THE EMERGENCE OF A THEORY OF MIND FROM INFANCY TO CHILDHOOD:

Related abilities at 12, 15 and 39 months of age

Cristina Colonnesi

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Ai miei genitori

Arcangela e Lucio

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Abstract

When do children develop a theory of mind? Is there a relationship between socio-cognitive abilities during infancy and the understanding of mental states in early childhood? The general aim of the present thesis is to investigate the emergence of theory of mind, and to examine a possible trajectory in the development of mental state understanding from infancy to childhood. Two studies are presented: the first study is an investigation on the emergence of theory of mind at the age of three years; the second study is a longitudinal investigation on the roles of pointing gestures and intention understanding in the second year of life, as precursors of theory of mind after the third birthday.

The first study examined how understandings of visual perception and intention relate to children's ability to explain actions, in terms of mental states. Children's explanations can be considered one of the strongest ways to explore their understanding of human actions. The first aim was to examine young children's understanding of perception and intention. The second aim was to examine young children's ability to explain others' actions in a psychological way. The third aim was to examine the relationship between the understanding of perception and intention and the ability to explain others' actions in terms of mental states. Eighty 3-year-olds (45 girls and 35 boys; mean age 3.3) were administered a perception task, an intention task, and an explanation task. Production of desires and beliefs explanations was evaluated on the basis of children's understanding of visual perception and intention. The ability to explain others' actions in terms of desires and beliefs is strongly related to perception understanding. Intention understanding is related to children's explanations involving inconsistent desires (as opposed to simple desires) but not to false beliefs (as opposed to true beliefs).

The second study evaluated the possibility that the pointing gesture and intentional understanding abilities at 12 and 15 months of age predict the later understanding of perception and intention, as well the ability to explain others' actions in a psychological way at 39 months of age. Thirty-five infants (17 girls and 18 boys) who participated at the study of Camaioni, Perucchini, Bellagamba & Colonnesi (2004), on the pointing gesture and intentional understanding, were re-tested at 39 months of age (mean age 38.22). At this age, children were administered a perception task, an intention task, and an explanation task. Results showed that 12-month-olds' ability in producing the pointing gesture significantly predicted later preschool mentalistic explanations of actions. Moreover, 12-month-olds' ability to understand intentions significantly predicted later preschool understanding of both perceptions and intentions.

Results of the first and second study are discussed on the basis of their contribution to investigations of an early theory of mind, and with regard to directions for future research.

Preface

My research

My research started in January 2000, when I was awarded a 4-year PhD position in "Clinical and developmental psychology" at the University of Rome "La Sapienza". Professor Luigia Camaioni was my formal advisor. My previous experience was a study on children's persuasive abilities during preschool age (Perucchini, Bonaiuto, Colonnesi & Gnisci, 2003).

When I started my PhD, I had the opportunity to participate in the National Project COFIN-MIUR on *Theory of mind and its precursors in typical and atypical development* (2000-2002), and in particular at the relative Research Unit on *Precursors to the development of a child's theory of mind: The proto-declarative pointing* at the University of Rome "La Sapienza". It was a formative research experience of two years, during which time I had the opportunity to gain experience with infant development. A longitudinal investigation on infants' understanding and production of the pointing gesture and of intention understanding was conducted. The main aim of the research was to investigate precursors of the theory of mind and their mutual relationship. This research has been recently published (Camaioni, Perucchini, Bellagamba & Colonnesi, 2004; Bellagamba, Camaioni & Colonnesi, submitted). When the research was finished I inquired about the possibility to go on with this investigation, in order to evaluate how those precursor abilities were related to a later theory of mind. Luigia Camaioni accepted my proposal, even though she warned me about the difficulties in continuing these kinds of longitudinal studies. Above all, the major risks were the attrition of participants and not choosing the appropriate age at which to observe a specific ability. However, she let me carry on with this project because of its relevance to the existing research on theory of mind.

I started to collect data for my research in the beginning of March 2003 and I finished in September 2004. I decided to carry out two studies. The first study investigated three-year-olds' understanding of perception and intention, and the role of these two abilities in the capacity to explain others' behavior in a psychological way. The second study evaluated whether, and how, the abilities investigated at the age of three could be predicted from previous capacities such as the pointing gesture and intention understanding at 12 and 15 months of age. I made my observations with 82 children of three years of age, 37 of whom were part of the sample in the previous research of Camaioni et al. (2004).

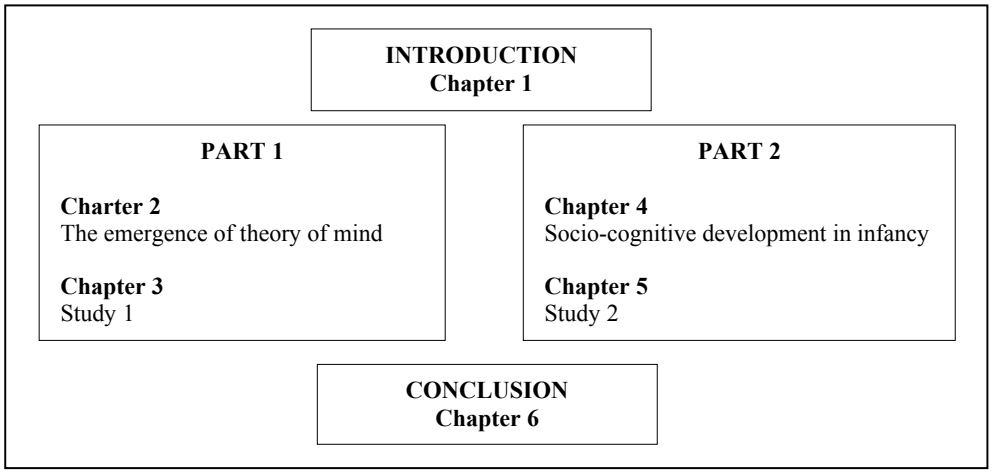
Structure of the book

The book is comprised of two main parts, preceded by an introduction and followed by a general conclusion. Each part consists of a theoretical chapter and a methodological chapter. In the theoretical chapters, the literature that formed the basis for the hypotheses of the study is presented and discussed. In the methodological chapters, the hypotheses, methods, results and conclusions for the present research are presented. Figure *a.* shows the main structure of the book.

Chapter 1 is a brief introduction about the concept of a Theory of mind. After a short description of the main interest of theory of mind, I briefly present the major theoretical positions on how the theory of mind develops during infancy and childhood. The main aim of this chapter is to provide some different perspectives of the same phenomenon, and how they can explain the trajectory in the development of theory of mind, from infancy to childhood.

The first section is dedicated to the emergence of theory of mind at the age of three years. Defining the theory of mind as the ability to understand (predict and interpret) behavior in a psychological way, many authors (Wellman, 1990; Wellman & Woolley, 1990) have reported the age of three as the beginning of a developmental process that allows the child to understand mental states. Chapter 3 is a theoretical contribution, based on prior research that investigates development of the theory of mind at the age of three. In particular, the understanding of perceptions, desires, beliefs and intentions are considered. A general picture about when and how three-year-olds are able to understand mental states is outlined.

Figure A. Main structure of the book



In Chapter 3, the first study is presented. Study 1 is an investigation of three-year-olds' ability to understand mental states. The main purposes of the study were: (1) to evaluate whether the understanding of perception precedes the understanding of intentions; (2) to evaluate children's ability to explain others' actions in terms of mental states, particularly in terms of inconsistent desires; (3) to evaluate whether there is a relationship between the understanding of perceptions and intentions and the ability to explain actions in terms of mental states. The study presents a general picture of young children's abilities to understand and explain mental states and of the concurrent relationship between these abilities.

The aim of the second section of this thesis was to evaluate the relationship between socio-cognitive abilities during infancy and the later development of theory of mind. Chapter 4 presents the main studies on socio-cognitive abilities during infancy, in order to provide a general picture of how infants are able to understand other people as intentional agents. This ability is considered a prerequisite, or a precursor, of later theory of mind. Although this possibility has been well documented in the literature in a theoretical way, and on the basis of indirect evidence (autism, and primatology), there is not much empirical evidence to support such a claim.

In Chapter 5, a longitudinal study is presented with the purpose to evaluate whether precursor abilities at 12 and 15 months of age can predict the later understanding of mental states at the age of three. The main purposes of the study were: (1) To evaluate whether children's ability in the pointing gesture at 12 and 15 months of age predicts their later theory of mind at 39 months of age; (2) to evaluate if children's ability to understand intention at 12 and 15 months of age is related to their theory of mind development at 39 months of age. The study attempts to assess whether a continuum exists in the development of social understanding from infancy to childhood.

In the final part of the present book, a general discussion of the first and the second studies is presented. The main results are discussed in light of existing evidence. Furthermore, the limitations of the studies and recommendations for future research are presented.

Chapter 1

Theory of mind: a brief introduction

1.1 Introduction

In the last twenty years, the investigation, within developmental psychology, of children's ability to understand mental states (or mind-reading) has been called "theory of mind" or "folk psychology". As reported by Flavell (1999, p.23):

"Theory-of-mind researchers try to find out what children know about the existence and behavior of the different types of states that inhabit the mind and also what children know about how mental states are causally linked to perceptual inputs, to behavioral inputs, and to other mental states".

A logical reaction of someone reading this definition may be to think that the investigated ability is just a kind of philosophical speculation. In fact, trying to discover what a theory of mind is, exactly, seems quite a difficult goal. Wellman tried to imagine the absence of a theory of mind (1985; pp. 169-170):

"Imagine a hypothetical being who knows nothing of internal mental states… Such a being might be able to remember, know, and learn, but it would possess no understanding of these activities. The social world, the world of self and others would be an impoverished place for such a creature… Persons would be seen and heard, but there would be no notion of a backlog of ideas and beliefs organizing their actions and personalities... No one could be construed as possessing private persona; public present behavior would have no deeper meaning. The concept of a lie would be inconceivable as would notions such as illusions, beliefs, hunches, mistakes, guesses, or deceptions."

We think, desire, intend, and emote throughout the life course. That we continuously experience these mental states makes the possibility of their absence nearly incomprehensible. So, how is it possible to explore this understanding? Usually we think about other people's mental states in the context of observing their behavior and interpreting it. For example, if we see someone crying, we know that this is probably because this person is experiencing a feeling of sadness. In the same way, we know that we behave on the basis of our own mental states. During social interactions, we coordinate our behavior based on inferences about our own mental states and those of others. That is, we are able to understand mental states by observing another person's behavior and interpreting it, while also making attributions for our own behavior.

Several authors (Perner, 1995; Perner & Wimmer, 1985; Wimmer & Perner, 1983) point to the fact that simply understanding others' mental states is not enough in order to have a mature theory of mind. It is necessary to understand that mental states have representational contents. Thus, it is necessary to understand that the self and others may perceive reality in different ways. For example, if we know that there is some chocolate in a cupboard, and we see a character going to take the chocolate in the cupboard, we can simply explain this phenomenon on the basis of the relationship between the behavior and the location of the chocolate. In this case it is not necessary to contemplate the character's representation. Yet, if we see the character going to take the chocolate in another place (a drawer) we can explain the behavior only on the basis of the character's wrong representation of the situation. Thus, in order to have a theory of mind it is necessary to be able to construct representations of others' mental states.

Research on theory of mind has been a prosperous area of study in developmental psychology. Often considered the inception of theory of mind research is the pioneering work of Premack and Woodruff (1978) on chimpanzees' ability to predict the behavior of a human person in specific situations. The authors demonstrated that chimpanzees were able to understand mental states of human agents and to consequently predict their behavior. They called this ability "theory of mind". Some years later, Wimmer and Perner (1983) developed the first task used to evaluate children's understanding of mental states. Their experimental paradigm was called the *false-belief task*, and it was destined to become famous in the following years. This task and several other tasks evaluating the same ability (false-belief understanding) will be described in Paragraph 2.3. The authors showed that four-year-old children were able to solve this kind of task, but not children aged 2-3 years. Several authors have replicated this

study, using different methods of evaluation, but all the results generally confirmed the original study.

In the same period, some authors like Bretherton, McNew and Beeghly-Smith (1981) and Wellman (1990) conducted experimental and naturalistic research on children's understanding of mental states such as desires, perceptions, beliefs, and intentions. Two important congresses took place in 1986, the first at the University of Toronto, organized by Astington, Gopnik and Olson, and the second at the University of Oxford, and organized by Harris. The contributions of these two congresses were collected in a volume, *Developing Theories of Mind* (Astington, Harris and Olson, 1988), which represents the state of investigation into theory of mind during that period, and the starting point of subsequent studies (Camaioni, 2001). After this first volume, many others have been published, as have hundreds of articles investigating how children acquire a theory of mind. In the Italian literature the volumes of Battistelli (1995), Camaioni (1995) and Liverta Sempio and Marchetti (1995; 2001) are relevant.

It is not possible to talk about theory of mind without first mentioning Piaget's theory and his research. Long before the emergence of theory-of-mind research, he mentioned some difficulties that young children have in understanding mental phenomena. At the beginning of their development children are cognitively egocentric (Piaget, 1929), because they are not aware of the existence of different conceptual, perceptual and affective perspectives. They know neither that they possess these perspectives, nor that other people have them, as well. Moreover, they are not able to understand that their perspective may be different from the perspectives of others. They acquire the ability to distinguish their own perspective from that of other people only gradually, from the preschool to the school period. According to Piaget, mental phenomena are quite confusing for young children because they are insubstantial and not obvious. In fact, young children have difficulties in understanding the nature of mental entities; they think that mental entities such as dreams and thoughts are tangible or physical. For example, young children tend to think that dreams are objective pictures in public view. Thus, Piaget argued that children employ, in the beginning, a realistic reasoning. In the same way, they have difficulty in explaining human action using psychological reasoning. For example they often incorrectly apply psychological reasoning to physical objects, or they apply physical reasoning to explain human acts. Research in children's ability to apply psychological reasoning continued after Piaget. Today there is a general agreement among researchers that children are not totally egocentric as Piaget believed, and that some abilities, like the understanding of mental states, emerge before the age proposed by Piaget. However, contemporary research has also found that

the abilities and psychological knowledge investigated by Piaget increase with age, much as he said they did (Flavell, 2000).

In the following paragraphs the main theoretical positions about the development of a theory of mind during childhood and during infancy are discussed. The main aim is to present the theoretical points of view that have guided the research presented in the following chapters. Arguing in favor of one of these theoretical positions is both too complicated and unproductive for the present discussion. However, they are reported in order to provide different perspectives with which to look the same phenomenon.

1.2 Theories of theory of mind

In the last 20 years, three main theoretical positions have been utilized to explain how and when children became able to understand mental states: 1) the Theory-theory, 2) the Modularity theory and 3) the Simulation theory.

The Theory-theory. One of the most common theories that explain the development of children's knowledge about the mind is the Theory-theory. According to this approach, the knowledge about the mind develops in the same way as an informal "everyday" theory (Gopnik, 2003; Gopnik & Meltzoff, 1997; Gopnik & Wellman, 1994; Perner, 1991; Wellman & Gelman, 1997). Children build their theory of mind in the same way that adults build their scientific theories through reasoning processes. This means that children make hypotheses and rules that are useful in making predictions, and in explaining or interpreting new evidence, in order to understand their world. When the evidence does not fit with the children's actual theory, they start to formulate alternative theories. If an alternative theory is able to explain the evidence in a better way, it replaces the existing theory.

In accordance with the philosophical tradition of Brentano, Wellman and Bartsch (1988) proposed a system of reasoning employed by adults in order to explain actions. This means that when a person sees somebody else doing a specific action, this person is interpreting that behavior in an intentional way. Figure 1.1 outlines the critical aspects of everyday belief-desire reasoning and the connections between them.

On the basis of this reasoning, intentional actions are the outward manifestations of internal mental states. People explain intentional actions by referring to the desires and beliefs of the actor. Underpinning this reasoning is the premise that to do something intentionally, it is

necessary to have at least a *desire*, and in order to engage in the act it is necessary to *believe* it will help in satisfying the desire. An easy example of this construct is: "Why does Paolo go to buy an apple? He wanted to eat an apple and he thinks that he can buy one".

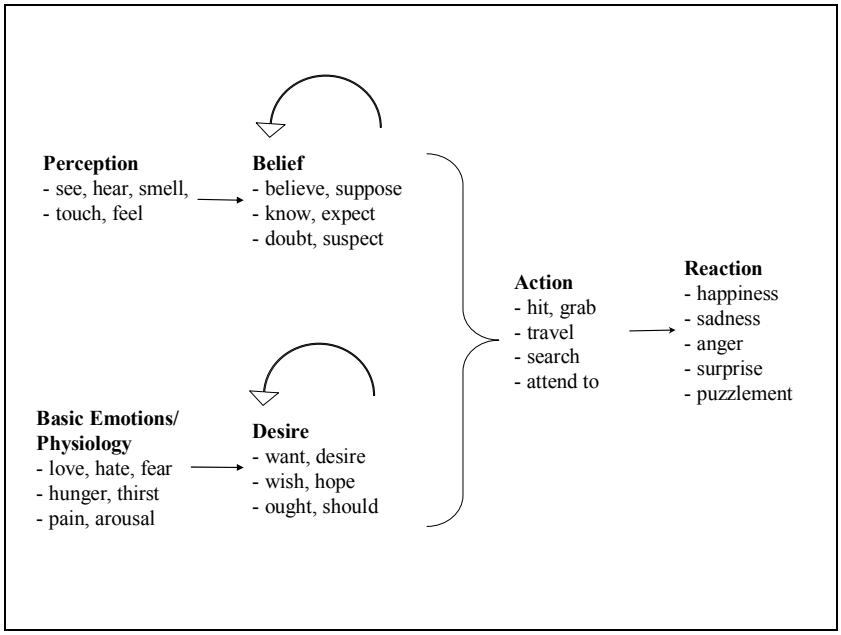


Figure 1.1 Scheme for the interpretation of actions on the basis of a belief-desire reasoning (Wellman & Bartsch, 1988)

Analyzing the scheme more in detail we have the following mental constructs:

- *Perceptions:* Perceptions provide input into the mind from an extra-mental source. This input comes from the external world of real objects, spaces, and events. Perceptions feed beliefs.
- *Physiology and basic emotions:* Physiology and basic emotions provide input into the mind, but they are internal to the body. This input feeds desires.
- *Beliefs:* Beliefs are mental attitudes that a person has toward a particular proposition. They are often derived from information that is extracted from perceptions, but they can also stem from other beliefs. Beliefs are about some content, a content that can be stated as a proposition. For example, Bill thinks that "the cat is there". The proposition provides information about the content of the belief.

- *Desires:* Desires are generally caused by physiological states or basic emotions, but they can also be caused by others' desires. As well as beliefs, desires can be construed as a propositional desire. For example Bill desires "a new computer game".
- *Simple actions:* Simple actions are the result of desires coupled with beliefs.
- *Reactions:* They are the result of an action. The outcomes are appropriately characterized in terms such as "success", that is, whether or not the outcomes match the actor's goal. Wellman and Bartsch report three possibilities: 1) the outcome can satisfy or fail to satisfy the actor's desires, so the goal is either achieved or it isn't. Consequently, the actor can be happy or unhappy; 2) the outcome can accord with or fail to accord with the actor's beliefs. The actor can believe something but that something does not occur, resulting in surprise; and 3) the outcome can fall outside the scope of the actor's intentions. Thus, when we see somebody doing a specific action and having a specific reaction, we can infer the previous desires and beliefs that "urged" the action. In the same way, knowing something about somebody's perceptions, beliefs, emotions, or desires can help us to predict which action this person will do. We do so using a desire-belief reasoning. Although, as the authors admit, this description of everyday psychology is oversimplified, it suggests the importance of the link between intentional actions and mental states as beliefs and desires in everyday reasoning on human actions (Bartsch & Wellman, 1989).

It is interesting to know when children start to engage in reasoning of this general sort. When they are able to do so, they show a mentalistic interpretation of action rather than a behavioral or a physical one. Wellman (1990) argues that they start at the age of three. Bartsch and Wellman (1995) identified three main steps in children's development of theory of mind. An overview of these steps is presented in table 1.1.

The Theory-theory is probably the point of view that is most similar to the constructivist theory of Piaget, in terms of the formative role that the experience plays in children's theory of mind development. In fact, experience provides young children with information that are useful to improve their present theory of mind. The role of experience is similar to the equilibration theory of Piaget (Flavell, 1999), because it engenders disequilibrium and, eventually a new and evolved state of equilibrium. Children assimilate evidence for their actual theory, but when the counterevidence is too strong, they experience a disequilibrium. Subsequently, the child's own cognitive structures accommodate to the new information and the result is a new theory.

Table 1.1 Milestones in children's developmental itinerary toward the adult theory of mind.

