face two options; confess (defect) or not confess (cooperate). If both prisoners do not confess they will get a shorter sentence; if they both confess this sentence will be longer. However, this longer sentence will still be shorter than the sentence the prisoner that does not confess gets if the other prisoner does confess. An example of the various outcomes in a prisoner's dilemma are shown in figure 1. The best outcome for both prisoners would be not to confess and each get a sentence of 1 year. However, the prisoners do not get the chance to communicate this to each other; therefore, the safest option is to confess and not risk the 10-year sentence (Wilkinson, 2008). Though defecting is the equilibrium strategy in the prisoner's dilemma humans often "solve" the prisoner's dilemma and cooperate (Hill & Sally, 2004).

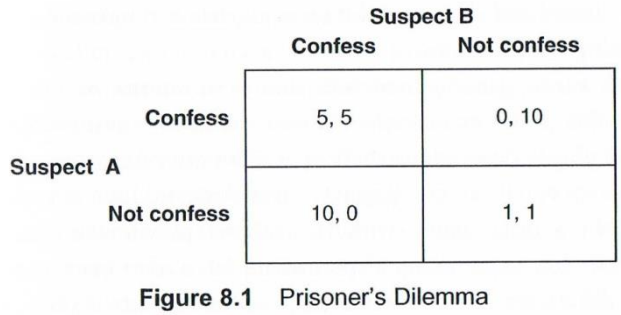

Figure 1. Outcomes in the prisoner's dilemma.

One property that might help humans reach this solution is ToM. As an ability to think about others' desires may help in understanding the fact that the other player also wants the highest payoff (first-order ToM) and that the other player is able to predict that the first player wants a high payoff (second-order ToM), a player with a higher ToM may be more likely to cooperate. More generally speaking, a higher ToM will make it easier to reason what the strategically logical response is.

Proof for this has, indeed, been found; Hill and Sally (2004) conducted a series of experiments to prove this. Behaviour in three versions of the prisoner's dilemma was observed for normally developing children and adults, in high-functioning children and in adults with autism. In one version the subjects thought they were playing against a computer and in a second version they played against a human. In a third version there was a further

manipulation, and subjects were encouraged to cooperate rather than compete with the human they were competing against; this was achieved by telling the subject that the amount of points for each player would be added up and divided at the end of the game. In this version it actually made more sense to cooperate, as payoffs would always be higher when cooperating than defecting. Each version was played sixteen times. Players were not told the game would be played more than once. Both the human opponent and the computer opponent cooperated on the first round and then followed a tit-for-tat strategy in which they copied the subjects strategy in the previous round.

As older participants have a higher ToM they would be expected to make more strategic decisions. This was indeed found to be the case, with the adults showing greater adjustments depending on the version of the game. The majority of children failed to adjust their strategy to the version of the game in which total payoffs were split between the two players. When first moves in the various versions of the prisoner's dilemma were compared there were no significant differences for the 6- and 8-year-olds, but the 10-year-olds cooperated significantly more in the encouraged cooperation task than in the computer opponent task, but not significantly more than in the human opponent task.

It is also expected that autistic adults will make less strategic decisions than normal adults. When looking at overall cooperativeness there was however no significant difference in number of cooperative responses in the human opponent version for the two adult groups (Hill & Sally, 2004). However, from the answers in the semi-structured interview it became clear that where normally functioning adults spontaneously predicted the workings of the other person's mind, autistic adults did this out of a rule-based knowledge that they should be doing so; they knew they needed to predict the other persons mind instead of spontaneously predicting it. Normally developing children seemed to distinguish more between the three versions of the prisoner's dilemma than autistic children. The difference between normally developing and autistic children was most prominent in the human opponent version. This is in line with expectations. Adults with autism were less cooperative on the encouraged cooperation task and less competitive on the other two tasks than normally developing adults. They were therefore influenced less by the type of task, which means they might apply a pre-set decision rule or pattern across all versions of the prisoner's dilemma. Normally developing children seemed to distinguish more between the three versions of the prisoner's dilemma. The difference between normally developing and autistic children was most prominent in the human opponent version. This is in line with the idea that autistic people have problems understanding other people's minds, but have no trouble understanding a computer's "mind".

From the answers in the semi-structured interview it became clear that the people with autism had the idea that the computer would be easier to predict, whereas most people without autism thought the human opponent would be easier to predict.

Hill and Sally (2004) also tested their subjects' first- and second-order ToM and tested more advanced ToM. The relationship between these results and strategic decision making showed a similar pattern, with subjects with a more developed ToM making more-strategic decisions. Performance on the second-order false belief task and decision strategy approached significance, with people who passed the second-order false belief task cooperating more than people who failed. This is probably because the child who had difficulty with the second-order false belief task had difficulty with understanding what the opponent might think about his or her intentions. Based on this understanding, the child might expect the opponent to cooperate and would therefore cooperate too; however, when they do not hold this expectation children may think competing is the better strategy. Though all normally developing children passed the first-order false belief task some children with autism failed. When the performance of autistic children on this task was compared with decision strategy it was found that people who passed the first-order belief task cooperated significantly less. This was probably caused by the fact that people who failed the task randomly choose to compete or cooperate in each round and, therefore, cooperated in about 50% of the rounds, which is higher than cooperation rates in people who actually follow a strategy. Therefore, it is likely that an ability to form first-order beliefs or a rule-based substitute is necessary to form a strategy at all. Performance on the more advanced ToM task was compared with decision-strategy. It was found that more people who did better on this task, irrespective of whether they were autistic, competed more in the human- and computer-opponent versions and cooperated more in the encouraged cooperation tasks. This means they show the expected decision strategy more often. It is, therefore, likely that mentalising ability is related to conditionally responding to the opponent.

To summarise, it seems that people with a more developed ToM make more strategic decisions in the prisoner's dilemma (Hill & Sally). Older people made more strategic decisions and people who did better on tests of ToM did too. There seemed to be no difference between autistic and non-autistic people, but on closer inspection it became clear that autistic people follow a more rule-based strategy for making their decision, whereas healthy people use their understanding of other people's minds.

Conclusion/discussion

The focus of this thesis was the influence of ToM on decision making, with a specific focus on three economic games: the ultimatum game, the dictator game and the prisoner's dilemma. The research question was: "What role does theory of mind play in economic decision making?"

ToM is the awareness of one's own mental processes and the mental processes of others (Santrock, 2004), and includes the ability to form a psychological theory about others (Verhofstadt-Denève et al., 1999). It develops with age, and various stages of development can be recognised. There are various ways of comparing people with a well-developed ToM to people with a less-developed TOM. One way is to compare younger children with older children; another way is to compare people with mental disorders such as autism and schizophrenia with healthy controls. Both of these methods were applied in the discussed literature.

As proposer in the ultimatum game people with a lower ToM seem to perform less well at making strategic decisions than people with a higher ToM. Whereas people with a developed ToM tend to offer half the amount or a little under half, people with less developed ToM tend to offer nothing or are hyperfair and offer more than half (Hill & Sally, 2004; Agay et al., 2008; Takagishi et al., 2010) and also tend to make illogical decisions in versions of the ultimatum game with several rounds (Agay et al., 2008). This means a limited understanding of others' mental processes can lead to less sensible offers, where the responder is either likely to reject the offer or the proposer gives the responder more than necessary.

It is unclear what the effect of ToM on reactions of the responder in the ultimatum game is. On the one hand some studies have found that more developed ToM leads to a more developed sense of fairness. Because of this people with a less developed ToM accept lower offers than people with a more developed ToM (Hill & Sally, 2004) and people accept lower offers in situations in which ToM does not play a role (Blount, 1995; Güroğlu et al., 2010). On the other hand ToM may not influence the decision of the responder (Takagishi et al., 2010).

In the dictator game some studies show that ToM does not influence offers made in the dictator game (Hill & Sally, 2004). Other studies however show that offers made depend on age (Gummerum et al., 2010; Benenson et al., 2006). This could mean that when ToM develops children become better at understanding other people's disappointment and understanding how their decision influences what others think of them.

In the prisoner's dilemma it seems that people with a more developed ToM make more strategic decisions in the prisoner's dilemma (Hill & Sally). Older people made more strategic decisions and people who did better on tests of ToM did too. There seemed to be no difference between autistic and non-autistic people, but on closer inspection it became clear that autistic people follow a more rule-based strategy for making their decision, whereas healthy people use their understanding of other people's minds.