Steps	Age	Ability
Desire psychology	2 years	Children have an elementary conception of simple desires, emotions and perceptual experience or attention. They are able to understand mental states in a mentalistic way. That is, they understand that people have an inner experience with objects but they are not able to understand that people mentally represent these things.
Desire-belief psychology	3 years	Children start to talk about beliefs and thoughts, and they start to understand that these things are representations. Thus, they can be true or false and they can be different for different people. However, at this age they still prefer to explain behavior in terms of desires rather than beliefs.
Belief-desire psychology	4 years	Children's understanding of a mental state is more similar to an adult's understanding. They are able to understand and to explain actions in terms of desires and beliefs, using them jointly.

It is important to note that proponents of the theory-theory have produced several important investigations in recent years, finding important evidence about how the theory of mind develops during childhood. However, the metaphor of the child as a little scientist could be considered, today, as less useful. As noted by Surian (2001a) the comparison proposed by the theory-theory is not between the child and the "normal scientist" described by Thomas Kuhn, but with geniuses such as Galileo, Newton and Darwin. In fact, children are destined to uncover great discoveries during their development that cannot be compared with the normal development of a scientific investigation. Already at the age of three years, children attain such important theoretical revolutions that it is difficult to believe that there is not an innate component.

The modularity theories. The general claim of the modularity theory is that cognitive development is a system with an "architecture", including specialized subsystems that serve specific information-processing purposes. These subsystems are also defined modules, and they emerge at particular points in development as a result of brain maturation. A module can be defined as a component of the mind or brain. It is a mechanism inside the mind that is responsible for a specific competence (Segal, 1996). These modules are domain-specific and they have a representational structure. It is necessary to talk about modularity *theories*, and not

of a single theory, because there are extreme positions (Fodor, 1983) as well as more moderate positions (Coltheart, 2000) inside the same perspective. The main contributions inside this approach are those of Leslie (1987; 1994; 2000) and Baron-Cohen (1994; 1995). It is important to note that modular theorists initiated theory of mind research on individuals with autism (Baron-Cohen, Leslie & Frith, 1985; Leslie, 1987). They proposed that social and communicative deficits of autism are a result of neurological impairment to the module of theory of mind. Here the theory of Leslie is briefly presented, while the theory of Baron-Cohen is presented in the next paragraph, as it is relevant for the development of possible precursors of a theory of mind during infancy.

Two main topics are central to Leslie's theory: pretend play and meta-representation. Leslie argued that both of these abilities develop at about 18-24 months of age as a result of a specific module called ToMM (Theory of Mind Mechanism). In his more recent theory, Leslie proposes three modules (1994). Their emergence is determined by the maturation of the child's cognitive architecture, and they can develop in a parallel fashion, even if normally their development emerges in a sequential way. The three mechanisms put forward by Leslie are:

- *ToBy (Theory of Body mechanism).* This module emerges at about 3-4 months of age. It processes information about the behavior of physical objects. It allows the infant to recognize that agents have an internal source of energy that allows them to move on their own. It receives information from the range of sensory modalities, and it is located in a central position in the information-processing architecture.
- *$ToMM_1$ (Theory of Mind mechanism).* This module emerges at about 6-8 months of age. It processes information about agents and their action toward objects. It deals with the "intentionality" of agents, instead of their mechanical properties. Thus, this module is suitable for processing events such as joint attention (see Chapter 4, paragraph 4.2), and it allows infants to connect their action with that of other persons in simple, goal-directed ways.
- *$ToMM_2$ (Theory of Mind mechanism).* This module emerges during the second year of life. It processes information about agents and makes the infant able to perceive agents as holding "propositional attitudes", or mental states as pretending, imaging, or believing. In sum, this module is responsible for meta-representation and enables children to engage in pretend games.

In general, modularity research is largely based on the study of autistic children and the study of normal development during the infancy. As reported by Surian (2001b) the innativistic theories are able to give a good explanation of three important facts: 1) the universality of some

central concepts of the theory of mind, 2) the precocity of their emergence, and 3) their absence in people with an atypical development (e.g., autism). Less considered is how children develop different abilities after the second year of life, such as their understandings of desires and beliefs. For example, according to Leslie, the $ToMM_2$ mechanism processes all of the individual's mental attitudes (all kinds of mental states). Thus, it does not explain why, in the beginning, children are better able to understand desires than beliefs, or true beliefs instead of false beliefs.

Fodor (1992) proposed a theory in order to explain children's understanding of mental states during childhood. He argued that three-year-olds have a Very Simple Theory of Mind (VSTM) that includes only desires and beliefs understanding. VSTM has two main principles: "*H1:* Predict that the agent will act in a way that will satisfy his desires. *H2:* Predict that the agent will act in a way that would satisfy his desires if his beliefs were true" (p. 286-287). According to Fodor, the difference between 3- and 4-year-olds is that younger children use H1 whenever it affords a unique behavioral prediction, and they use H2 only when this uniqueness condition is not satisfied. Differently, 4-year-olds and adults use H1 when the beliefs that the agent is acting on are true. When they are not sure about it, they use H2. This is the reason why 4-year-olds are able to solve a false-belief task and younger children are able to do so only when they are prompted to use H2. Moreover, while young children are able to recognize only desires and beliefs, older children and adult are also able to recognize other mental states, such as hunches, hopes, or yens.

It is clear that, in modularity theories, experience does not play a fundamental role in the development of a theory of mind. The specific abilities come "on line" as the child's brain matures. The only role of experience is to promote the operation of these mechanisms, but it does not determine their nature.

The simulation theory. This approach has been proposed by Harris (1992). From the perspective of simulation theory, children are aware of their mental states and they use this awareness to infer mental states of other persons. They do so through a kind of role-taking or simulation process. That is, the person pretends to be the other person and to have the same mental states as the other person. Based on this, the child makes some prediction about what the target might do (Gordon, 1986; Goldman, 1989). According to this approach, what develops is the ability to engage in this kind of simulation, and to make it more accurate. This simulation process allows the child to acquire socio-cognitive knowledge and skills. In a recent work,

Harris (1996) gives an alternate explanation of the temporal lag between the understanding of desires and beliefs, proposed by Bartsch and Wellman (1995). According to Harris, at first children are able to conceive of other persons as agents with goals. Only later, starting by the age of three, they construe people as epistemic subjects. In this way, they move from a desire psychology to a belief psychology. The development of a desire-belief psychology is attributable to an increasing proficiency at conversation involving the deliberate exchange of information. In other words, starting by the age of three years old, children's conversation ability develops because they increasingly engage in conversations. This gives them the opportunity to experience others' points of view. Moreover, children are confronted with what other persons think and believe, and with the possibility that these mental states could differ from what they know and think (Harris, 1996). However, it is not clear if conversational competence is a precondition only for belief understanding or also for the earlier understanding of desires. If this is the case, the question of why a desire-based perspective emerges earlier is not solved, from a simulation point of view. Harris (1992) also explored children's failure in the false-belief task. To simulate the different desires or beliefs of somebody else, the child must ignore his or her own state and the reality of a situation, while also imagining the mental states of the other person. Thus, children's simulations operate against two main default settings: the mental state of the self and the state of the "real world".

Simulation theory is in agreement with the theory-theory approach, in that both approaches assume that experience plays an important role in the acquisition of children's social skills, and consequently of a theory of mind. Simulation theory also stresses the role of imagination and of pretense in children. Harris (1996) argued that pretend play, so common during childhood, does not disappear in adult age. We continue to use it in our ability to empathize and understand others' behavior. In contrast to the theory-theory, simulation theory emphasizes the fact that there is no theory behind our understanding of mental states, but instead a natural predisposition to be "in the role of" the other person. Thus, simulation theory proposes that the understanding of our own mental states precedes the understanding of others' mental states, while for the theory-theory both understandings emerge at the same point in time, as the result of the maturation of a theory.

1.3 Theories of mind during infancy

As mentioned previously, many recent investigations have focused upon the first years of life, in order to evaluate whether it is possible to find some "roots" of a theory of mind during infancy (Camaioni, 2001; Moore, 1996). It is clear that, already in the first year of life, infants show the beginnings of social-cognitive ability. There are three main theoretical positions that have considered a possible relationship between abilities during infancy and childhood and the later development of a theory of mind (see also Camaioni, 2001; Moore, 1996): the Piagetian theories, the Modularity theories and the Matching theories. According to Camaioni (2001), all these three theoretical positions share two main assumptions. First, if it is true that before the age of 4 years is not yet present a complete and exhaustive theory of mind, it is also not true that before this age there is no theory at all. Second, it is possible to study the emergence of a theory of mind in children aged 2-3 years. To do this, it is necessary to use specific experimental observations that can work with children. Also, naturalistic observations are useful in order to evaluate the development of social comprehension during the infancy.

Piagetian theories. Piagetian theories emphasize social information-processing models and the influence of the social world. Frye (1991), Tomasello (1995), Russell (1996) and Camaioni (1997) can be considered as proponents of this approach. Frye argued that when infants are able to understand means-ends sequences of action, they also start to differentiate the social- from non-social world. He argues that gestures and vocalizations that infants and other people perform during social interactions lead the infant to attribute intentions to others, connects these actions to the discovery of the mind (1991). Tomasello points to the fact that at 12 months of age infants are able to differentiate, in their behavior, between means and ends, and this leads them to understand intentional behavior (1995). In agreement with Frye, Tomasello emphasizes the importance of experience in intentional action. Russell focuses on the concept of "agency" (1996). This refers to the knowledge of the relation between the self, as somebody who is having an experience, and the object. Russell claims that the infant experiences his or her own agency in relation to the world. In other words, through social interactions infants develop the understanding of agency in both the self and others. This experience leads to the understanding of mental states. Camaioni (1997; 2001) focused her attention on intentional communication. She claimed that declarative communication (especially through the pointing gesture) might be considered as a first understanding of the mind. Her position will be addressed again in Paragraph 4.2. In sum, what is central to the Piagetian theories is infants' direct experience with

objects and agents early in the second year of life, which is equivalent to the Piagetian sensorimotor stages 4 and 5, with objects and agents. This experience is considered the starting point of a more complex understanding of human intentionality or agency.

The modularity theories. Modularity theories have been partially described in the previous section (1.2). The two main proponents of this approach are Leslie and Baron-Cohen. Leslie's position has been already presented. The theory of Baron-Cohen gives special attention to the detection of eye direction (Baron-Cohen, 1994; 1995; Baron-Cohen & Ring, 1994). In fact, eyes are particularly important for the understanding of other people as intentional agents. He agrees with Leslie's claim for a Theory of mind module (ToMM), but he considers the idea of the ToBy mechanism too non-specific, because it does not make a distinction between the agent and the object. In addition to the ToMM, Baron-Cohen proposes the existence of three, earlier-developing modules. Figure 1.2 shows the mind-reading system, with the four phases proposed by Baron-Cohen (1991).

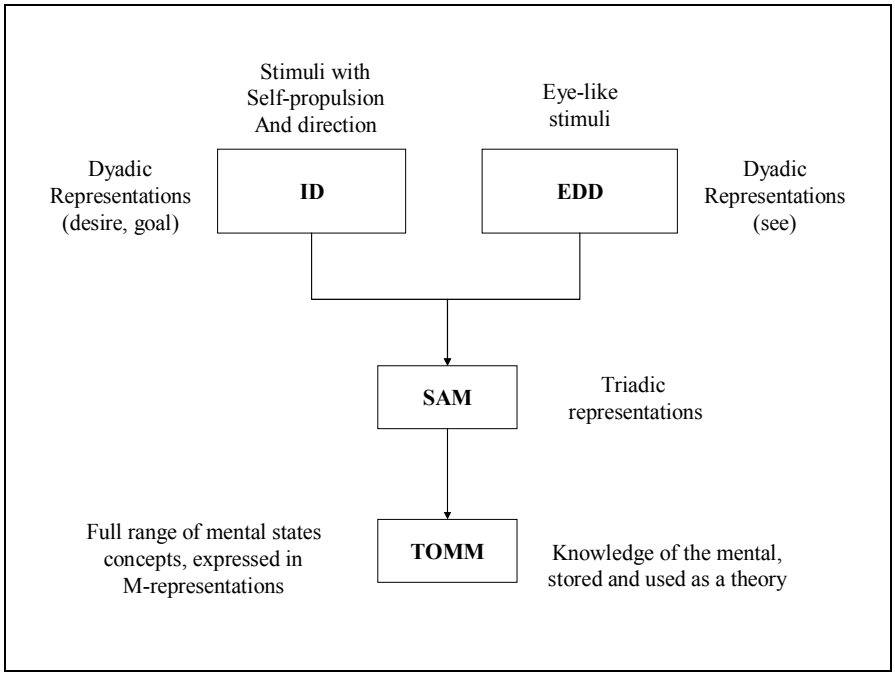


Figure 1.2 Baron-Cohen's model of the development of theory of mind (1991).

ID (Intentionality Detector) and EDD (Eye-Direction Detector) are active already in the first year of life. They allow the infant to understand dyadic representations of an agent's behavior with an object, through an intentional relation. The agent could be the self as well as another person, and the object can be inanimate as well as an agent. Infants, in this period, are already able to distinguish between the self and another person.

SAM (Shared Attention Mechanism) emerges toward the end of the first year of life, and is the mechanism responsible for shared attention. "Its function is to identify if you and another mechanism are both attending to the same thing" (Baron-Cohen, 1994, p. 530). This mechanism takes information from the ID and the EDD and it is responsible for triadic representations that are formed by embedded dyadic relations. The last module, the TOMM, is similar to the one proposed by Leslie. However, he points to the important role of the detection of eye direction as an early social ability that precedes and predicts the later theory of mind. In his theory, the triadic interactions made possible by the module SAM are the first input for the activation of the Theory of mind module (TOMM). Thus, SAM could be considered as a precursor to a theory of mind.

The matching theories. Matching theories are more recent than the first two perspectives. They call attention to the understanding of equivalence between the self and another person, as a starting point for mental understanding. This equivalence is more evident when, for example, the infant and the adult are both psychologically engaged in the same activity. This can be considered a matching situation. During this kind of situation, infants can understand that they and other persons are the same and they both can have the same kind of experience with objects (Moore, 1996). The main exponents of this approach are Meltzoff and Gopnik (1993) and Corkum and Moore (1995). Meltzoff and Gopnik point to the role of imitation as a precursor to later theory of mind (1993). They claim that infants are, quite early, able to understand a cross-modal equivalence between the actions of another person and the proprioceptive experience of that same action. These experiences lead infants to understand that others are "like me". As a demonstration of this phenomenon, Meltzoff and Moore (1977; 1983) reported on neonates' ability to imitate facial expressions. The authors hypothesized the presence of an innate, amodal body scheme. At the end of the first year of life infants start to imitate what other persons do with objects. This allows them to understand the equivalence between the self and another, in actions directed toward objects. This equivalence in movements of the body leads the infant to

understand the equivalence about psychological states. Also Corkum and Moore (1995) claim that matching situations, in which the infant and the adult are involved in the same activity, enable the infant to understand a similarity between self and other. However, Corkum and Moore argue that only when infants are able to understand both the information of the first and of the second person can they attribute a full psychological relation to the self, the other, and their equivalence. This ability is not yet present at the beginning of the second year of life, but only at the end of infancy.

1.4 Conclusion

Concerning the way in which children develop a theory of mind during the childhood, there are three main positions in the literature. The debate is between those who argue that mental understanding is based on the building of an implicit theory (Wellman, 1990; Perner, 1991; Gopnik & Wellman, 1992), those who propose a simulation account (Harris, 1992), and those who endorse modular development (Leslie, 1994; Baron-Cohen, 1995). The first two positions share a constructivist approach, in which nature and nurture collaborate together in the building of a theory of mind. However, there is also an important difference between these two positions. According to the theory-theory, children start to understand their own and others' mental states at the same time, as a result of the development of their theory. Differently, the simulation theory argues that children understand others' mental states using a simulation process. This process implies that they can already recognize these mental states, on their own. Thus, the ability to understand their own mental states should develop *before* the ability to understand others' mental states. Some authors have argued that it is quite difficult, and even useless to gather evidence that supports one of these theories over the other (Nichols & Stich, 2001).

In contrast to the other two positions, the modularity approach stresses innate influences. It could be argued that the basic disagreement is between proponents and opponents of modularity (Camaioni, 2001). However, in the theory-theory we can also find some innate hypotheses about children's development of a theory of mind, for example the theory proposed by Gopnik and Meltzoff (1997). According to Gopnik (1988) and Gopnik and Meltzoff (1997) the development of a theory of mind starts in early infancy. They argued that infants are born with initial innate theories, and in early infancy they begin to change and revise them. Thus, the matching theory of Meltzoff and Gopnik, even if considered from a Piagetian perspective, also takes into consideration some important, innate aspects of development. Also some other proponents of the

theory-theory, like Wellman and colleagues (Dunphy-Lelii & Wellman, 2004; Phillips, Wellman & Spelke, 2002; Wellman, Phillips, Dunphy-Lelii & LaLonde, 2004) have recently focused more attention upon infancy.

All the three approaches about theories of mind during infancy discuss the possibility that some of the abilities that develop during the first two years of life are a manifestation of the infant's understanding of others' intentionality. Moreover, they acknowledge the possibility that these first abilities are the "roots" of a later theory of mind. However, some important differences are present between the three approaches. One of the most important differences is the proposed period of emergence of the important precursors. For the modularity theory, the first important precursor of a theory of mind is the detection of eye direction inside a triadic interaction. Thus, already at the end of the first year of life it is possible to observe a potential precursor. Moreover, although the child manifests this ability in an interactive context, it develops because of the maturation of the cognitive system. Differently, Piagetian theories consider relevant the social information-processing models. Infants start to discover the mind in interactions with persons and objects. The most important period is between 10 and 15 months, when they are able to differentiate in their behavior between means and ends. Finally, the matching theory emphasizes the infant's understanding of the similarity between himself and the other. Although Meltzoff and Gopnik recognize a neonatal form of this ability due to innate body schemes, the relevant period stressed by the authors as being important for the understanding of intentionality is the second year of life. Similarly, Moore and colleagues noted that it is possible to find a beginning of theory of mind development only at the end of the second year of life.

Examining all the theoretical positions about the development of a theory of mind during infancy and childhood, it is possible to distinguish a Piagetian branch that encompasses the theory-theory, the simulation theory, and the matching theory, as well as the research of several authors (like Camaioni, Tomasello and Carpenter). In another branch, there is the modularity theory that stresses the innate components of development. In all these positions there is a general agreement that, in early childhood, children develop a theory of mind and that it may be possible to find some precursor abilities during infancy. However, this possibility still lacks sufficient empirical evidence. Meltzoff (1995, p. 839) explained that:

"There is a keen interest among both psychologists and philosophers (Campbell, 1994, 1995; Fodor, 1992; Goldman, 1992, 1993; Gordon, 1994) in the aboriginal roots of children's understanding of mind. Several nonverbal abilities in infancy have been proposed as candidates, including: symbolic play and metarepresentations (Leslie, 1987; 1988), joint attention and social referencing (Baron-Cohen, 1991; Butterworth, 1991; Wellman, 1990), and crossmodal representation of others as "like me" coupled with body imitation" (Meltzoff, 1990; Meltzoff & Gopnik, 1993; Meltzoff & Moore, 1995).

Additionally, Wellman, Phillips and Rodriguez (2000, p. 896) noted that:

The depth of understanding evident in 3-year-olds makes obvious that even younger children must have some intriguing psychological conceptions. Some authors suggest that the onset of intentional communication, social referencing, and pointing-gesturing mean that even year-old infants demonstrably construe people in deeply psychological fashions. But that conclusion is controversial (Baldwin & Moses, 1996; Moore & Corkum, 1994; Wellman, 1993) and at the least unproved.

Considering these reports, an important step for the future of theory-of-mind research is the construction of a bridge between infancy and childhood periods of development. As proposed by Flavell (2000), this means not the discovery of new abilities, but a better explanation of the abilities that we already know. After sufficient knowledge has been attained regarding the emergence of a theory of mind during childhood, it is interesting to evaluate whether there is a relationship between infants' social-cognitive abilities and later abilities during childhood.

PART 1

Three-year-olds' understanding of mental states

Cristina Colonnesi

Chapter 2

The emergence of a Theory of mind

2.1 Introduction

The aim of this chapter is to point out that the age of three represents a crucial phase in children's understanding of mental states. The literature reports two main reasons for this contention. First, beginning in the second year of life, children start to use their language in a mature way in order to talk about desires, emotions, and beliefs. Even if they have only basic linguistic skills, it is an important tool to express the way they understand human behavior (Astington, 2001). Second, during the third year children start to represent mental states as mind entities. Thus, they start to make meta-representations of the world. Given this, the possibility is not ruled out that children are able to understand mental states before the age of three years, or that some precursors of this ability are present. This argument will be discussed in a more detailed way in the second part of this thesis.

Several studies, beginning in the late 1980's, investigated how children are able to understand everyday behavior in a psychological way. This means to understand human actions as a result of internal psychological states, such as beliefs, desires, intentions, or wishes. One of the first studies in this direction was conducted by Wellman and Bartsch (1988). They investigated 3-year-olds' ability to predict behavior when they are given information about an actor's mental states. Different kinds of stories were employed in order to control various alternative interpretations. Children appropriately predicted actions on the basis of given information about the character's beliefs and desires. Moreover, they were able to distinguish beliefs as internal mental states, separate from desires. The authors' conclusion was that young children were able to predict others' behavior, based on information about their mental states.

In a second study, Bartsch and Wellman (1989) evaluated children's ability to explain behavior in terms of desires and beliefs. Children of 3 and 4 years of age, and adults were asked

to explain the actions of story characters. Three different kinds of stories were used. *Neutral stories* presented a simple action, such as "Here's Jane. Jane is looking for her kitten under the piano. Why do you think Jane is doing that?" In *Anomalous-desire stories*, the character performed an action that was opposite to his/her preferences; an example was "Here's Beth. Beth hates apples. But she's taking a bite out of this apple. Why do you think Beth is doing that?" In *Anomalous-belief stories,* the character performed an action opposite to the real state of affairs, such as "Here's Sam. This is a rock that looks like a peanut. But Sam is putting it in his mouth. Why do you think Sam is doing that?" Children's explanations of actions did not differ from adults' explanations, in terms of their dependence on a psychological belief-desire framework. That is, 3-year-olds were just as good as 4-year-olds and adults in explaining the character's actions in terms of beliefs, desires and other psychological states, and they did not use many behavioristic explanations. It was interesting that more than half of the 3-year-olds spontaneously mentioned desire and belief terms in their explanations. Thus, in their third year of life children already utilize these mental states in their explanations of others' actions. Another important result of this study was that more than half of the 3-year-olds explained an anomalous action at least once, by attributing a false belief to the actor. This finding suggested to the authors that 3-year-olds can explain actions via false beliefs, although they fail to correctly predict actions based on false beliefs.

Bartsch and Wellman (1995) also investigated children's use of mental-state terms in their everyday talk. Nearly 12.000 uses of desire and belief terms, found in transcripts of at-home conversations of 10 children between the ages of 2 and 5 years, were examined. Results showed that children start to refer to a character's desire, with terms such as "*want",* quite early, before their third birthday. Differently, they later start to refer to beliefs, with terms such as "*think"* and "*know"*, just before the third birthday. Moreover, two-year-olds can clearly distinguish their own desires from the desires of somebody else, but only at the age of three are they able to do the same with beliefs.

In the present chapter, children's ability to understand mental states at the age of three years is discussed. Paragraph 2.2 addresses which kind of understanding of desire and belief is present at the age of three years and whether the understanding of desires precedes the understanding of beliefs. In paragraph 2.3 the understanding of perception and intention and its role in children's desire-belief reasoning will be considered. The main aim is to examine how theory of mind emerges, and which abilities precede and underpin a more developed, meta-representative understanding.

2.2 Young children's understanding of beliefs and desires

There is a general agreement in the literature about the important role of understanding desires and beliefs in having a theory of mind. In accordance with Davidson (1963) in order to explain intentional actions it is necessary to appeal to beliefs and desires. The understanding of desires and beliefs are reported here in order to see the ability but also the limits at the age of three years.

Beliefs

In the beginning, theory-of-mind research was primarily focused on children's ability to understand false beliefs. This refers to the capacity to recognize that actions are determined by mental representations, and not by objective facts. It also involves the capacity to distinguish between "mental contents" and "world contents", and to understand that only the first determine human actions (Wellman, 2002).

Wimmer and Perner (1983) deigned the first, classic false-belief task, also known as "task with an unexpected change". Children are shown a character named Maxi, who puts some chocolate into a green cupboard of the kitchen and then leaves the room to go play. During his absence, the mother takes the chocolate and moves it into a blue cupboard. When Maxi comes back, children are asked where he will look for the chocolate.

Another very well known false-belief task, "task with an unexpected content", was designed by Hogrefe, Wimmer and Perner (1986). Children are shown a popular candy box (Smarties) and then asked what they think there is inside the box. When they say "candies", they are shown that there is actually a pencil in the box. Subsequently, children are asked to predict what another child (waiting outside the room) will answer when asked what there is inside the box.

These are both "prediction tasks". The child is required to recognize the false belief of the character, which stems from the misleading information at the character's disposal, and based on that, to predict what the other person will do or say. However, in Wimmer and Perner's task children are presented a story, whereas in the task of Hogrefe et al. children deal with a real situation in which they, personally, experience the false belief.

There is a general agreement that, starting from the age of 4 years, children are able to solve this kind of task. They say that Maxi will look for the chocolate in the green cupboard, even if now it is in the blue cupboard, and that another person will say that there are Smarties in the candy box. In contrast, three-year-olds tend to fail the false-belief task. Their typical answer is that Maxi will look for the chocolate in the blue cupboard, and that another person will say that

the candy box contains a pencil. Thus, it can be argued that three-year-olds are not yet able to understand that others' actions are determined by their beliefs, rather than by objective facts.

A different kind of task was designed by Bartsch and Wellman (1989), known as the "explanation task". Their aim was to investigate children's performance when they were asked not to predict, but to explain, a wrong action. Children were shown an empty Band-Aid box, a plain unmarked box full of band-aids and a "wounded" puppet named Bill. First, children were told that Bill wants a band-aid. Then the puppet was made to look in the empty Band-Aid box. Subsequently the child was asked "Why do you think he's looking there?" and "What does Bill think?" In the prediction task, the child must choose between two possible alternatives (e.g., two places where the character goes to find the object). Differently, in the explanation task, children are shown the action of the character that does not fit with the objective facts. Subsequently, the child is asked to explain why the character behaves in this way.

In their study, Bartsch and Wellman also administered to children a prediction version of the same task. In this version the child was asked, "Where do you think he will look for Band-Aids?" Their aim was to compare the children's performance in the two different tasks. Sixty-six percent of the children solved the explanation version of the task, but only 31% of them solved the prediction version. Thus, children were much more competent in explaining a puppet's inappropriate behavior by referring to the puppet false belief than they were in predicting that inappropriate behavior. So, is the explanation task really easier than the prediction task? This question opened a great debate among researchers. Several studies followed Bartsch and Wellman (1989), in order to confirm (Robinson & Mitchell, 1995; Wellman & Bannerjee, 1991;) or disconfirm (Clements & Perner, 1994; Wimmer & Hartl, 1991; Wimmer & Mayringer, 1998; Wimmer & Weichbold, 1994) their findings.

Wellman and Bannerjee (1991) asked children to listen to a story in which a character was depicted as being surprised when confronted with a situation that was contrary to the character's expectation. Many three-year-olds were able to explain this surprise by referring to a false belief. However, Wellman and Bannerjee did not include a classic prediction task in their study, so it was not possible to prove that the same children would have failed such a prediction task.

Robinson and Mitchell (1995) seemed to confirm the results of Bartsch and Wellman (1989), as they also found the explanation-over-prediction advantage among 3-year-olds. In their task, they used two twin puppets and two cups. Both twins were presented as watching when a ball was put in one of two cups. After one twin left the room, the ball was moved into the other cup. Following this action, the second twin also left the room. When the two twins came back into the room with the intention to take the ball, one of them went to each cup. Children in the study were asked, "So, this one's gone to the wrong place, hasn't he. Why's he gone to the

wrong place, is it because he went outside or because he stayed inside?" They also used a prediction version of the same task. Twins were dressed in a different way to make clear who went outside, and who stayed inside, during the unexpected transfer. Referring to the twin who was absent during the transfer of the ball, investigators then asked, "Now, where will he go first of all to look for the ball, here or here?" Children performed better in the explanation version than in the prediction version of the task. Eighty-five percent of 3- and 4-year-olds solved the explanation task, but only the 37% solved the prediction task.

Wimmer and Weichbold (1994) carried out an interesting similar study. They used the standard unexpected transfer task of Wimmer and Perner (1983). When the child had predicted correctly that Maxi would look in the empty cupboard, the child was also asked to explain this prediction: "Why will Maxi look for his chocolate in this cupboard?" When the child predicted incorrectly, the experimenter gave the correct prediction and asked again for justification: "No, Maxi is going to the green cupboard to get his chocolate. Why will Maxi look for the chocolate in the green cupboard?" They found a strong association between prediction and explanation among 3- and 4-year-olds. Almost every child who gave a correct answer in prediction was also able to explain this action (except three children). Not a single child with incorrect prediction was able to explain the misguided action. However, it could be argued that children may have been confused when they themselves made a wrong prediction and were then corrected by the experimenter. This study was followed by another one of Wimmer and Mayringer (1998). Children were confronted with two different stories, one in the explanation condition and another one in the prediction-plus-explanation condition. Results confirmed previous findings of Wimmer and Perner (1983), revealing that explanation was not easier than prediction.

However, there are also some other aspects that may influence young children's performance in the false belief task. A study of Surian and Leslie (1999) examined whether 3-year-olds' failure in the false belief task is related to limitations in their pragmatic skills. In their first study children were administered a standard false belief task (Baron-Cohen, Leslie & Frith, 1985) and a new version. Half of the sample received a false belief task with the standard question "Where will Sally look for her marble?" and the other half received a modified version of the question "Where will Sally look *first* for her marble?". The authors, in accordance with Siegal and Beattie (1991), hypothesized that children of 3 years of age require some extra "pragmatic" help in order to get the point about what exactly the experimenter is asking. Results showed that 83% of children passed the look first question whereas only 30% passed the standard question. In their second study they compared 3-year-olds' performance in the standard and in the modified version of the false belief task with the performance of autistic children. Results showed that 33% of children passed the standard false belief task and 57% of them the

same task with the look first question. Autistic children's performance with the standard belief task was similar to that of normal children (38%). Yet, only 29% passed the task with the look first question. This study brings out the possibility that there are some pragmatic aspects related to the false belief task that may be more demanding for young children. Moreover, performance factors seem to play a role in the young children's failure of the false belief task but not in the failure of autistic children.

Wellman, Cross and Watson (2001) carried out a meta-analysis on 77 articles, published between 1983 and 1998, including 178 separate studies and 591 conditions. The first aim of the meta-analysis was to investigate the developmental trend of the false-belief understanding from the second to the ninth year of life. As expected, false-belief performance improves with age. In particular, the most considerable period of improvement was between 2,6 and 5 years. Figure 2.1 reports the probability of being correct at any age.

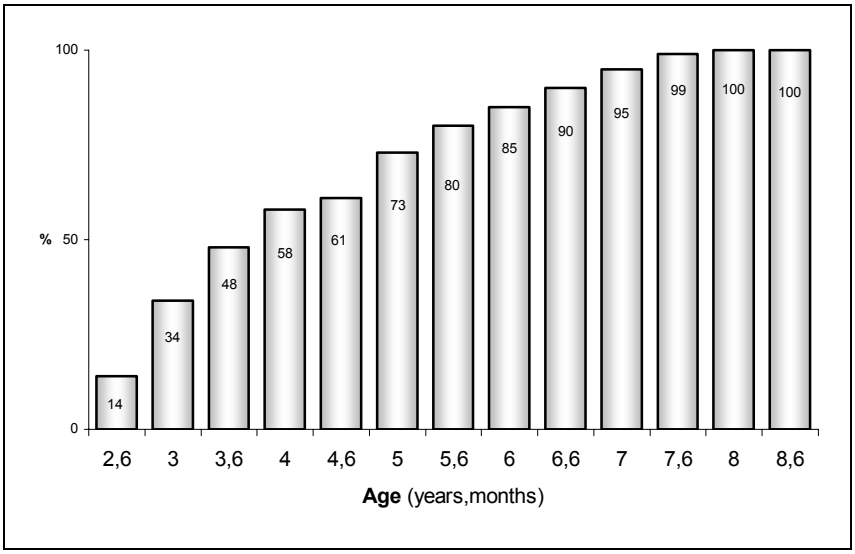


Figure 2.1 Percentage of the probability of being correct on the false-belief task at any age (adapted from data in Wellman et al. 2001)

Before the age of 3,6 children's performance was below chance, whereas at 4 years their performance was above chance. The possibility of being correct increased by a factor of 2.94 times, for every year that age increased.

The second aim of the meta-analysis by Wellman et al. (2001) was to find out which variables influence children's performance. Table 2.1 shows the variables taken into consideration, and the main and interaction effects with age found in this study.

Table 2.1 Independent variables of the meta-analysis of Wellman, Cross and Watson (2001) and their main and interaction effects.

Variables[1]	**Main effect**	**Interaction with age**
1. Year of publication	□	□
2. Country of participants	■	□
3. Type of task	□	□
4. Nature of the protagonist	□	□
5. Nature of the target object	□	□
6. Real presence of the target object	■	□
7. Motive for the transformation	■	□
8. Participation in the transformation	■	□
9. Salience of the protagonist	■	□
10. Type of question	□	□
11. Temporal marker	■	■

Six variables appeared enhance children's performance in the false-belief task. Children's country of origin (2.) was one such variable, though children in all countries exhibit the same developmental trajectory. Using conditions from the United States and the United Kingdom as a baseline (because they represent the largest sample), children in Korea performed similarly, children in Australia and Canada performed somewhat better, and those in Austria and Japan performed somewhat worse. The second variable was the real presence of the target object (6.). This refers to the status of the target object at the moment when the false-belief question is asked. Perhaps counter-intuitively, results showed that if the object is not real or present, children are more likely to answer correctly at a younger age.

The third variable to show a main effect was the motive for the transformation (7.). Children were more correct in their answers for tasks with deceptive motives, over those without deceptive motives. The fourth variable was participation in the transformation (8.). That is,

[1] Percentage of participants passing control questions was also considered as a variable. Subject who failed the control tasks were dropped from the reported data analyses.

children perform better when they actively make, or assist in making, the crucial transformation. The fifth variable was salience of the protagonist (9.) This refers to conditions in which the protagonist's belief, itself, is clearly stated or pictured (e.g., the child initially discovered that the crayon candy box contained pencils, or the child was told "Maxi thinks it is in the cupboard"). This seems to significantly raise children's performance. The last variable to demonstrate a main effect was the temporal marker (11.), which also showed a significant interaction with age. This refers to whether the false-belief question explicitly mentioned the time frame involved (e.g., "When Maxi comes back, where will he look first for his chocolate?"). Results showed that the inclusion of temporal information in the target question significantly increased correct performance, though only at older ages. In sum, the present meta-analysis sheds some light on the issue of when children start to understand false beliefs, how fast this development is, and which variables have an effect on this ability. The fact that the type of task, and the type of question, did not affect children's performance proves that the different versions of the false-belief task were valid measures. However, there are some specific aspects that make the task more salient. For example, enlisting the child's participation in making the transformation can improve children's performance.

Thus, at the age of three years, only 30-36% of children are able to solve a false-belief task. However, as shown in the introduction of the present chapter, children, at the age of three, are already able to explain others' behavior in terms of simple beliefs.

Desires

Desires, together with beliefs, are taken to be constitutive of an explanatory theory of mind. As mentioned previously, children start to refer to desires even before their third year of life (Bartsch & Wellman, 1989; Bartsch & Wellman, 1995; Wellman & Liu, 2004).

Repacholi and Gopnik (1997) conducted an investigation on the understanding of desires with an especially young group of children. The main aim of the study was to evaluate whether very young children were able to understand that desires are mental states underlying behavior, and that different people may hold different desires toward the same object. In this experiment, children aged 14 and 18 months were presented with two familiar foods: an attractive snack and a relatively unappetizing raw vegetable. A group of children were administered a matched condition. The adult expressed pleasure in response to the attractive object and disgust with the vegetable. Another group was administered a mismatched condition, in which the adult expressed disgust for the attractive object and pleasure for the vegetable. In both the conditions, afterwards the experimenter held out a hand, palm facing up, and requested some food. In the matching situation, children of both ages gave to the experimenter the food for which she

showed more preference (72% of 14-month-olds and 76% 18-month-olds). However, the two age groups had a different performance in the mismatch situation. Sixty-nine percent of 18-month-old children were able to infer the referent of the experimenter's request. On the contrary, only 13% of 14-month-old children were able to do the same. Thus, it can be argued that, already at the age of 18 months, the understanding exists that other people also have desires. The authors suggested that children were able to associate desired food with happiness and an undesirable food with disgust, even if the previous experimenter's behavior could be better defined as a preference than an emotion. In this case, it could be argued that children were able to infer what the adult would like to have (desire), based on the experimenter's shown preference.

Wellman and Woolley (1990) conducted a classic work on children's understanding of desirability. In their study, 2-year-olds' ability to reason about actions and emotions, via desires, was tested. Children were told a series of stories about a character who wanted to find something. There were three types of situations: (1) *Finds-Wanted,* in which a character wanted something that may could be in one of two locations; the character searched in location 1 and found the object. (2) *Finds-Nothing* was a situation identical to Finds-Wanted, except that upon searching in location 1, nothing was there. (3) *Finds-Substitute* was a situation identical to Finds-Wanted, except that upon searching in location 1 the character found an attractive object, but not the one said to be wanted. Children were asked to make an action judgment and an emotion judgment. In the action judgment, children had to predict the character's subsequent action (i.e., whether the character would go on to search in location 2 or would stop searching). In the emotion judgment, children had to state the character's emotional reaction (i.e., whether the character was happy or sad about what was found). Two-year-old children correctly predicted actions from information; for example, that the character who did not find the desired object in the location 1 would look in the other location. They also were able to predict the emotional reaction; for example, that the character could be happy when the desire was fulfilled. Thus, children were able to appreciate desires as internal, psychological states. However, the authors also noted that it could be argued that children had, in this experiment, the same desire as the protagonist. Thus, when asked whether the character would search in location 1, children could simply report their own action tendency. In the same way, when asked to rate the character's emotion, children could simply report their own emotion.

Wellman (1990) used a different procedure in order to investigate whether children can distinguish their own desire from the desire of somebody else. Children were asked, for example, whether they preferred swimming or playing with a dog. Subsequently, they were told that a story character had an opposite preference. Three-year-olds showed no problems in

predicting the character's action on the basis of the character's preference. This study gives some evidence that children are able to appreciate that other people's desires can be different from their own.

All these studies show that children are already at the age of three years able to understand desires. However, it is easy to imagine that there are some aspects of desires that can be more demanding for children. This is the case when children have to understand their own previous desire that contrasts with a present desire, that the desire of somebody else can be different from their own desire, or when they must explain a specific action in terms of desires that are consistent with the character's preference (instead of with the action itself). Recent studies have shown that when these aspects of desires are investigated, children at three years show some difficulties in their understanding.

Moore, Jarrold, Russell, Lumb, Sapp and MacCallum (1995) analyzed children's ability to understand *conflicting desires*. Children of 3, 4, and 5 years of age were administered two conflicting desire conditions. In the first, the *No preference* condition, the child was shown two stickers that were equally attractive, representing two animals, and asked to choose one to take home after the game. Subsequently, the child was told a story about a character that, one day, had a bad experience at the zoo with the same animal as chosen by the child. The next day, the character had to choose between the same two stickers. The child was asked which sticker the character would choose. In the *Preference* condition, the child was shown two stickers, but one was more attractive than the other one. Again the child was instructed to choose the sticker that he or she liked more. Subsequently, a story similar to that in the first condition was told, and at the end the child was asked which sticker the character would choose. All the children demonstrated good performance in predicting which sticker the character would choose in the No preference condition. However, only 5-years old showed good performance in the Preference condition. Only 35% of 3-year-olds and 45% of 4-year-olds correctly answered reporting the character's desire in accordance with the story. Thus, young children are able to predict others' actions on the basis of their desires and preference but only when there is not a conflict between their own desire and the one that is attributed. This difficulty is very similar to young children's difficulty in judging another person's belief when that belief is in conflict with what the child knows (false belief).

According to Rieffe, Meerum Terwogt, Koops, Stegge and Oomen (2001), children's difficulty in this kind of task is not due to the presence or absence of a conflict, but to the intensity or salience of the conflict. In other words, in the No preference condition the overlap between the protagonist's desire and the child's desire was greater than in the Preference condition. In their study, Rieffe et al. (2001) evaluated children's understanding of conflicting

desires at 3, 4, and 5 years of age. Children were asked to rank a number of toys, and subsequently, a number of snacks, from most- to least-liked. Subsequently, children were presented with eight stories, four about toys and four about snacks. In each story, the protagonist was presented as having a preference that was either consistent or in conflict with the preference of the child. The four stories had a decreasing level of conflict: most saliently in conflict, less saliently in conflict, less saliently consistent, and most saliently consistent. Children of 5 years old predicted the protagonist's preference under all circumstances, and 4-year-olds improved their performance when the difference between their own preference and the protagonist's preference was reduced. Children aged 3 years performed poorly under all circumstances, even when their preference was highly consistent with the one of the protagonist.