So to answer the research question, although it is unclear whether ToM plays a role in every form of economic decision making, in general people with a more developed ToM seem to be better at making strategic decisions, e.g. both as proposer in the ultimatum game (Hill & Sally, 2004; Agay et al., 2008; Takagishi et al., 2010) and in the prisoner's dilemma (Hill & Sally, 2004). This is probably the case because people with a well-developed ToM have a better understanding of how other people think and react and can take this into account when making a decision. On the responder side of the ultimatum game again it is unclear if ToM plays a role, but if it does this is probably because people with a more developed ToM have a greater sense of fairness (Hill & Sally, 2004 Blount, 1995; Güroğlu et al., 2010). In the dictator game ToM may play a role, because people with a more developed ToM have a better understanding of other people's disappointment and have a better idea of how their decisions can have an effect on other people's view of the person.

So it is indeed possible that ToM influences the decisions made in simple decision-making situations such as the ultimatum game, the dictator game and the prisoner's dilemma. These games are too simple too represent most real-life economic decision-making situations, but they do offer us insight into the working of the human mind that can be very relevant in real life situations.

As most adults have a well-developed ToM the findings from the simple games can be generalised to a large proportion of the adult population and can be applied to real-life situations. As we have seen, a developed ToM enables people to consider how other people think and react and take this into account when making decisions, which in turn leads to an ability to make strategic decisions. A developed ToM can also lead to a greater sense of fairness, an understanding of other people's disappointment and an idea of how one's decision can influence the view others have of them.

The ability to take into account how others think and react of course is a very broad concept, but one that could be put into use more often by the national leaders and heads of banks. For instance, it is often presumed that lowering interest rates leads people to save less, borrow more and essentially buy more, which should have a positive influence on the

economy. However, the many interest rate decreases by the European Central Bank have not had as big an influence on consumer spending as was expected (Van Duijn, 2014). This may be predicted when one does not just consider economic logic, but also takes into account the way human beings actually think. For a lot of people the idea of having a debt and having less savings may actually be quite nerve-wracking. Therefore, they will not spend their savings or borrow money even when it is relatively cheap to do so.

A current example of how the fact that people have a sense of fairness may be economically relevant is in the situation of pay cuts. Whereas yearly salary increases were the norm for many years and pay cuts were a rare phenomenon, more recently various smaller and larger companies are now considering salary cuts. Recent examples are the proposed salary reductions at the Dutch warehouse chain Vroom & Dreesman and the salary reduction for KLM pilots (De Waard, 2015). From a purely economic viewpoint, salary cuts make sense in times of deflation and should not cause a problem; after all, when prices decrease people need less money to buy as much as they did before. However, employees tend to act with anger rather than understanding to the idea of receiving a lower salary. An explanation for this could be people's sense of fairness. They may, for example, feel that getting less money for the same amount of work is unfair.

The knowledge that people understand other people's disappointment may be taken into account when designing campaigns for collecting money for charity. In theory, giving money to charity does not make sense from the view of a selfish profit-maximising *homo economicus* as it is literally giving money away without getting anything measurable in return. However, when one takes into account people's ability to feel what other people are feeling, whether this is disappointment or another emotion, it makes more sense for people to try to help these other people. This can be, and is in fact used, in charity campaigns. For example, in campaigns for natural disasters in far-away countries a single person's personal story is often used instead of a more general description of the situation. By doing this it is easier for people to empathise and they are more inclined to donate money.

The knowledge that decisions can influence the image others have of a person should, for example, be taken into account by companies that use unethical production methods. Whereas these methods may be cheap and seem to be the most profitable option, they could damage a company's reputation and thereby the company's profits because they forgot to take into account that the image consumers have of the company also matters. This factor may for example have influenced consumer behaviour following the 2012 clothing-factory fire in Dhaka, Bangladesh. More than a hundred employees were killed in the fire in the factory that

produces clothes for various Western clothing chains, bringing to light the inhuman working conditions in this factory and similar factories (Burke & Hammadi, 2012).

The previous examples are just a selection of situations in which findings from studies on the influence of ToM in simple games could be applied to real-life situations. Though ToM is a concept that is not often taken into account in economic decision-making situations it could in fact have a great influence on economic outcomes. Therefore, it makes sense to consider real-life human beings with a developed ToM when making economic decisions.

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