Meerum Terwogt and Rieffe (2003) argue that also some other factors may influence the way children interpret others' desires, like the cultural knowledge. For example, it could be argued that when children believe that something is not desirable, they think that it could also be not desirable for somebody else. The authors investigated how children's understanding of desires is influenced by sex-stereotyped preferences for toys. Children of 4 and 5 years of age were presented with stories in which the protagonist (who could be a boy or a girl) likes one object more than another (that could be conform or not conform to his/her gender) and at the end received the toy the protagonist's claimed or received the less desired toy. Children of both age predicted correctly the protagonist's emotion on the basis of his/her desire when the desirable object was conform to his/her gender. Differently, children of both ages produced less correct answers when the desirable object was not conform to his/her gender. Thus, children of both ages are not biased in their predictions of emotion by their own desires. Yet, they use generalized beliefs about desirability in predicting others' emotions, even when these beliefs on desirability do not coincide with the protagonist's desires.

The studies here reported showed that it is not always easy for 3-year-olds to understand desires. Astington and Gopnik (1991) reported three components of the understanding of desires that might be more or less difficult for young children. To have a full understanding of desire, children need:

- to know that desires are a mental state, and not to simply identify desires with actions. They also need to recognize the causal link between desire and action. For example, different actions may stem from different desires.
- to know the relationship between desires and their satisfaction conditions; that is, the outcome of the action.
- to understand the representational nature of desire. Indeed, desires are intentional states that involve attitudes toward *representations* of things, and not the things themselves.

The authors suggest that children develop the third kind of understanding later than the first two kinds, and that such understanding precedes an equivalent, representational understanding of belief. In order to confirm this hypothesis, Astington and Lee (1989) examined whether children find it easier to answer questions about another's desire than about another's beliefs. Showing small and big boxes of Smarties, children were asked which one they wanted to have. Almost all the children said a big one. Subsequently, children were shown that small boxes were full of Smarties and big boxes contained only one Smarty. Then, the boxes were closed again and they were asked which kind of box they wanted when they first saw them, and which box another child would want when this child first saw them. Only 36% of three-year-olds answered that they had wanted a large box when they first saw it. And, only 21% of them said that another child would want a larger box. The authors claimed that understanding desire is sometimes as difficult as understanding belief. However, it could be argued that in this task both desires and beliefs are implicated in action, and that desire depends upon belief. Thus, children's lack of a representational model of belief also affected their understanding of desires.

In sum, the literature shows that children are able to understand and to explain behavior in terms of desires before they do so in terms of beliefs. Moreover, the ability to understand false belief seems, at this age, not yet developed. However, there is some evidence that, in some cases, children can find it difficult to understand desires as well as to understand false beliefs. This is true when the desire of somebody else is conflicting with the desire of the child.

2.3. Young children's understanding of perception and intentions

Our knowledge is forged, in part, from seeing, hearing or feeling various stimuli (Bartsch & Wellman, 1988). For this reason it is possible to argue that the understanding others' perception plays a relevant role in understanding others' mental states. That is, only when we know others' point of view we can understand also others' mental states. For example we are able to predict the false belief of somebody else only when we are able to understand that the perception of that person is different from our perception. For this reason it may be argued that the understanding of perception, is a fundamental prerequisite for the understanding of mental states.

Differently, understanding can be considered as mediators between beliefs and desires (Schult, 2002). To understand intention is important in order to distinguish between acts that are intentional as compared to acts that are deliberate (not done on purpose). Thus, it may be argued that the understanding of intention is a prerequisite for the comprehension of desire and belief with a high level of representation, like false beliefs.

Perceptions

Investigations regarding when and how children develop the ability to understand perception started, obviously, before the inception of theory-of-mind research. Some social-cognitive research, such as that conducted by Flavell and colleagues, focused on children's ability to understand the visual perception, thus the perspective-taking of another person, as one of the most important skills. Later, visual perception (or perspective-taking) was also considered as one of the first post-infancy developments in theory-of-mind ability (Flavell, 1999). It could be expected that the early understanding of perception might serve as a model for the later understanding of beliefs. By 1.5 to 2 years of age, children begin to understand that other people see things. At the same age, they also start to use perception terms such as "look" and "see" (Bretherton & Beeghly, 1982). During the early preschool period, children understand that a person sees an object only if his/her eyes are open and aimed in the general direction of the object, and if there are no obstacles to vision interposed between the person and the object (Flavell, 1992).

In a series of studies, Flavell and colleagues investigated how 2- and 3-year-olds understand visual perception. They distinguished two levels of perspective-taking. Level 1 refers to children's understanding that others may not see what they see themselves; therefore two different people may see different objects. Level 2 refers to children's understanding of what the other sees when the self and other view the exact same object, but look at it from a different angle. In a study of Flavell, Everett, Croft & Flavell (1981), children of 3 years of age were given two tasks, a Level 1 and a Level 2. In the Level 1 task, a card with a picture of a dog on one side and a cat on the other was held vertically between the child and the experimenter, and the child's task was to indicate which animal he/she and the experimenter saw. In the Level 2 task, a picture of a turtle was placed horizontally on the table between the child and the experimenter so that it appeared upside down from the child's side and right side up from the experimenter's. The child was asked to indicate in which of these two orientations it appeared to the child and to the experimenter. Results, in line with a preceding study carried out by Masangkay, McCluskey, McIntyre, Sims-Knight, Vaughan and Flavell (1974), showed that 3-year-olds appear very competent in making Level 1 inferences, but they have great difficulties in making Level 2 inferences. Thus, while the ability to utilize Level 1 inferences develops by the end of the second year, the ability to utilize Level 2 inferences develops only after the third year of life. Flavell and colleagues suggested that children progress from inferring only what others know (about what they see) to also inferring how they think or feel about what they know. In this way, a relationship could be argued between the ability to understand what a person can see and the ability to understand his or her mental states.

It is not yet clear in the literature whether children's understanding of visual perception means that they comprehend that the other person is having a different perceptual experience, or if they simply recognize that the other person's eyes are behaviorally directed at a specific target. For sure, there is a connection between perception, mind and the world. Perception provides the information to build our beliefs, as well as information about the "objects" that can be the targets of a person's emoting or wanting. Wellman, Phillips and Rodriguez (2000) tested a connected understanding of perception and emotion in young 3-year-olds. They administered two tasks to 3-years-old children who passed a preliminary Level 1 perception task; a *perception-to-emotion task* and an *emotion-to-perception task*. In the first task, children were asked to predict the emotion of a third person (sad *vs.* happy), on the basis of what this person was looking at (an empty box vs. a box with a nice gift inside). In the second task, children were asked to report on the perception of a third person (seeing an empty box vs. to seeing a box with a nice gift inside), based on the emotion being expressed by the target (happiness vs. sadness). Three-year-olds performed almost perfectly in this task, showing an understanding that people can experience different emotions or desires on the basis of their perceptions.

However, visual perceptions seem to share more features with beliefs than with desires. According to Searle (1983) desires have a mind-to-world direction of fit, because they often result in attempts to change the world in order to get what one wants. In contrast, beliefs have a world-to-mind direction of fit, because they attempt to record the world as it is. Also perceptions have a mind-to-world direction of fit, because people change their mind to fit the world, rather than change the world to fit their mind. Moreover, similar to beliefs, but different from desires, perception can be false or true. If this is true, children's early understanding of perception can provide a model for their understanding of belief and false-beliefs.

Starting with this hypothesis, Gopnik, Slaughter and Meltzoff (1994) attempted to evaluate why perceptual perspective-taking tasks (both Level 1 and Level 2) are simpler for children than the false-belief task. They proposed two main explanations. The first explanation is that perspective-taking tasks are easier because they are perceptual in nature. The second explanation is that they are easier because they do not require a "representational model of the mind". One has a representational model of the mind when is able not only to understand that people may fail to know something about the world, but also that they may actively misconstrue it (Flavell, 1988; Forguson & Gopnik, 1988; Perner, 1988). This makes the understanding of false beliefs more difficult, so that this comprehension is attained only after Level 1 perspective-taking has been achieved. However, in the literature there are a number of tasks that are usually solved at the age of three, after Level 1 perspective-taking and before the acquisition of false-belief understandings. For example, Wellman and Bartsch (1988) found that 3-year-olds (and not 2-

year-olds) are able to solve a "discrepant belief task". Children were told a story: "*Look, there are bananas in the cupboard and bananas in the refrigerator. Jane wants a banana. Jane thinks there are only bananas in the cupboard; she doesn't think there are bananas in the refrigerator. Where will Jane look for bananas?*" Children were able to predict that Jane would only search for the object where she thinks it is. This task is perceptual in nature, and has a structure quite similar to the perspective-taking task because the child must realize that another person only sees a part of the world that the child herself sees. Also, like the false-belief task, the question is phrased in terms of thinking rather than seeing, and the child is asked to understand a perceptual misrepresentation.

Gopnik, Slaughter and Meltzoff (1994) conducted a series of studies in order to investigate the relationship between visual perspective-taking with a perceptual misrepresentation and false-belief understanding. Children, aged three years, were administered two visual perspective-taking tasks: a Level 1 and Level 2 task. In both tasks, the questions were phrased both in terms of perception and in terms of thought. The main aim of the authors was to assess whether children have the same difficulty for Level 2 visual perception, in terms of "thinking" and the false-belief task. In general, children performed significantly better on the perception task than on the belief task. This was true for both the "see" and "think" questions in the Level 1 and Level 2 tasks. Even if children were more competent when the perceptual nature of the task was made explicit (i.e., "see" tasks), they showed improved understanding when the tasks were phrased in terms of "thinking". Children's level of performance was similar to the levels on desire tasks (60-75% correct). These results suggested that children were better able to understand perceptual misrepresentation than false beliefs. The authors concluded that children could initially understand misrepresentation in the context of desire and perception, and only later did they extend that understanding to false belief. Thus, it is possible to argue that understanding what another person perceives is an ability that is necessary for understanding mental states.

The understanding of perception seems to be a prerequisite for the understanding of others' mental states. Yet, Gopnik et al. (1994) show that the understanding of perception is a necessary but not a sufficient prerequisite in order to understand mental state with higher level of representation, like false-beliefs.

Intentions

There is evidence that children are able to appreciate intentions early in life. Bretherton, McNew and Beeghly-Smith (1981) and Dunn (1988), in their studies of children's natural language, showed that 3-years-olds use words such as *want* and *gonna* before they carry out

their own actions, as well as when they comment on the action of another person. Some experimental studies confirmed results found in naturalistic studies. Shultz and Wells (1985) asked 3-year-olds to make intentionality judgments in an electronic target-shooting game. In the game, the shooter selected one of five different target colors to try to hit. After it was fired, the shot hit either the selected target or a different one. Children were asked to indicate whether the shooter had meant to hit that target. Results revealed that children reported intentionality more often when the outcome matched the shooter's goal than when it did not. They also appeared to understand that the same outcome could be either intended or unintended, depending on the shooter's goal.

Usually, studies about children's understanding of intention have compared children's judgment of actions performed on purpose with judgment of actions performed by accident or mistake. Schultz, Wells and Sarda (1980) asked 3- to 5-year-olds to perform a number of tasks. Some of them were quite easy, and some others were designed so that mistakes would be made. For example children were asked to point to a shiny penny as opposed to a dull penny. On half the trials children wore a pair of glasses that distorted their vision and caused them to pick the dull penny. Children as young as 3 were able to judge that they did not mean to pick the dull penny when they were wearing the distorting glasses, and did mean to pick the shiny penny when no glasses were worn. In this task, children needed to look for a match between the started goal (or desire) and the outcome of the action. In accordance with the matching strategy, when the previous desire and the outcome match (thus, the outcome satisfies the desire), the action is judged to be intentional. However, when the previous desire and the outcome do not match (thus, the outcome does not satisfy the desire), the action is regarded as a mistake or an accident. In this way, a simple desire-outcome matching strategy was evaluated, because in this situation the desire and the intention were both not satisfied.

What differences exist between intentions and desires? According to Searle (1983), these two mental states are very closely related. Unlike beliefs, which can be either right or wrong, desires and intentions are either fulfilled or unfulfilled. Moreover, desires and intentions have a mind-to-world direction of causation. This means that we are motivated to act in order to bring about changes in the world. Probably for this reason, the majority of psychological studies consider intentions and desires together. However, they also have some key differences, as proposed by Bratman (1987, see also Schult, 2002):

- *Intentions have a different motivational force than do desires.* Someone can desire something, like to have an ice-cream. But, this person can decide to not have an ice-cream, because desires to lose weight. On the other hand, when someone has an intention, and nothing

unexpected happens, this person will act on that intention. Thus, the intention's relation with action is stronger than the relation between desire and action.

- *A salient characteristic of intention is "resistance to reconsideration".* This means that, while in having a desire someone can repeatedly weigh the pros and cons of this wish, this does not happen with intentions.
- *Desires and intentions differ in the ways they influence future intentions.* An intention always leads to other, related intentions that are congruent with the first one. In contrast, there is no need to make desires congruent with one another (e.g., one can desire at the same time to spend some time at home and to go out for a walk).

Feinfield, Lee, Flavell, Green, and Flavell (1999) investigated whether children were able to understand the causal nature of intentions, independent from desires. Their first study presented children with stories. For example, a boy in the story expressed a preference for one activity (such as going to the mountains) and a dislike for another activity (playing football). His mother urges him to do the disliked activity, so the child decides to comply with her request. Due to circumstances beyond his control (the bus driver got lost), the boy ends up at the location of the preferred activity. Thus, the initial desire was satisfied, but the intention was unfulfilled. Children in this study were asked questions that probed the character's desire, intention, and belief. The results indicated that 4-year-olds, but not 3-year-olds, were able to tell where the character liked to go (desire), what was trying to go (intention), and where the character thought was going (belief). In the second study, children were presented with stories in which the mother told a boy to go get a particular object (A) and, in looking for A, the boy found a much more desirable object (B). Four-year-olds could report what the child thought he was going to get, whether he got what he was looking for, what he was trying to get, and which object he liked better. Three-year-olds could only answer to the last two questions. It could be argued that 4-year-olds have competency in distinguishing intentions and desires, and that 3-year-olds lack this competency.

Schult (2002) investigated children's ability to recognize the causal nature of intentions, as distinguished from desires. Children of 4, 5, and 7 years old were presented stories in which the character had a desire and formed an intention to perform an action. These stories included situations in which the character's desire and intention were both satisfied, situations in which one but not the other was satisfied, and situations in which neither the desire nor the intention was satisfied. An example of a story in the intention-unfulfilled /desire-satisfied condition was about Becky. Her desire was to have a new doll, and her intention was to go the store and buy one with her money. That day, before to the store, her mother gave her the doll. Children were

asked to explain: 1) what was the character's plan, 2) whether the character did what planned to do, 3) what the character wanted, and 4) whether the character got what she wanted. Results showed that 4- and 5-year-olds were able as able as 7-year-olds and adults in differentiating intentions and desires, when asked whether the character did what she planned to do and got what she wanted, and in the description of the character's desires. However, 4- and 5-year-olds were unable to tell consistently whether the character's intentions, as opposed to desires, were satisfied. They seemed to know intentions were different from desires, but they did not know exactly what intentions were. In his second study Schult (2002) made a similar investigation with 3-, 4-, and 5-year-olds. In this task, a game context was used. Children were invited to toss some small beanbags into three colored buckets. Children were asked to choose a particular bucket at which to aim, that could contain a desired object (a picture) or not. After the action, the children were asked what they were trying to do, what they wanted, and if they got what they wanted. Results showed that all the children were able to remember their intention when they missed the intended bucket, and the bucket contained no picture. However, when 3-year-olds missed their intended bucket and still found a picture, they were no longer able to remember their previous intention. Thus, they were not able to distinguish between their intention and their desire in the mismatch condition. Schult's conclusion was that 3-year-olds are not yet able to distinguish between intentions and desires. There are two other possible explanations for their poor performance in this task. First, this task appears to be very demanding on children's memories; children had a lot of information to remember in order to correctly answer the questions. Second, 3-years-olds could not distinguish the two questions, "What where you trying to do?", and "What did you want?". Again, this study shows how difficult it is to evaluate children's understanding of intention apart from their understanding of desire.

What kind of relationship exists between intentions and beliefs? In accordance with Moses (1993), intentions presuppose beliefs. If someone intends to perform an action, the intention will normally be accompanied by, and consistent with, beliefs. Moses (1993) proposes two main intention-relevant beliefs: (1) an intention to perform an action is most closely associated with a belief that the action will, in fact, be performed. So, if someone intends to get a beer from the refrigerator, this person must believe that it is possible to do that; (2) an intention is typically underpinned by a host of other, increasingly tacit, background beliefs. So, the same person who intends to take a beer from the refrigerator has some beliefs about what he or she is going to do, but also that the beer is in the refrigerator, that the refrigerator is located nearby, that it is possible to open the refrigerator, and so on. This means that it is possible to evaluate whether there is a relationship between intentions and beliefs, examining the child's belief that goes with a specific action. Seale (1983) reported two broad types of intentions. The first type is called

prior intentions, or mental states that occur in the mind of the actor before the action is performed. Prior intentions can be described by the expression, "I will do X." When somebody has this kind of intention, it could still be that the person will not perform the action for some reason. The second kind of intention is called *intention-in-action,* and it is involved at the moment of purposely performing a particular bodily movement. A person can have a momentary impulse of the moment intention intention-in-action, without having a prior intention. When somebody does an intention-in-action this person has also an immediate belief about the result of the action.

Russell, Hill and Franco (2001) carried out a study that investigated children's understanding of intention-in-action. They employed a task in which the final product of an action was not as predicted. Children 3 and 4 years old were administered two conditions of the task: a false-belief condition and a true-belief condition. In the false-belief condition, children were presented with a transparency of the kind used with overhead projectors on which there was an incomplete drawing (e.g., a boy's head missing an ear). The child was given a pen and invited to finish the drawing. Subsequently, it was revealed that, in fact, he/she had been drawing on the uppermost of two overlaid transparencies, so that removing the top transparency showed that the lines drawn by the child had actually completed another drawing (e.g. a cup with the ear outline now representing the handle of the cup). The child was then asked whether he/she intended to draw an ear or a handle, or whether he/she thought he/she was drawing an ear or a handle. These questions were about the participant's intentions as the drawing was being carried out, so about an intention-in-action. The children's task was to report their mental state at the time of acting, in a way that was not influenced by the actual outcome of the action. In the true-belief condition of the task, the child was initially given a single transparency (e.g., a cup) rather than two, overlapping transparencies. After the child drew the missing cup handle, he/she then saw this being placed on top of the other one (e.g. the boy's face). After, the same question was asked as in the other false-belief condition. In this condition, the child's belief about what he/she was drawing on a transparency was true, although the resulting drawing could be made to appear as something else in a different context. Thus, the perceived outcome of the action at the time of questioning was not as intended. Children were also administered a third-person version of the same task, in which the actions were carried out by a puppet. The fact that, in this task, children had to finish a drawing because the adult requested it, made their performance more independent from their personal desire. Moreover, the question was in terms of what the child meant, and what the child intended to draw. Children also received an unexpected transfer task, an unexpected contents task, and an appearance-reality task. Results showed that 4-year-olds performed better than 3-year-olds. There was an equivalent difficulty of the false-belief and

true-belief version of the transparent intentions task, as well as for the first-person task and the third-person task. Yet, no relationship between the transparent intention task and the false-belief tasks was found. In conclusion, it seems that the ability to understand intentions, when examined independently from desires, is still developing at the age of three.

2.4 Conclusion

It is clear, from the studies reported in the present chapter, that children's ability to understand mental states has a gradual development from the age of two to the age of five. Furthermore, the age of three seems to represent an important transition. Children appear to understand some mental states before some others, and they use their mental level of understanding to explain the world.

Wellman and Liu (2004) conducted a meta-analysis, in order to compare different types of mental-states understanding. Only studies reporting comparable data, for children's performance on tasks that contrasted two constructs (e.g. desires vs. beliefs), were included in the meta-analyses. The first comparison focused on belief versus false belief, the second focused on desire versus belief and the third on knowledge (or ignorance) versus false belief. Results revealed a consistent, empirically strong contrast between belief and false belief. Children can correctly judge a person's belief before they can judge false belief. Regarding the contrast between desire and belief, results of this study confirmed previous evidence in the literature. Children correctly judge others' desires before they correctly judge others' beliefs. The last result showed a significant contrast between knowledge and false belief. It appears that the understanding of ignorance (knowledge) develops significantly earlier than understanding of false belief.

This study like, some others reported in this chapter, points to the fact that understanding of desires seems to precede understanding of beliefs (Wellman & Bartsch, 1988; Wellman & Woolley, 1990). However, some other studies have demonstrated that 3-year-olds show some difficulties in understanding desires when there are conflicts with others' desires, with their own previous desires, or with the outcome of an action. It is clear that children cannot be evaluated on their understanding of "false desires". In fact, in contrast to beliefs, desires cannot be true or false - only fulfilled or unfulfilled. However, there is evidence that, at the age of three, children are able to understand only simple desires and not desires that require a higher level of representation. Studies of Wellman and colleagues, discussed here, have shown that children have a conception of desires (as well as a conception of simple beliefs) quite early on (Bartsch & Wellman, 1989, 1995; Gopnik & Slaughter, 1997; Wellman & Woolley, 1990). However, some

other investigations have pointed to the difficulties that children experience with more complex desire understanding (Astington & Gopnik, 1991; Moore et al., 1995; Rieffe et al., 2001).

Why do children have these difficulties? Gopnik, Slaughter & Meltzoff (1994) claim that, at the age of three, children have a mentalistic (but not-representational) understanding of desires and beliefs. This could explain their difficulties in understanding other people's desires when they are different from their own desires. Moore et al. (1995) proposes another point of view. They claim that these kinds of tasks have a strong executive component. Children could have problems in inferring another person's desire because they must "disengage" from their own strong, but conflicting, desire. Children have the same difficulty with false-belief tasks. A more detailed investigation of children's ability to explain actions could be important in showing their competence at the age of three. Above all, it is interesting to evaluate whether they have difficulties in explaining desires when they are asked to consider conflicting elements of the story, as well as if they have difficulties in explaining a false belief.

In which way does the understanding of perception and intention play a role in the way children explain behavior? The studies presented in the present chapter show that the understanding of perception underpins the understanding of belief. It is less clear whether the same applies for the understanding of desire. It could be argued that the understanding of perception is a prerequisite for a general understanding of others' mental states.

The studies reported in the present chapter show that at the age of three is not yet present a good understanding of intentions. It is possible to argue that they require the combined understanding of desires and beliefs. Wellman (1990, pp. 110) claimed that:

"Intention… is the meeting ground where belief and desire join forces in a plan of action. An intended plan of action is designed to achieve certain desires and designed on the basis of certain beliefs. In naïve psychology, intentions are the proximal cause of actions. Hence in commonsense psychology actions are essentially intentional; they are to be explained in terms of the actor's intentions".

Accordingly with Wellman (1990) intentions are "plans to actualize certain desires". However, they are implicit in the action, thus they have to be inferred on the base of the person's beliefs, desires, perceptions and preferences. For this reason it could be argued that the understanding of intentions is related to an higher level of understanding of desire and beliefs. Although the study of Russell et al. (2001) reports the fact that there is no relationship between understanding of intentions and false belief, there is the possibility about a relationship between the understanding of intention and a high level of desire explanations.

Chapter 3

First study: The role of perception and intention understanding on children's explanation of actions

3.1 Aims of the study

Which kind of understanding of mental states do 3-year-olds have? Chapter 2 presents how children are able, already at the age of 3 years, to construe human actions as a result of mental states. In particular, they are able to understand and to talk about simple desires and beliefs (Bartsch & Wellman, 1989, 1995; Wellman & Woolley, 1990). However, their understanding of false belief at this age is still poor. Numerous studies (Hogrefe, Wimmer & Perner, 1986; Wimmer & Perner, 1983) and a recent meta-analysis (Wellman, Cross & Watson, 2001) have shown that children's ability to solve a false-belief task at the age of three is less than a chance expectation of 50%. In the same way, there is some evidence in the literature that children of 3 years of age can find it difficult to understand desires as well as to understand false beliefs (Astington & Lee, 1989; Moore, Jarrold, Russell, Lumb, Sapp & MacCallum, 1995; Rieffe, Meerum Terwogt, Koops, Stegge & Oomen, 2001). This is the case when the desire of somebody else is in contrast with the desire of themselves. Thus, although there are many studies in the literature about children's capacity to understand false beliefs, further study is necessary in order to evaluate how children understand mental states at the age of three years and, in particular, how they understand desires.

Another aspect considered in Chapter 2 is the role that the understanding of perception and intention plays in the way children construe actions in a psychological way. Before the inception of theory-of-mind research, Flavell and colleagues (Flavell, Everett, Croft & Flavell, 1981; Masangkay, McCluskey, McIntyre, Sims-Knight, Vaughan & Flavell, 1974) conducted a series of studies in order to evaluate when children become able to take the point of view of the other

person. Later, this ability has been considered an important prerequisite in order to understand mental states, above all the understanding of beliefs (Gopnik, Slaughter & Meltzoff, 1994; Searle, 1983). Children at the age of 3 years have a good understanding of perception. It may be argued that this understanding forms the basis for their ability to understand mental states, beliefs as well as desires.

As far as intention understanding is concerned, naturalistic studies show that children use, in everyday contexts, words such as *want* or *gonna* (Bretherton, McNew & Beeghly-Smith, 1981; Dunn, 1988). Some experimental research confirmed this result, showing that children are able to distinguish actions performed on purpose from actions performed by accident or mistakes (Schultz & Wells, 1985; Schultz, Wells & Sarda, 1980). However, in these studies, intentions and desires are evaluated concurrently. In other studies, in which children's understanding of intentions was evaluated independently from desires, children at the age of 3 years were not able to distinguish intentions from desires (Feinfield, Lee, Flavell, Green & Flavell, 1999; Schult, 2002). According to Wellman (1990) intentions are plans that people have in order to actualize certain desires. This means that intentions are formed by the person's personal beliefs, and desires. It might be argued that a high representational ability is necessary in order to understand intentions. For this reason the understanding of intentions may be related to children's understanding of false beliefs and to an equal level of desires.

The present study investigated the emergence of theory of mind at the age of three. Children's ability to explain others' actions in a psychological way was examined. The aim was to evaluate their ability to construe human actions as a result of mental states. Moreover, children's understanding of perception and intention was related to their ability to explain actions in terms of mental states.

Children's ability to understanding visual perception (Level 1) was evaluated with a perspective-taking task (Flavell, Everett, Croft & Flavell, 1981) and their ability to understand intention was evaluated with an intention-in-action task (Russell, Hill & Franco, 2001).

Children's capacity to explain others' behavior in a psychological way was evaluated with the Bartsch and Wellman's explanation task (1989). What is relevant about this task is that it can be used not only to evaluate whether children have mastered a specific ability or not, but also as a general overview of children's natural tendency to explain specific situations. In this task children are presented with three kinds of stories. *Neutral stories* show neutral actions that can be simply explained using all kinds of mental states. They require a basic ability to use psychological explanations. In *Anomalous-desire stories,* there is a discrepancy between the

character's action and preferences. Finally, in *Anomalous-belief stories* there is a discrepancy between the character's action and the real state of affairs. The following types of explanations given by children were considered: *Psychological explanations* and *Desire-belief explanations* produced in the three kinds of stories; *False belief explanations* produced in Anomalous belief stories; and *Inconsistent desire explanations* produced in Anomalous desire stories. Psychological explanations provide an index of children's ability to explain behavior in a psychological way. Desire-belief explanations were considered in order to evaluate children's ability to construe behavior in an intentional way. In *Anomalous-belief stories* children were asked to explain an action that was not consistent with the current situation. For example the child was told: "Here is Luisa. Luisa is looking for her kitten. The kitten is behind the chair. But Luisa is looking behind the table. Why do you think she is doing that? What does Luisa think?". Only when children are able to understand that the protagonist has a different belief, they can explain this action in terms of a false belief. In the *Anomalous-desire stories,* children were asked to explain an action that was not consistent with the character's preferences. This kind of explanation was called "Inconsistent desire". For example the child was told: "Here is Filippo. This is a snake. Filippo doesn't like snakes (preference). But now he's trying to catch a snake (action). Why do you think he is doing that? What does Filippo want?". If children simply identify the protagonist's desire with the action, they will explain the action with a simple desire (e.g., Filippo is trying to catch a snake because he wants it), not taking in consideration the information about his preference. On the other hand, if children are able to recognize the causal link between desires and actions they will consider the preference of the character, giving an explanation that is apparently not consistent with the action (e.g., Filippo wants to throw the snake in water). In this way the understanding of inconsistent desires may be comparable to the understanding of conflicting desires (Moore, et al., 1995; Rieffe, et al., 2001).

The main purposes of the study were:

1. *To evaluate children's understanding of perception and intention in the beginning of the third year of life and to assess whether the understanding of perception precedes the understanding of intentions.* Perception understanding supports children's ability to take into consideration the difference between their own and others' point of view. Intention understanding seems supported by the ability to take into consideration the point of view of the other person. Thus, it was expected that children who are able to understand intentions are also able to understand perception.

2. *To examine the nature of young children's explanations of actions in terms of mental states, as a way to construe behavior in an intentional way. Moreover, to examine children's ability to understand desires that are not consistent with the actions: the Inconsistent desire.* This kind of desire explanation was considered for the first time in the present study. It may be argued that young children find it equally difficult to produce inconsistent-desire explanations as false-belief explanations.
3. *To evaluate whether a relationship exists between the understanding of perception and intention, and the ability to explain actions in terms of mental states.* Figure 3.1 depicts the hypothesized relation between the three abilities. If the understanding of perception is related to children's ability to consider another's point of view, it is expected that children who do not have this ability are also not able to explain actions by considering mental states. In the same way, if the understanding of intention is related to a more mature understanding of human action, there should exist a relationship between this ability and both the inconsistent-desire and false-belief explanations. In sum, it was expected that there was a difference in the ability to explain actions between children who fail both the perception and the intention understandings, children who pass only the perception understanding, and children who are able to solve both the two tasks.

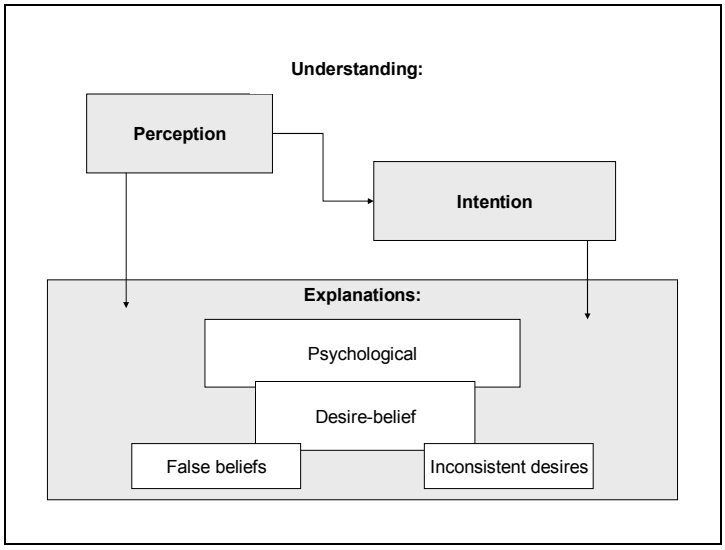


Figure 3.1 Hypothesized relationships between the understanding of perception and Intention and the ability to ability to explain actions in terms of mental states.

The three tasks were initially administered to a pilot sample of 10 children, in order to evaluate the translation of the procedure and for the training of the experimenter. These three tasks were used for the first time in the Italian research on theory of mind. Thus, for their standardization and their validity, it is important to confirm the results that were found in previous studies.

3.2 Method

Subjects

Eighty 3-year-olds (*Mean* (years;months) = 3;3; *SD* = 0;1; *range* = 3;0-3;8), 45 girls and 35 boys, participated in this study. The children were recruited from child-care centers and pediatric offices in the city of Rome. The socio-economic levels of their families ranged from middle to middle-high (as determined by parental educational level).

Materials and procedure

Children were observed at home or in a day care center. The experimental observation was carried out in a quiet place in the house or school, and in the presence of a familiar figure for the child (a parent or an educator). After a warm-up period, three social-cognitive tasks were administered:

Visual-perception task. Children were shown a colored, plastic card (12cm x 12cm) with a picture on one side (e.g., a dog) and a different picture on the other side (e.g., a cat). The experimenter demonstrated to the child that different pictures were on each side of the card. Then she asked: “What do you see, a dog or a cat? What do I see, a dog or a cat?” The child could answer by either naming the picture or pointing to each side of the card. The two questions were counterbalanced. Three cards were used: Cat/Dog, Tree/Flower and Shoes/Sun. Appendix A shows the pictures used in the task. Children viewed each card combination, and after they answered what they and the other person could see. Children received a score ranging from 0 to 3 (three trials).

Intention-understanding task. Children were shown a transparency on which there was an incomplete drawing (e.g., a boy's head without an ear). The child was given a pen and invited to finish the drawing. When the child finished, the experimenter revealed that, in fact, he/she had been drawing on the uppermost of two overlaid transparencies. Removing the top transparency showed that the line drawn by the child had, in fact, completed the drawing of a cup on the top transparency, with the "ear" outline now representing a handle of a cup. The experimenter than asked to the child what he/she thought had been drawn[2]: *'Did you think you were drawing an ear or did you think you were drawing a handle?'* Children were presented four transparency pictures: Ear (face)/Handle (cup), Smoke (chimney)/Smoke (boat), Top of tree/Ice-cream and Face (girl)/Face (boy). The order of presentation of the 4 trials was counterbalanced across children. Appendix A shows the protocols and the pictures for the task. Children's answers about what they thought they drew were scored 1 if they answered the previous drawing, and 0 if they answered the second, "actual" drawing. Thus, children received a score ranging from 0 to 4 (four trials).

Explanation task. A modified version of the Bartsch and Wellman's procedure (1989) was used. Children were presented nine stories with simple descriptions of a character engaging in a specific action. Each story was accompanied by an illustration of the story with the character, the object and the final location. There were three different kinds of stories: (1) *Neutral stories*: The character is engaging in a simple action; (2) *Anomalous-desire stories*: The character is engaging in an action that does not directly fit with what the character likes; (3) *Anomalous-belief stories*: The character is engaging in an action that does not fit with the state of the reality (false-belief stories). Table 3.1 displays the nine stories used for the Explanation tasks.

[2] In accord with the study by Russell et al. (2001), in the present study children were also asked a "mean" question: *'Did you mean to draw an ear or did you mean to draw a handle?'* However, in the result section of the present study, only data concerning the "think" question are reported. The decision to exclude data concerning the "mean" question was based on two justifications. First, there were some difficulties in translating the verb "mean" in the Italian language. In fact, the Italian translation of the verb "mean" (intendere) is difficult and unfamiliar for young children. For this reason, in the present study the easier verb "volere" (want) was used. Second, from preliminary analyses, children's performance in the two questions (mean vs. think) was equivalent. The same result was found from Russell et al. (2001) with children of 3 years old.

Table 3.1 Stories used to describe action to-be-explained in the Explanation task

Neutral stories	Here is Marta. Marta is looking for her kitten behind the table. [*Lei è Marta. Marta sta cercando il suo gattino dietro il tavolo.*]
	Here is Paolo. This is a candy. Paolo is putting it in his mouth. [*Lui è Paolo. Questa è una caramella. Paolo se la sta mettendo in bocca.]*
	Here is Maria. Maria is going to buy an ice-cream at the ice-cream parlour. [*Lei è Maria. Maria sta andando a comprare un gelato in gelateria.*]
Anomalous-desire stories	Here is Giulia. These are apples. Giulia doesn't like apples. But now she is taking an apple. [*Lei è Giulia. Queste sono mele. A Giulia non piacciono le mele. Ma adesso lei sta prendendo una mela.*]
	Here is Maria. This is a frog. Maria doesn't like frogs. But now she is looking for a frog behind the table. [*Lei è Maria. Questa è una rana. A Maria non piacciono le rane. Ma adesso lei sta cercando una rana dietro il tavolo*.]
	Here is Filippo. This is a snake. Filippo doesn't like snakes. But now he's trying to catch a snake. [*Lui è Filippo. Questo è un serpente. A Filippo non piacciono i serpenti. Ma adesso lui sta cercando di acchiappare un serpente*.]
Anomalous-belief stories	Here is Luisa. Luisa is looking for her kitten. The kitten is behind under the chair. But Luisa is looking behind the table. [*Lei è Luisa. Luisa sta cercando il suo gattino. Il gattino si è nascosto dietro la sedia. Ma Luisa lo sta cercando dietro il tavolo.*]
	Here is Tommaso. This is a rock that looks like a peanut. Tommaso is putting it in his mouth. [*Lui è Tommaso. Questo è un sasso che assomiglia ad una nocciolina. Tommaso se lo sta mettendo in bocca*.]
	Here is Paolo. Paolo is going to this shop. This shop does not sell balloons. But Paolo is going to this shop to buy a balloon. [*Lui è Paolo. Paolo sta andando in questo negozio. In questo negozio non vendono palloni. Ma Paolo sta andando in questo negozio a comprare un pallone*.]

In each story, after the experimenter told to the child what was happening, she asked explanation questions: *'Why do you think (e.g.) Marta is doing that?'* If the child responded with anything other than an attribution of desire or belief, the experimenter simply repeated the 'why' question with premise information. The aim of the second 'why' question was to extend the

reasoning opportunities for the child to explain the action in terms of desires or beliefs. If the child did not respond with an attribution of desire or belief, or the answer was not completely clear, following Bartsch and Wellman (1989), the experimenter asked a desire or a belief prompt: *'What does Marta want?'* Desire prompts were given on the Anomalous-desire stories and on the second Neutral stories. Belief prompts were given on the first and third Neutral stories.

In Anomalous-belief stories, the child was asked to understand a false belief of the character, as well as provide an answer attributing a false belief. The procedure was analogous for Neutral and Anomalous-desire stories (first 'why' question, second 'why' question, prompt question). In Anomalous-desire stories, the experimenter checked that the child understood the character's preference before the first "why" question. In Anomalous-belief stories, the experimenter asked to the child a control question, '*where is the kitten?*', after the child's spontaneous or complete (when it was necessary) explanation. The order of presentation of the other three tasks was counterbalanced.

A modified version of the Bartsch and Wellman's coding system was used. In each kind of story, children received a score ranging from 0 to 3 on the basis of the number of Psychological explanation given. Table 3.2 shows the scheme for coding spontaneous and complete explanations in the three stories.

Table 3.2 Scheme for coding spontaneous and complete explanations for actions

<table>
<tr><td rowspan="2">1. Psychological explanations</td><td rowspan="2">Desire-beliefs</td><td>Beliefs</td><td>False belief*</td></tr>
<tr><td>Desires</td><td>Inconsistent desires**</td></tr>
<tr><td></td><td colspan="3">Other psychological states</td></tr>
<tr><td colspan="4">2. Non-psychological explanations</td></tr>
<tr><td colspan="4">3. No explanations attempted</td></tr>
</table>

* Only in Anomalous-belief stories; ** Only in Anomalous-desire stories

Each child's explanation for a single story was coded twice. First, to characterize a s*pontaneous explanation* (on the basis of what was said in the first and in the second "why"

question), and second, to characterize a c*omplete explanation* (the participant's comprehensive explanation, taking into account what was said before and after the belief or desire prompt).

As shown in Table 3.2, children's explanations in the three kinds of stories were first coded as being one of three general types: 1) an explanation referring to psychological causes, including the protagonist's desires, beliefs and other psychological constructs like physiology, perception, emotion, pretense, preference and traits; 2) an explanation referring to non-psychological causes such as external states of affairs, physical causes, or explanations that may have been but were not clearly psychological; or 3) a failure to generate an explanation at all. Second, within the category of psychological explanations, children's explanations that referred to desires and beliefs of the protagonist were coded. In Anomalous-desire stories, inconsistent desires were also coded, referring to a proper attribution of desire to the character, on the basis of what he/she likes, as an explanation of his/her action. In Anomalous-belief stories, false-belief explanation was coded, referring to whether a false belief was attributed to the character as an explanation of his/her action. When a child failed the control question, the answer was coded as 'no explanation attempted'. Appendix B shows examples of explanations, in each category, given by children in the three kinds of stories.

Reliability

Two coders categorized the explanations. Reliability was assessed for 25% of the sample. For Neutral stories, Cohen's Kappa was .94 and .91 for spontaneous and complete explanations, respectively. For Anomalous-desire stories, Kappa was .95 and .94, and for Anomalous-belief stories, Kappa was .93 and .92.

Analyses

First presented are results from the two preliminary tasks, the visual-perception task and the intention-understanding task, and the composition of three groups of children on the basis of their performance in these two tasks. Descriptive (frequencies and percentages) and Chi-squared analyses were used. Next, results are presented regarding children's performance in the explanation task, and the comparison between the three groups of children in the ability to explain action in a psychological way. The use of desire-belief explanations inconsistent-desire explanations, and false-belief explanations will be reported. In addition to descriptive analyses (means, standard deviations), simple and repeated-measure ANOVAs were conducted. In all ANOVAs with more than one factor, the *Eta* Value (η) was also reported as an index of the

variance explained by a specific factor. All the analyses were carried out using SPSS 11.5 and Statistica 6 for Windows.

3.3 Results

Visual perception task

Children performed well in the visual-perception task, reporting the two different perspectives (their own perspective and the one of their interlocutor). Fifty-nine of 80 (74%) children passed the task, correctly reporting what they and the other person saw in three items out of three. Children's performance was not related to gender ($\chi^2(1, N = 80) = 2.66$, $p = .103$), birth order ($\chi^2(1, N = 80) = 0.06$, $p = .799$), or the order of the questions ($\chi^2(1, N = 80) = 2.50$, $p = .114$). Figure 3.2 depicts the percentage of children giving correct answers.

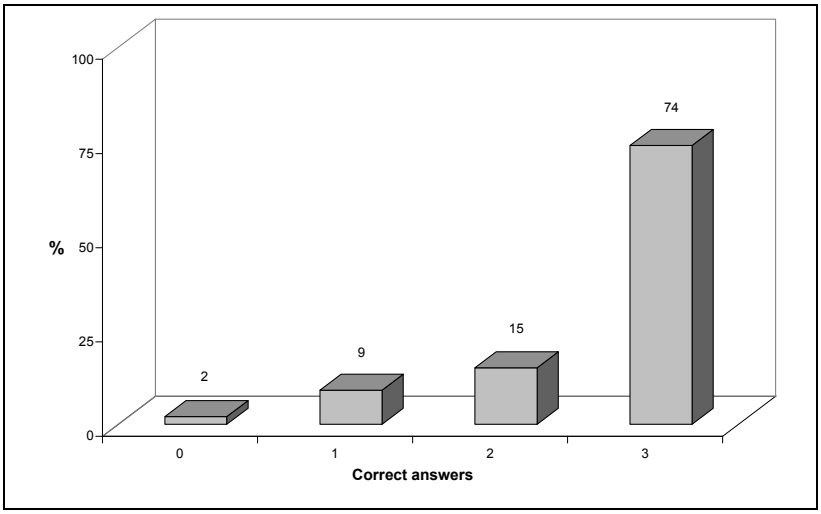


Figure 3.2 Percentages of children who correctly answered the Visual perception task.

Intention understanding task

Twenty children (25%) passed the intention-understanding task by correctly answering all four items. Thus, it could be argued that this ability is still developing at the age of three years.

Children's performance was not related to gender ($\chi^2(1, N = 80) = 1.27$, $p = .260$), birth order, ($\chi^2(1, N = 80) = 0.80$, $p = .371$) or order of items, ($\chi^2(3, N = 80) = 5.11$, $p = .164$), nor to the order of tasks (intention-understanding task/explanation task) ($\chi^2(1, N = 80) = 0.53$, $p = .818$). Figure 3.3 displays the percentage of children giving correct answers.

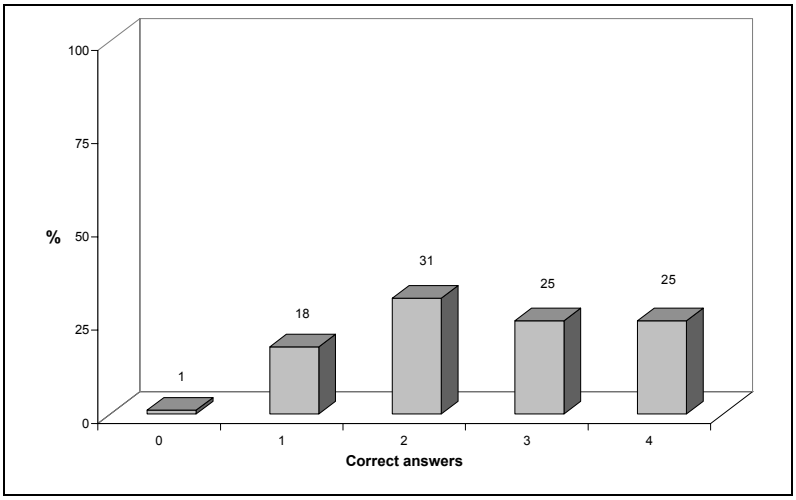


Figure 3.3 Percentages of children who correctly answered the Intention-understanding task.

Twenty children correctly answered all four items, 20 children correctly answered 3 items, 25 children were correct on two items, and 14 children were correct on only one item out of four. Only one child was not able to answer to any of the items. Thus half of the sample correctly answered at a greater-than-chance expectation of 50%.

Composition of groups of children based on performance in the visual-perception and intention-understanding tasks

In order to investigate how perception and intention understanding lead to the ability to explain actions in a psychological way, children were divided into three groups, based on the number of tasks they successfully passed. Table 3.3 shows the division of children, based on their performance in the two tasks.

The majority of children (56%) solved the Visual-perception task but not the Intention-understanding task, 19% failed both the tasks and 15.5% solved the both the tasks. A minority of the sample (7.5%) solved the intention-understanding task, but not the perception task.

Table 3.3 Distribution of children on the basis of their performance in the Visual perception task and on the Intention understanding task

		Intention-understanding task	
		Not passed	*Passed*
Visual-perception task	*Not passed*	15	6
	Passed	45	14

Three groups were formed in order to compare children who were not able to understand neither perception nor intention, children who were good only in understanding perception and children who showed a full ability in understanding both perception and intention. The groups were formed in the following way:

- *Low group:* Children who did not pass either the visual-perception or the intention-understanding task.
- *Middle group:* Children who passed the visual-perception but not the intention-understanding task.
- *High group:* Children who passed both the visual-perception task and the intention-understanding task.

The six participants with the unexpected profile were not considered in the following analyses.

Explanation task

Children received scores ranging from 0 to 3 in each explanatory category, reflecting the number of explanations given for each of the three stories. The same scoring system was used to evaluate the nested categories related to Psychological explanations, in accordance with the story type. Table 3.4 shows means and standard deviations for psychological explanations and nested categories used by children in the three kinds of stories.

Table 3.4 Means and standard deviations for psychological explanations and nested categories in the three kinds of stories (Maximum score 3).

Explanations	**Explanations**	
	Spontaneous	*Complete*
Neutral stories		
Psychological	1.88	2.42
	(0.98)	*(0.87)*
Desires-beliefs	0.95	2.07
	(0.99)	*(0.99)*
Anomalous-desire stories		
Psychological	1.96	2.49
	(1.08)	*(0.81)*
Desires-beliefs	1.39	2.24
	(1.17)	*(0.94)*
Inconsistent desires	0.43	0.45
	(0.76)	*(0.76)*
Anomalous-belief stories		
Psychological	1.69	2.41
	(1.19)	*(1.00)*
Desires-Beliefs	1.08	1.97
	(*1.11)*	(*1.20)*
False beliefs	0.19	0.61
	(0.54)	(0.*94)*

Psychological explanations. As shown in Table 3.4, children produced in the three kinds of stories a high number of spontaneous and complete explanations, respectively, showing their ability to explain actions. The majority of spontaneous explanations referred to psychological states, and half of them referred to desire-belief states. In the Neutral story condition, 89% of children explained the character's action by reporting a spontaneous psychological explanation at least one time, and this percentage increased to 95% with complete psychological explanations. The same result was found for Anomalous-desire stories; 88% of children provided a spontaneous psychological explanation at least once, and 96% of children provided at

least one complete psychological explanation. The number of children who gave a spontaneous explanation at least once in Anomalous-belief stories was smaller. Indeed, 77% of them reported a spontaneous psychological explanation, and 89% of them reported a complete psychological explanation. In general, in the three kinds of stories children produced at least one Psychological explanation (80% of the cases). The percentage of children that used spontaneous and complete psychological explanations in each kind of story was always equal to, or higher, than 60%. As expected, all the three kind of stories motivated children to explain the character's action by referring to mental states.

A series of analyses of variance were conducted in order to evaluate whether the gender, birth order of children, or order of story presentation had an effect on children's psychological explanations. A 2 (gender) x 3 (stories) x 2 (explanations) analysis of variance with repeated measures revealed only a main effect of explanation ($F(1,72) = 62.08$; $p < .001$; $\eta = .46$). No effect for gender or for stories was found, nor were interaction effects. Complete psychological explanations were, in all the three stories, and for boys and girls, significantly higher ($M = 2.43$; $SD = 0.74$) than spontaneous psychological explanations ($M = 1.84$; $SD = 0.87$). A second repeated-measures analysis of variance, 2 (order of birth) x 3 (stories) x 2 (explanations), was conducted. Again, only a main effect of explanation ($F(1,72) = 62.68$; $p = .001$; $\eta = .46$) was found. A third, 6 (sequence of stories) x 3 (stories) x 2 (explanations) with repeated measures confirmed the main effect of explanation ($F(1,68) = 62.20$; $p = .001$; $\eta = .45$). Thus, these variables were collapsed for further analyses.

Desire-belief explanations. Nested within the general psychological explanations, children's desire-belief explanations were considered.[3] A first repeated measure analysis of variance revealed that children produced a different number of spontaneous desire-belief explanations in the three stories ($F(2,146) = 5.97$; $p = .003$). Post-hoc tests of within-subjects contrasts indicated that children produced a higher number of spontaneous desire-belief explanations for Anomalous desire stories than for Neutral stories ($F(1,73) = 9.88$; $p = .002$) and

[3] Children's production of desire and belief explanations were considered together because the low number of belief explanations. In Neutral stories, 2 (3%) children produced a spontaneous belief explanation at least once, and 24 (38%) produced at least one complete belief explanation. In Anomalous-desire stories, 1 (1%) child produced a spontaneous belief explanation at least once, and 2 (5%) a complete belief explanation. In Anomalous-belief stories, 3 (4%) children produced a spontaneous belief explanation at least once, and 24 (46%) produced at least one complete belief explanation.

Anomalous belief stories ($F(1,73) = 7.07$; $p = .010$). However, these differences were not found for complete desire-belief explanations ($F(2,146) = 2.65$; $p = .074$).

In Neutral stories, 58% of children, at least once, explained in a spontaneous way the character's action using a desire-belief explanation, and 30% of children used such an explanation more than one time. These percentages increased with complete explanations; 90% of children explained the character's action using a complete desire-belief explanation at least once, and 73% of children used it more than one time. Children produced for Neutral stories more complete desire-belief explanations than spontaneous desire-belief explanations ($F(1,73) = 85.99$; $p = .0001$)[4]. In Anomalous-desire stories, children produced the highest number of spontaneous and complete desire-belief explanations. Seventy percent of children used Spontaneous desire-belief explanations at least one time, and 43% of them used them more than one time. These percentages increased for complete explanations; 92% of children explained the action at least one time in terms of desire-belief, and 81% did so more than one time. Also the mean number of complete desire-belief explanations was higher than that of spontaneous desire-belief explanations ($F(1,73) = 58.12$; $p = .0001$)[4].

As expected, explaining the character's behavior in Anomalous-belief stories was the most difficult task for children. Only 55% of children provided, at least one time, a spontaneous desire-belief explanation, and 39% children did so more than one time. This percentage increased for complete explanations, as 78% of children used a complete desire-belief explanation at least one time, and 70% did so more than one time. This result confirms children's difficulty in dealing with stories that include a salient aspect related to beliefs. More than in the other stories, non-psychological explanations were used to explain the protagonist's action. However, children produced in also for Anomalous belief stories more complete desire-belief explanations than spontaneous desire-belief explanations ($F(1,73) = 54.30$; $p = .0001$)[4].

Inconsistent-desire explanations. In Anomalous-desire stories, an additional kind of explanation was considered; called inconsistent desires. This kind of desire explanation takes into account the discrepancy between the protagonist's preferences and his/her current action (see Appendix B for some examples of this explanation). This kind of explanation was quite difficult for children, and the prompt question did not assist them (with the exception of one participant) in increasing the number of inconsistent-desire explanations. Thirty-one percent of children spontaneously explained the story, at least once, in terms of inconsistent desire, and

32% of them did so at least once with a complete explanation. It could be argued that this kind of explanation is quite difficult for children at 3 years of age.

False-belief explanations. Only 12% of children explained, at least one time, the character's action with a spontaneous false-belief explanation, but the 36% of them did so for complete false-belief explanations. The number of complete false-belief explanations was significantly higher than the number of spontaneous false-belief explanations ($F(1,73) = 27.87$; $p = .001$)[4].

The role of perception and intention understanding on children's explanation of actions

The three groups of children were compared, in order to evaluate their spontaneous and complete psychological, desire-belief, inconsistent-desire, and false-belief explanations in the three kinds of stories. Table 3.5 shows means and standard deviations of the different kinds of explanations produced by the three groups of children.

3.5 Means and standard deviations of psychological, desire-belief, inconsistent-desire, and false-belief explanations produced by the three groups of children.

	Psychological Explanations (Max score 9)		**Desire-belief explanations** (Max score 9)		**Inconsistent-desire explanations** (Max score 3)		**False-belief explanations** (Max score 3)	
	Spont.	Compl.	Spont.	Compl.	Spont.	Compl.	Spont.	Compl.
Low group	3.66 *(2.19)*	5.60 *(2.74)*	1.46 *(1.64)*	4.13 *(2.77)*	0.00 *(0.00)*	0.00 *(0.00)*	0.00 *(0.00)*	0.00 *(0.00)*
Middle group	6.08 *(2.52)*	7.66 *(1.94)*	3.66 *(2.57)*	6.57 *(2.39)*	0.40 *(0.65)*	0.40 *(0.65)*	0.27 *(0.65)*	0.78 *(1.04)*
High group	5.71 *(2.58)*	8.00 *(1.70)*	4.78 *(2.86)*	7.64 *(1.82)*	1.00 *(1.10)*	1.07 *(1.07)*	0.14 *(0.36)*	0.71 *(0.91)*

Psychological explanations. The number of spontaneous psychological explanations produced by children in the three groups was significantly different ($F(2,71) = 5.45$; $p = .006$). A

[4] Repeated measure analysis of variance.

Tukey's test revealed that the Low group produced significantly fewer spontaneous psychological explanations, compared to the Middle group (p = .004). A non-significant trend in the expected direction was found between the Low and the High groups (p = .07). Also, the number complete psychological explanations produced by children in the three groups differed significantly (F(2,71) = 6.45; p = .003). A Tukey's test revealed that the Low group produced significantly fewer complete psychological explanations, compared to the Middle group (p = .004) and the High group (p = .008). Figure 3.4 reports the means of spontaneous and complete explanations produced by the three groups of children.

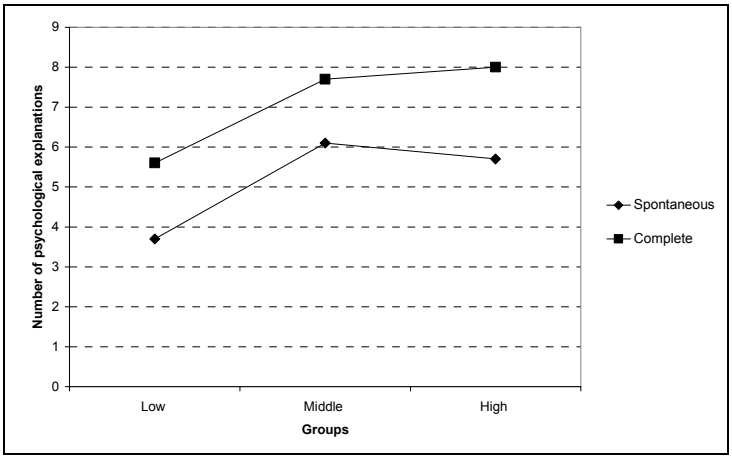


Figure 3.4 Mean scores of the total number of spontaneous and complete psychological explanations produced by the three groups of children.

Children who did not pass the visual-perception and the intention-understanding tasks (Low group) produced fewer psychological explanations than the other two groups. However, no difference was found between children who passed only the visual-perception task and those that passed both of the tasks.

Desire-belief explanations. Preliminary analyses of variance were conducted in order to evaluate the general production (in all the three kinds of stories) of desire-belief explanations. The three groups of children produced a significantly different mean number of spontaneous desire-belief explanations (F(2,71) = 7.01; p =.002). Tukey's tests revealed that Low children (M = 1.46; SD = 1.64) produced significantly less spontaneous desire-belief explanations than

Middle children (M = 3.66; SD = 2.57; p = .011) and High children (M = 4.78; SD = 2.86; p = .002). The three groups of children produced also a significant different mean number of complete desire-belief explanations (F(2,71) = 8.71; p = .0001). Tukey's tests revealed that Low children (M 4.13, SD 2.77) produced significantly less spontaneous desire-belief explanations than Middle children (M = 6.57; SD = 2.39; p = .003) and High children (M = 7.64; SD = 1.82; p = .001). Table 3.6 report means and standard deviations of spontaneous and complete desire-belief explanations produced by children in the three kinds of stories.

Table 3.6 Means and standard deviations of spontaneous and complete desire-belief explanations produced by children in the three kinds of stories.

	Neutral stories (Max score 3)		**Anomalous-desire stories** (Max score 3)		**Anomalous-belief stories** (Max score 3)	
	Spont.	Compl.	Spont.	Compl.	Spont.	Compl.
Low group	0.66 *(0.63)*	1.40 *(1.05)*	0.60 *(0.91)*	1.80 *(1.20)*	0.27 *(0.59)*	0.93 *(1.00)*
Middle group	0.89 *(1.00)*	2.11 *(.96)*	1.51 *(1.10)*	2.20 *(0.97)*	1.27 *(0.65)*	2.13 *(1.14)*
High group	1.57 *(1.01)*	2.64 *(0.63)*	1.86 *(1.29)*	2.36 *(0.74)*	1.36 *(1.08)*	2.57 *(0.85)*

An analysis of variance conducted to evaluate spontaneous desire-belief explanations produced for Neutral stories by the three groups of children, yielded a significant effect (F(2,71) = 4.01; p = .022). A Tukey's test revealed that High children produced significantly more spontaneous desire-belief explanations than Low children (p = .022). The difference between High and Middle children approached significance (p = .059). The three groups of children also produced a significantly different number of complete desire-belief explanations (F(2,71) = 6.60; p = .002). A Tukey's test revealed that Middle children produced more complete explanations than Low children (p = .033). High children also produced more complete explanations than Low children (p = .002). Figure 3.5 reports the mean scores for spontaneous and complete desire-belief explanations produced by the three groups of children for Neutral stories.

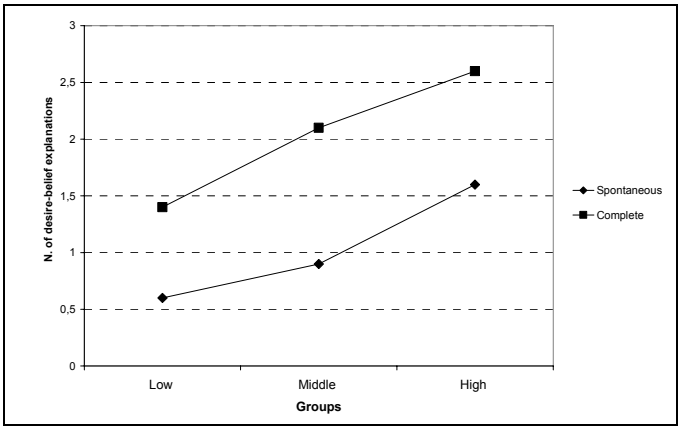


Figure 3.5 Mean scores of spontaneous and complete desire-beliefs explanations produced by the three groups of children for Neutral stories.

As shown in Figure 3.5, the production of spontaneous and complete desire-belief explanations increased in the three groups of children. In sum, the three groups explained Neutral stories using a different number of desire-belief explanations. Children passed neither the visual-perception or the intention tasks (Low group) produced the lowest number of spontaneous and complete desire-belief explanations.

An initial analysis of variance conducted to evaluate spontaneous desire-belief explanations produced by the three groups of children in Anomalous-desire stories, revealed a significant effect ($F(2,71) = 5.36$; $p = .007$). Tukey's tests revealed that Middle children ($p = .019$), as well as High children ($p = .009$), produced more spontaneous desire-belief explanations than Low children. However, the production of complete desire-belief explanations was not different in the three groups of children ($F(2,71) = 2.18$; $p = .121$). Figure 3.6 shows the mean scores of spontaneous and complete desire-belief explanations produced by the three groups of children in Anomalous-desire stories.

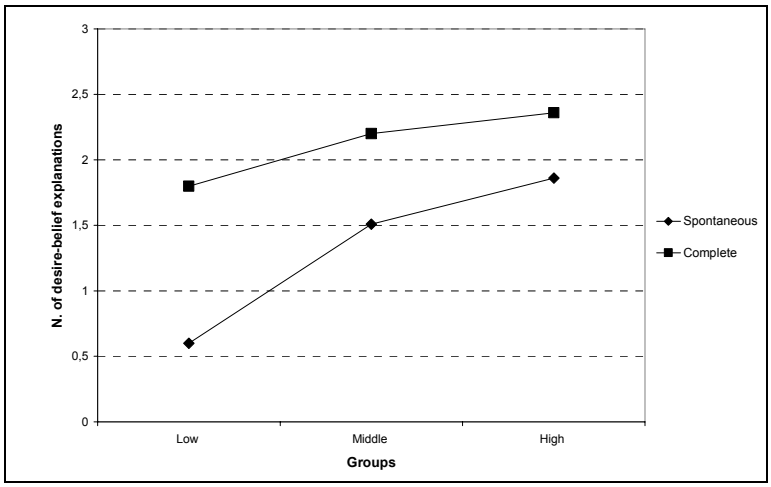


Figure 3.6. Mean scores of spontaneous and complete desire-belief explanations produced by the three groups of children in Anomalous-desire stories.

Children who did not pass the visual-perception task produced a low number of spontaneous desire-belief explanations. However, this difference between groups was no longer present in their number of complete explanations.

An analysis of variance was conducted to evaluate the spontaneous desire-belief explanations for Anomalous-belief stories produced by the three groups of children. This test yielded a significant effect ($F(2,71) = 5.65$; $p = .005$). Tukey's tests revealed that Middle children produced more complete explanations than Low children ($p = .006$), and that High children also produced more complete explanations than Low children ($p = .019$). A second analysis of variance conducted on complete desire-belief explanations strengthened this finding ($F(2,71) = 9.51$; $p = .000$). Again, Tukey's post-hoc tests revealed that Middle children produced more complete explanations than Low children ($p = .001$), and that High children also produced more complete explanations than Low children ($p = .0001$). Figure 3.7 reports the mean score for spontaneous and complete desire-belief explanations produced by the three groups of children.

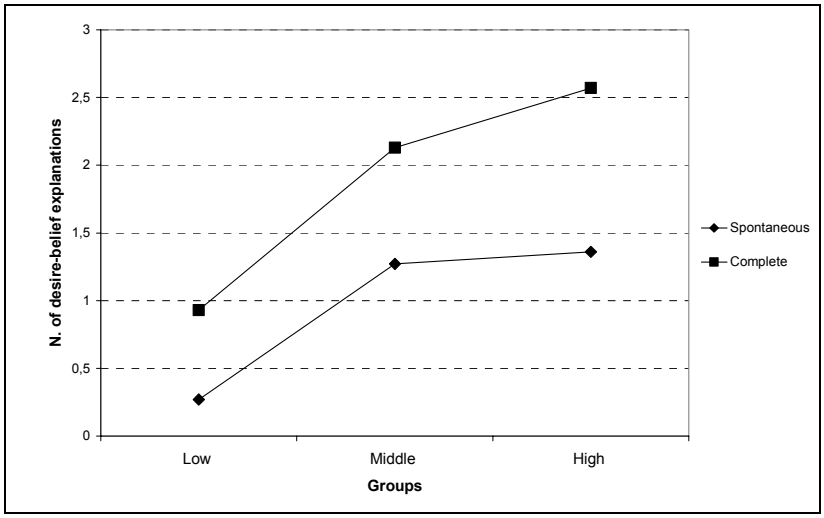


Figure 3.7 Mean scores of spontaneous and complete desire-beliefs explanations produced by the three groups of children in Anomalous-belief stories.

In Anomalous-belief stories, as well as in Neutral stories and Anomalous-desire stories, the children that produced the least number of desire-belief explanations were those in the Low group (children who failed both the visual-perception and the intention-understanding task). However, the performance of the Middle group was very similar to that of the High group. Thus, in stories with anomalous-belief content, visual-perception understanding is related to children's ability to explain actions in terms of desires and beliefs.

Inconsistent desires. Table 3.5 shows the means and standard deviations of spontaneous and complete inconsistent-desire explanations produced by the three groups for the Anomalous-desire stories.

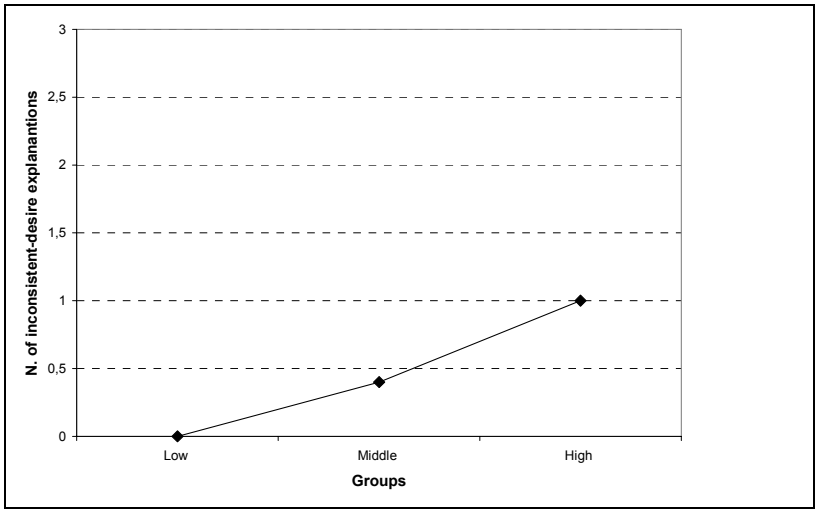


Figure 3.8 Mean scores of spontaneous inconsistent-desire explanations produced by the three groups of children.

Children of the Low group did not produce any inconsistent-desire explanations. Thus, they never explained the protagonist's action – neither with a spontaneous or a complete explanation – by taking into consideration the information about the preference of the protagonist. An analysis of variance was conducted in order to evaluate whether there was a difference in the production of spontaneous inconsistent desires in the other two groups. The result confirmed that the two groups of children produced on average a different number of inconsistent-desire explanations ($F(1,57) = 6.14$; $p = .014$). Children of the High group produced significantly more inconsistent-desire explanations than children of the Middle group. Figure 3.8 shows means of inconsistent-desire explanations produced by the three groups of children. A second analysis of variance examining the number of complete inconsistent-desire explanations was not conducted because only one child increased his production from the spontaneous to the complete answer. Thus, children who successfully passed the intention-understanding task were more able to produce inconsistent-desire explanations than children passing only the visual-perception task.

In general, children showed a good ability in explaining Anomalous-desire stories by referring to the protagonist's desires and beliefs. However, it could be argued that the ability to

produce inconsistent-desire explanations is still developing at this age, and that there is a relation between this kind of explanation and the understanding of intentions.

False belief. Table 3.5 reports means and standard deviations of false-belief explanations produced by the three groups of children. While the prompt question did not increase the number of inconsistent desires reported in Anomalous stories, it did increase the production of false-beliefs explanations in Anomalous-belief stories. For the production of false belief in Anomalous-belief stories, children of the Low group did not produce any false-belief explanations. Thus, children who failed both the visual-perception task and the intention-understanding task never explained the protagonist's action - either with a spontaneous or a complete explanation – by considering the information about the situation in the story. Figure 3.9 reports means of false-belief explanations produced by the three groups.

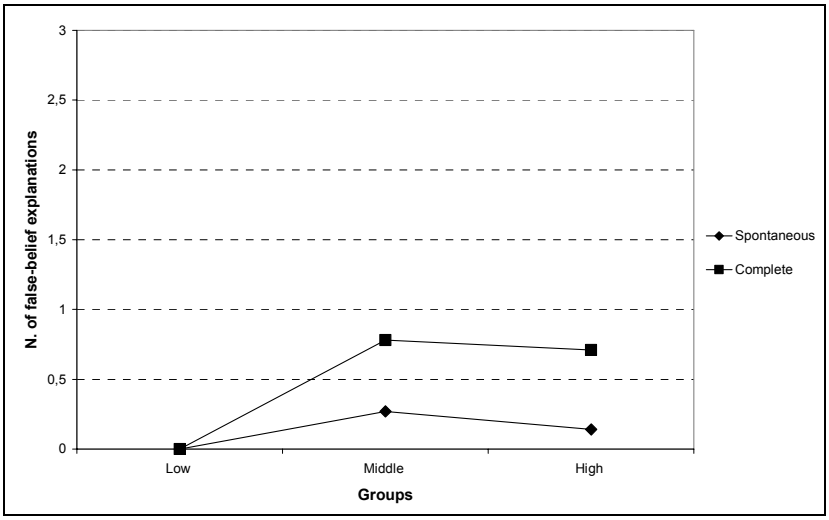


Figure 3.9 Mean scores of spontaneous and complete false-belief explanations produced by the three groups of children.

An initial analysis of variance examining the production of spontaneous false-belief explanations in the two groups (Middle and High), was not significant ($F(1,57) = 0.45$; $p = .502$). Thus, children who solved the intention-understanding task did not produce more false-

belief explanations than children who did not pass the task. A second ANOVA, examining the production of complete false-belief explanations of the two groups (Middle and High), confirmed the same effect ($F(1,57) = 0.41$; $p = .838$).

In sum, the understanding of visual perception was related to the production of inconsistent-desire and false-belief explanations. Moreover, children who solved the intention-understanding task also produced a greater number of inconsistent-desires explanations, but the same effect was not found for the production of false-belief explanations.

3.4 Conclusion

The three tasks used in the present study evaluated Italian children's understanding of perception and intentions, and their ability to explain actions in terms of mental states. Children were able to understand the translated version of the tasks, and their performance was similar to those found in previous studies (Bartsch & Wellman, 1989; Flavell, et al., 1981; Russell et al., 2001). In the visual-perception and intention-understanding tasks, both the figures and main sentences were familiar to children. The Explanation task version used here was also understood well by children, even if some objects were different from the original version (e.g., the piano *vs.* the table).

Young children's understanding of perception and intention. The majority of children (74%) were able to solve the visual-perception task, answering to all 3 items. However, the level of performance was lower than the 100% reported by Flavell et al. (1981) using 15 participants, the 89% reported by Gopnik, Slaughter and Meltzoff (1994) using 18 participants, and the 94% reported by Wellman et al. (2000) using 17 participants. It might be argued that this result is due to the fact that the sample investigated in the present study had a mean age lower than that of children in previous studies.

With regard to intention, only one half of the sample correctly solved the intention-understanding task at a level significantly greater than the chance expectation of 50%. Children's performance was lower than that reported by Russell et al. (2001) for a group of 3-year-old children, with 69% of children (11 children out of 16) passing the task. Thus, 3-years-olds did not show good performance in understanding intentions within an experimental context, even if in naturalistic observation they seem able to refer to intentions before they carry out an

action (Bretherton et al., 1981; Dunn, 1988). However, this result is consistent with other, experimental investigations (Feinfield et al., 1999; Schult, 2002; Schultz et al., 1980).

Fifty-six percent of children were able to solve the visual-perception task but not the intention-understanding task. This result suggests that at the age of three years children are already able to manage with visual perception (of Level 1) but not with intentions. Only six children (7.5%) who failed the visual-perception task were able to solve the intention-understanding task. Thus, although a general developmental pattern is present, there are also still some individual differences in the emergence of specific abilities at the age of three. Only a longitudinal study might shed light upon the order in which these abilities emerge, and whether there is a casual relationship between them. However, the results of the present study support the claim that perspective taking precedes the understanding of intentions, as well as the understanding of other mental states.

Young children's ability to explain actions in terms of mental states. In the present study children were able to explain actions by referring to psychological states, especially desires and beliefs. This result confirms findings from previous investigations (Bartsch & Wellman, 1989, 1995; Wellman & Bartsch, 1988; Wellman & Woolley, 1990), namely the idea that 3-year-olds already have a basic grasp of the rudiments of belief-desire psychology.

Children produced, on average, the same number of spontaneous and complete psychological explanations for the three kinds of stories. However, some differences in children's desire-belief explanations for the three kinds of stories were found. In particular, children produced the highest number of spontaneous desire-belief explanations in Anomalous desire stories. In accordance with the view that at the age of three children have a desire-belief psychology (Bartsch & Wellman, 1995), it could be argued that this kind of story urged more children's explanations based on desires. Moreover, children's performance increased after the prompt, above all assisting their false-belief explanations. This result is consistent with the Vygotskian perspective proposed by Astington (1996). She claims that children's complete explanations in this kind of task inform us about their understanding on the "intermental plane". This is the zone of proximal development in which the child is guided by the adult's leading questions.

As expected, some aspects investigated in the present study were more demanding for children, like to explain Anomalous-desire stories with inconsistent-desire explanations. An inconsistent desire is a desire that is not based on the current action of the agent, but on the

previous information regarding the agent's preference. It requires the child to understand the implied plan behind a specific action. Thus, the child is asked to explain the character's desire not only on the basis of the action, but also on the basis of the character's preferences. The ability to explain others' actions in terms of inconsistent desires was a difficult task for children at the age of three, as were false-belief explanations. Only 31% of them were able to explain spontaneously, at least one time, a story by referring to an inconsistent desire, and 32% did it in a complete explanation. Children were more likely to use simple desires like "he wants to play with the frog", without taking into consideration the previous information. Children's difficulty with inconsistent desires is in accordance with 3-year-olds' difficulty in understanding conflicting desires (Moore et al., 1995: Rieffe et al., 2001). However, it is important to note that in contrast to conflicting desires, in which there is a conflict between the preference of the children and the preference of the character, in inconsistent desires the conflict is between the preference and the actions of the character. The study of Moore et al. (1995) shows that children are not able to appreciate that a story character could have a different desire from them, when that desire is consistent with the character's past experience. In the same way, children in the present study were not able to find another desire, in explaining a character's action that matched the protagonist's own preferences. Children were more likely to explain the action in terms of desires that are consistent only with the action (e.g. if Giulia is taking an apple, it is because she wants to eat it). According to Astington and Gopnik (1991), children's explanations that include a simple desire, instead of an inconsistent desire, should indicate that they identify the desire of the character with the current action. It could be argued that, during the third year of life, the ability to explain others' actions in terms of desires is already developed. However, still undeveloped is the ability to explain others' actions in terms of desires that take into account the others' point of view or preferences. This kind of desires are implicit, thus the child has to infer them. An effect due to the executive component of the task should also be considered (Moore et al., 1995). In fact, it could be argued that the character's action is the strongest component of the story, and children could have difficulties in "disengaging" from what the character is currently doing and the simple desire related to that action.

Thirty-six percent of the children produced at least one false-belief explanation in their complete answers. This result is consistent with the probability percentage of being correct, reported in the meta-analyses of Wellman et al. (2001) for children of three years of age (34%). The prompt question often directed the child's implicit false-belief explanation to a more

explicit one. Below, two examples of implicit false-belief explanations that became explicit after the prompt question are reported:

Example 1 (First Anomalous-belief story)

Child:	It is here *(she points at the chair)* but she goes to look for it behind the table
Experimenter:	Why she is looking behind the table?
Child:	Because if the kitty is here (*she points at the chair)* she should come here to take it
Experimenter:	What does she think?
Child:	She thinks the kitty is here *(she points at the table)* but in fact the kitty is here *(she points at the chair)*

Example 2 (Third Anomalous-belief story)

Child:	Because he is going there to do that
Experimenter:	But why is he going to this shop if they don't sell balloons there?
Child:	Because he wants a balloon
Experimenter:	What does he think?
Child:	He thinks they sell balloons but they do not

It could be argued, on the basis of these examples, that even if children are able to understand the false belief of the character, they find it more normal to explain the character's behavior in terms of desires or external justifications. Only when they are asked about the character's belief proposition is the false belief reported.

In contrast to false-belief explanations, the prompt question did not increase the number of children's inconsistent-desire explanations for Anomalous desire stories. This result could be related to the nature of the prompt questions. The prompt question, "What does… want?", only stresses the immediate desire related to the action of the character, giving no clue about the character's previous preferences. This probably did not help the child in construing another desire that was not consistent with what the character was currently doing without to take in consideration the character's preference. Differently, the prompt question, "What does … think?", for Anomalous-belief stories stressed the character's belief. In this case, there is a closer

relationship between what the character is doing and what is thinking (e.g., if she is going there to look for her kitty, (what does she think?) she thinks the kitty is there). For this kind of story, after the prompt, the child has only to find the logical mental state related to the action. Differently, for the Anomalous-desire story the child is asked to find another plausible reason for the action of the character.

Relationship between the understanding of perception and intention and the ability to explain others' actions in terms of mental states. A main aim of the present study was to evaluate whether understandings of perception and intention influence the way children explain others' actions. The results are synthesized in Figure 3.10.

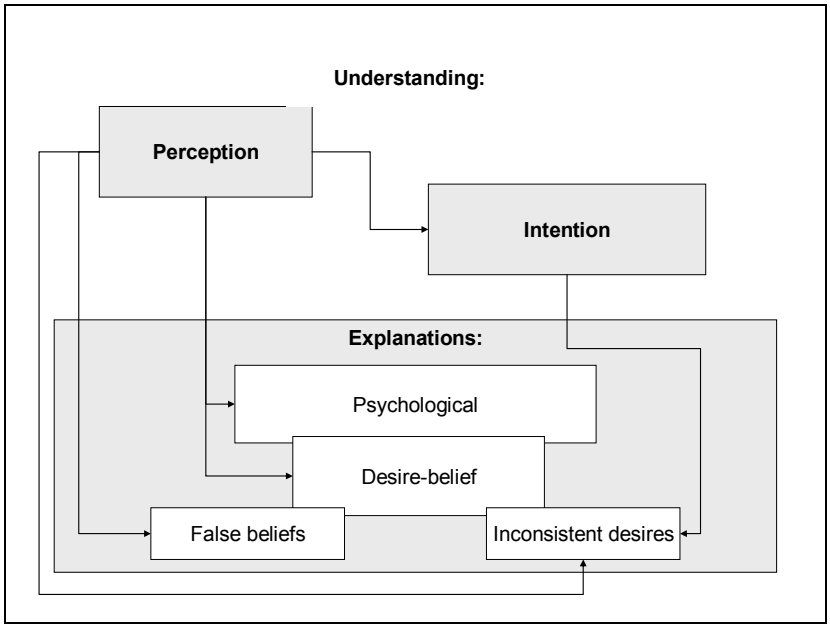


Figure 3.10 Results about the relationship between Visual perception and Intention understanding and children's ability to explain actions in terms of mental states.

Visual perception understanding had a strong influence on children's ability to explain actions in terms of mental states. Children who failed the visual-perception task were also less likely to produce psychological explanations, and the nested desire-beliefs explanations. Moreover, this ability was a prerequisite for higher-level explanations. In fact, children who did

not pass this task did not produce any false-belief or inconsistent-desire explanations. It could be argued, in spite of Searle's (1983) point of view, that perceptions are equally related to beliefs and desires. This relationship with desires is consistent with the study of Wellman et al. (2000). More presumably, the general ability to assume the point of view of another person is an important prerequisite in order to understand the fact that another person can desire or belief something. Thus, perceptions form a base for the understanding of mental states. On the basis of this, it is possible to explain or to predict the behavior in an intentional way.

As expected, perception understanding resulted to be a necessary ability in order to explain others' behavior in a psychological way. However, it was not sufficient in order to explain an anomalous action with an inconsistent-desire. Both perception and intention understanding resulted important prerequisites for this kind of explanation. In fact, children who solved the intention-understanding task had a better performance in producing inconsistent-desire explanations than children who passed only the perception-understanding task. The relationship found in the present research between intention understanding and inconsistent-desire explanations is consistent with the ideas of Wellman (1990) about the strong connection between desires and intentions. Defining intentions as "plans to actualize certain desires" (Wellman, 1990), it was expected to find a relationship between them and desires that require higher level of representation. The relationship between the understanding of intentions and the understanding of high level of desires is strengthened by the fact that no relationship was found, neither in the study of Russell et al. (2001), between intention understanding and false-belief explanations.

In general, two important results were found in the present study. The first is that both perception and intention understandings play an important role in children's ability to explain others' actions. The second is the fact that young children do not always find beliefs more difficult to incorporate into their explanations than they do desires. Desires with a higher level of representation may be as difficult to understand as beliefs on a comparable level, such as false beliefs.

PART 2

Socio-cognitive abilities in infancy as precursors of a theory of mind

Cristina Colonnesi

Chapter 4

Precursors of a theory of mind

4.1 Introduction

How is it that at the age of 3 years children develop a theory of mind, yet children younger that 3 years have a very limited, if not altogether absent, understanding of both their own and other people's minds?

A shift in focus from preschool age to infancy, in order to investigate social sensitivity, is one recent trend. As presented in Paragraph 1.3, there are theoretical accounts of the existence of a relation between some socio-cognitive abilities that emerge during infancy and children's later theory of mind. However, there are no studies that analyze the progression of theory of mind from infancy to preschool and school age. The main reason for this is methodological in nature. Indeed, the well-established techniques that are suitable to investigate socio-cognitive abilities during infancy are not adequate once children begin to talk. In the same way, standard tasks used to investigate theory of mind, starting from preschool age, are too much for infants, both in a cognitive and a linguistic sense. The result is that there exists a large gap (of about 20 months) between theory-of-mind precursors and the abilities examined in standard theory-of-mind tasks. Some investigators have created non-verbal tests in order to investigate children's understanding of mental states in the period of late infancy (Meltzoff, 1995; Repacholi and Gopnik, 1997). Some additional steps are necessary in order to have a clear picture about the hierarchical development of theory of mind in the first 5 years of life.

In the following paragraphs, after a general consideration of the emergence of the most important socio-cognitive abilities during infancy, infants' pointing gesture and their

understanding of intentional actions are reported and discussed. The last part of the chapter includes a review of longitudinal studies that have, particularly in the last five years, investigated a possible relationship between precursors and the later theory-of-mind ability. This chapter precedes chapter 5, which reports a longitudinal investigation on the relation between both the pointing gesture and intention understandings during infancy and some theory-of-mind abilities (production of psychological explanations and understanding of perceptions and intentions) at the age of 3 years.

4.2. Infants' socio-cognitive abilities

There is a great deal of evidence in the literature that suggests the presence of knowledge about the mind during infancy. Carpenter, Nagell and Tomasello (1998) presented a clear and exhaustive picture of the main abilities that develop between the end of the first and the beginning of the second year of life, and that may be considered as the first socio-cognitive abilities to arise during infancy. Figure 4.1 displays a chart of these abilities.

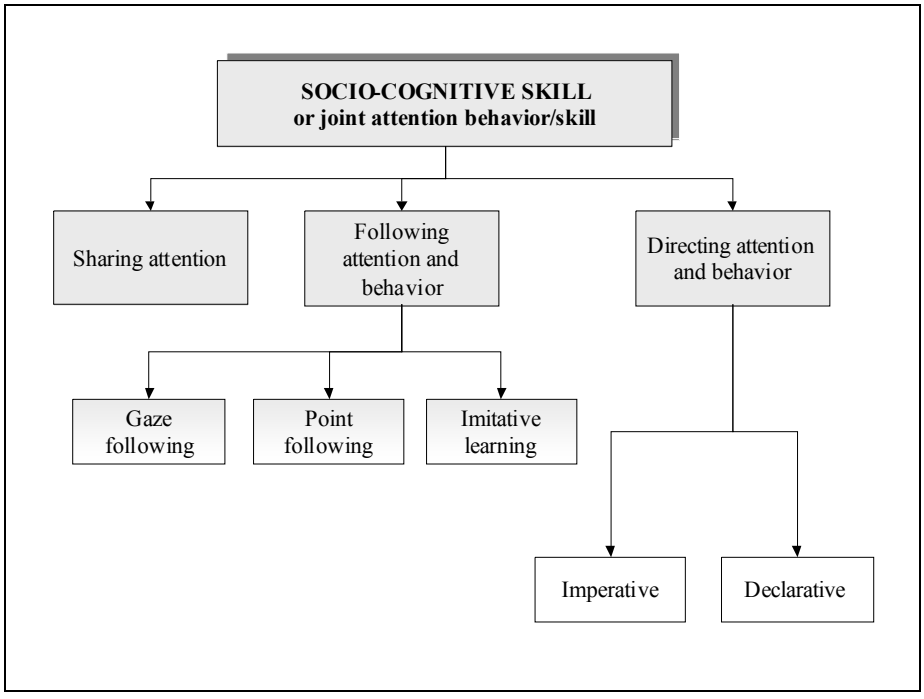


Figure 4.1 Socio-cognitive skills on the basis of Carpenter, Nagell and Tomasello (1998).

The main ability to arise in infancy is children's joint-attentional behavior, which represents the first "meeting of minds". That is, joint-attentional behavior refers to infants' ability to share experiences with other people through acts of communication about the outside world (Bruner, 1983). Starting from the moment infants are born, they display a consistent number of abilities that assist them in understanding people. For example, they are particularly interested in human faces, voices and movements. They can discriminate different facial expressions (Nelson, 1987). They are attentive to and can distinguish between different voices (Cooper & Aslin, 1989). With regard to imitation, even newborns seem to be able to represent and imitate another person's movements (Meltzoff & Moore, 1994). All of these abilities can be considered as a foundational to infant's social-cognitive development. However, their existence does not prove that children are able to understand that other people are psychological agents who can interact with and show interest in outside entities such as objects. In fact, infants' interactions during the first months of their life are dyadic, meaning that they are able to interact with another person or with an object, but not with both of them at the same time. Only during the second part of the first year do interactions became triadic, meaning that children start to share attention to an object with another person (Trevarthen & Hubley, 1978). These are interactions in which the child, for example, gives or asks to the other person for an object that he or she wants. There are some agreements in the literature that these behaviors may be interpreted as the infant's beginning to understand other persons as intentional agents (Tomasello, 1995). In other words, children at this point seem to recognize that other people are animate beings who are able to direct their attention toward something, to control their spontaneous behavior, and to make active choices in order to achieve their personal goals (Baldwin, 1995). Coming back to Figure 4.1, these triadic interactions are considered to reflect infants' socio-cognitive skill of joint-attention behavior.

There are three main behaviors that give evidence regarding this ability: (1) sharing attention, (2) the ability to follow attention and behavior, and (3) the ability to direct attention and behavior.

Sharing attention

During the sharing of attention, or joint engagement, the infant divides the attention between another person and an object or an event of mutual interest for a few seconds. For example, the infant and the adult are playing together with a toy and the infant looks repeatedly to the toy and to the other person. Thus, gaze alternation is the main indicator of this ability. The first study on sharing attention was conducted by Trevarthen and Hubley (1978), on a single

child observed longitudinally in a laboratory during her first year of life. During the first 6 months, she was able to direct her attention to her mother and to a specific object, but not to both of them at the same time. When she was 8 months old, she started to coordinate her attention and smile during a game with an object and the mother. This result was confirmed by the more recent research of Saxon, Frick, and Colombo (1997).

Bakeman and Adamson (1984) conducted another relevant investigation on infants' shared attention. They carried out a longitudinal study on 28 infants, observed from the age of 6 to 8 months. Children were observed four times during a spontaneous game at home with the mother. Results indicated that the frequency of occurrence of joint engagement, the percentage of time spent in joint engagement, and the duration of joint engagement episodes increased with age.

Following attention and behavior

This refers to an infant's ability to follow the direction of another person's visual gaze or manual pointing gesture to an object or event. According to Carpenter et al. (1998), it represents the ability to understand the psychological relation between a person and the outside world. Three specific abilities are considered with respect to the main ability of following attention and behavior: gaze-following, point-following, and imitative learning.

Gaze following occurs when the infant looks where someone else is looking (Butterworth, 1991). An example of this behavior is when a specific event happens (for example an airplane is flying), and the noise attracts the attention of both the child and the mother. The child directs the attention to the event that the adult is looking at, and then to the adult as a way to monitor the adult's attention. Scaife and Bruner (1975) conducted the first, systematic study on infants' ability to follow the gaze of another person, using infants aged 2-14 months. During the experiment an adult was seated in front of the infant, and in each trial the adult first established eye contact with the infant. After eye contact was established, the adult shifted the direction of her gaze, turning her head toward one of several locations in the room. There were no specific targets that the infant could see, only concealed marks on the wall. Thirty percent of 2-4-month-olds, 39% of 5-7-month-olds, 67% of 8-10-month-olds, and 100% of 11-14-month-olds followed the adult's gaze on at least one of two trials. Thus, even infants as young as 2-4-months old seemed to be able to follow the gaze of another person. Another, relevant study on infant gaze following was conducted by Corkum and Moore (1995), using the same procedure as Scaife and Bruner (1975). In contrast to the previous study, Corkum and Moore found that

only around 10 months of age were infants able to follow the direction of an adult's gaze (see also D'Entremont, Hains & Muir, 1997).

Morissette, Ricard and Gouin-Décarie (1995) conducted a longitudinal study, in which infants were observed every 3 months between 6 and 18 months of age. They found that an infant's ability to look at the target of the experimenter's attention varied on the basis of age. In particular, at 12-15 months infants responded correctly only when the target was located, with respect to them, nearby and at a narrow angle. Only around 18 months were they able to respond correctly when the target was positioned at greater distances and wider angles.

Butterworth and colleagues conducted a series of studies, varying the target locations with respect to the position in the infant's scan path and visual field. Six-month-olds localized the target when there was just an object (Butterworth & Cochran, 1980; Butterworth & Jarrett, 1991). However, when more than one target was presented, they looked to the same side of the room as the adult but were not able to correctly locate the particular target (Butterworth, 1991; Butterworth & Jarrett, 1991). Starting from 12 months of age, infants were able to respond correctly when the target was the second object along their scan path (Butterworth & Jarrett, 1991). Finally, at 18 months of age they were able to localize the target even when more than two targets were presented (Butterworth & Cochran, 1980). The studies presented here suggest that only after 10-12 months of age do children become able to locate specific targets by following an adult's gaze.

Point following refers to a child's ability to direct her attention toward an object or event at which another person is pointing. There is no evidence in the literature that children show this ability before the ninth month of life. Often-cited is the result of Butterworth and Grover (1988, 1990) that infants of 6-9-months of age were more likely to look at the mother's pointing hand than at the pointed object. However, at around 12 months of age infants are able to locate the object being pointed at. The ability to understand the pointing gesture will be considered again in Paragraph 4.3.

Imitative learning refers to an infant's ability to follow adult behavior with respect to an outside object. In contrast to gaze following and point following, this behavior does not refer to the child's understanding about where the adult's attention is directed. Instead, it refers to the infant's understanding of the adult's psychological state toward a specific object and, as a consequence, to the learning of a new behavior as a result of observation. Simple imitation by the infant precedes a more advanced, imitative learning ability. Pawlby (1977) conducted an early study on this capacity, by observing eight infants longitudinally, from the age of 4 to the

age of 10, interacting with their mothers. An increasing production of simple imitative acts was found during this period of time.

A well-known study on infants' imitative learning was conducted by Meltzoff (1988). Fourteen-month-olds were separated into three groups, and shown a number of actions upon six novel objects. The infant could see the adult performing the action with the object, but it was not possible to touch the object. Then, a week-long memory delay was interposed. One of the actions was quite unusual. The object was a flat box with a translucent top panel. The adult action was to touch the panel with the top of the head, making the top panel light up. Two-thirds of the infants in the imitation condition imitated the unusual head-touching action after a week. Two other control groups were used (the first group did not see the adult doing any kind of action with the object, the second group saw the adult manipulate the object without demonstrating the target behavior). No children in the control groups spontaneously performed the act touching the panel with the top of their heads. The imitation paradigm used as a method to investigate infants' understanding of intentional actions will be reported in Paragraph 4.4.

In all of the three following types of attention behavior, infants see another agent acting upon an outside entity, and they attempt to follow the other person's attention in the situation. In contrast to the gaze and point following abilities that emerge at about 12 months of age, imitative learning is a more complicated ability that emerges at about 14 months.

Direct attention and behavior

Infants are not only able to follow the attention of someone else. In the same period, they are also able to direct the attention and behavior of another person to objects/events through acts of intentional communication. Infants begin to communicate with adults very early on, crying, showing their anger or pain, or by reaching to get some object. But only later, in the beginning of their second year, are they able to communicate in an intentional way (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979). In other words, their communication serves a communicative purpose: the signals are aimed at the other person instead of at the goal itself. Strong evidence of intentional communication includes the fact that infants direct their signals toward another person, and they alternate their gaze between the person and the object/event.

Bates, Camaioni & Volterra (1975) distinguished two kinds of gestures, imperative and declarative[5]. Both indicate the intention behind a gesture. With an imperative gesture, the infant

[5] The original terms used by Bates et al. (1975) were proto-imperative and proto-declarative.

tries to direct the attention of another person toward an object in order to get something that he desires. For example, the child can point in the direction of a desired toy, alternating the gaze between the adult and the toy, in order to get it. With a declarative gesture, the infant directs the attention of another person toward an object or event in order to direct the adult's attention and to share the specific event with her. In this case, the infant is asking for the adult's attention instead of asking the adult to perform an action. According to Bates et al. (1975), both declarative and imperative gestures emerge around 10-13 months of age, and both were considered as evidence for the infant's understanding that the adult is a psychological being and that her attention can be directed or changed. Later, Camaioni performed a re-analysis of the previous theory (1992; 1993; 1997) in order to differentiate between these two intentions. She argued that while the imperative intention is an expectation about the functioning of the human beings as causal agents, the declarative intention implies the capacity to represent and influence the other persons' attentional states. Thus, imperative intention does not require a representational understanding of attention. As a consequence, infants should be able to produce imperative gestures before declarative ones. This hypothesis has been confirmed in longitudinal studies that examined children's production and comprehension of the pointing gesture with imperative and declarative intentions (Perucchini, 1997; Camaioni, Perucchini, Bellagamba & Colonnesi, 2004; Perucchini & Camaioni, 1999).

Probably, Carpenter, Nagel and Tomasello (1998) conducted the most exhaustive study on infants' socio-cognitive abilities in the first and in the second year of life. The authors wanted to establish a developmental trajectory of early social cognition and joint attention. Furthermore, they wanted to investigate the developmental interrelations among these different skills in early ontogeny. A longitudinal study was conducted in which 24 infants were observed in a laboratory 7 times, from the ages of 9-15 months. Five main abilities were investigated, along with children's referential language. Table 4.1 shows the main and specific abilities and their mean age of emergence (AOE), or the age at which children showed a specific behavior for the first time.

All children showed the ability of joint engagement starting from the first observation. Thus, this ability could be considered as already developed at the age of 9 months. With regard to attention following ability, on average children were able to follow a pointing gesture one-and-a-half months before they were able to follow another's gaze. Two kinds of imitative learning were investigated. Imitation of instrumental action referred to the infant's ability to

reproduce an action upon an object, while the imitation of arbitrary action referred to the infant's ability to reproduce movements such as patting or touching the head. Results showed that these two imitations developed about in the same period.

Table 4.1 Mean age of emergence (AOE) of the social-cognitive abilities investigated in the study of Carpenter, Nagell and Tomasello (1999).

Main abilities	**AOE of main abilities**	**Specific abilities**	**AOE of Sp. abilities**
Joint engagement	9.0	Joint attention	9.0
Declarative gestures	10.5	- Shows	10.7
		- Points	12.6
		- Gives	13.3
Imperative gestures	12.7	- Gives	13.4
		- Points	14.0
Attention follow ability	11.5	- Point following	11.7
		- Gaze following	13.0
Imitative learning	11.9	- Imitative instrumental actions	12.3
		- Imitative arbitrary actions	12.9
Referential language	15.2	- Referential language	15.2

Regarding declarative gestures, investigators took into consideration both proximal gestures (showing and giving) and the distal gesture of pointing. In some observations, they found some difficulties in distinguishing between children's pointing and reaching (i.e., some of the infant's reaching behavior turned into pointing behavior). Thus, they decided to consider both reaching and pointing gestures within the main category of pointing. The declarative gesture that emerged first was showing, followed by pointing/giving. Results indicated that imperative gestures emerged later than declarative gestures. In particular, the AOE of imperative gestures was one-and-a-half months later than declarative gestures. This result is not consistent with other research (Camaioni, et al., 2004; Perucchini, 1997; Perucchini & Camaioni, 1999); this will be discussed later in paragraph 4.3 Children started to display referential language later than the other abilities; the first referential words were produced at 11 months of age.

The most common pattern of emergence of the main social-cognitive skills was:

[(1) joint engagement → (2) communicative gestures → (3) attention following → (4) imitative learning → (5) referential language.]

Sixty-two percent of children followed this pattern. In sum, this study reported a general picture of the main socio-cognitive abilities developing between the first and the second year of life. The results show that the majority of them emerge between 12-13 months of age.

The studies reported here provide a picture of infants' socio-cognitive abilities, and support the idea that there is a beginning of understanding others as intentional agents already in the first two years of life. Moreover, the child is an active agent able to direct others' attention toward aspects of the environment. In the following paragraphs, two specific abilities reported in this paragraph, will be considered as possible precursors of the later theory of mind during childhood. The first is the production of the pointing gesture as a distal act to direct attention of other persons, with an imperative or declarative intention. This necessitates an implicit understanding of the pointing gesture and point following. The second ability is infants' understanding of intentions, or the ability to recognize the intentions that drive other people in their interactions with objects.

4.3 The pointing gesture

The pointing gesture is defined as the simultaneous extension of the arm and index finger towards a target (Schaffer, 1984). It emerges in human infants between the end of their first year of life and the beginning of the second, in a period during which communication switches from a preverbal form to conventional language (Franco & Butterworth, 1996). For this reason, pointing is considered particularly relevant for language acquisition (Werner & Kaplan, 1963; Vygotsky, 1926/1962). However, in recent years the pointing gesture has also been considered an early form of psychological understanding (Baron-Cohen, 1991; Camaioni et al., 2004; Carpenter et al., 1999; Wellman, 1993). It can be considered a *deictic gesture* along with showing, giving, and asking, that refers to an external target. Tomasello and Camaioni (1997) posited three main characteristics of the pointing gesture: 1) it is *triadic*, because the infant shares his/her attention between a person and an external object; 2) it is *distal*, because it refers to something that can not be touched; 3) it is accompanied by *alternating the gaze* between a person and a goal, as a way to monitor whether the signal is efficient. Moreover, the pointing gesture is considered to be a universal gesture, because it is used in every culture and represents

an efficient modality of communication when language is absent (Perucchini, 1997). Within the main ability of pointing, it is possible to consider two modalities of the gesture, production and comprehension. It is also possible to consider two intentions of the gesture, imperative and declarative. Table 4.2 provides definitions of the two different modalities of gesture, with the two types of intention addressed accordingly (Baron-Cohen, 1991; Bates et al., 1975; Franco & Butterworth, 1996; Camaioni et al., 2004).

Table 4.2 Definitions of the pointing gesture on the basis of the modality and of the intention.

		INTENTION	
		Imperative	*Declarative*
MODALITY	*Comprehension*	Infants' understanding of the pointing gesture of an adult, who tries to direct his/her attention to an object or an action in order to request it	Infants' understanding of the pointing gesture of an adult, who tries to direct his/her attention to an event or an object that is of interest to him/her
	Production	Infant's attempt to direct the adult's attention to an object, in order to request an object or an action that he/she desires	Infant's attempt to direct the adult's attention to an event or an object that is of interest to him/her

In accordance with Carpenter et al. (1999), infants' pointing comprehension is considered to be a following-attention behavior (point-following). Infants' ability to produce the pointing gesture is considered to be a directing-attention behavior (imperative and declarative pointing).

Probably the first study on infants' ability to understand pointing was conducted by Murphy and Messer (1977). Infants of 9 and 14 months of age were observed during interactions with their mother in the laboratory. Infants' ability to follow the mother's pointing gesture was different in the two groups. Older infants showed no difficulty in following the pointing gesture

of the mother. Younger infants were only able to direct their gaze in the direction of the object when it was inside their own visual range (within 90°). In the literature there exist several studies related to infants' visual-attention and pointing comprehension (Butterworth & Cochran, 1980; Butterworth & Grover, 1989; Butterworth & Jarret, 1991). Until 9 months of age, infants are not able to comprehend the pointing gesture. Their attention is more focused on the hand that is pointing than on the object/event in question. At about 12 months of age, infants start to direct their attention toward the object, but only when it is within their visual range. At the age of 15 months, they also become able to direct their gaze to a target object when it is outside their visual range, for example behind them (Butterworth & Grover, 1988; 1990).

Production of the pointing gesture emerges in normal development between 8 and 16 months of life (Murphy & Messer, 1977; Lempers, 1979; Leung & Rheingold, 1981; Lock, Young, Service & Chandler, 1990; Perucchini & Camaioni, 1999). Camaioni et al. (2004) asked to 133 families to fill in the QPOINT questionnaire as soon as their infants started to use the pointing gesture (i.e., within 2 weeks since the child's first use of pointing noted by the parent). The QPOINT (Perucchini & Camaioni, 1999) is a structured questionnaire composed of two closed-list items, one relative to imperative pointing (8 items) and the other relative to declarative pointing (8 items). The items specify different situations in which the child may use pointing gestures at home. One list includes situations concerning the child's intention to request an action or an object to somebody (e.g., the child points at the home's door to go out). The other list includes situations concerning the child's intention to share his or her attention with somebody (e.g., the child points in the direction of an unexpected noise). For each item, the parent (usually the mother) has to mark whether the child points in the specified situation, and how often (e.g. 1-2 times, several times). Results showed that children started to use the pointing gesture on average at 10 months and 29 days. Figure 4.2 depicts the age of onset for the pointing gesture found in this study.

Considering parental reports on the QPOINT questionnaire, 71% of infants started to use the pointing gesture between 10 and 12 months of age, and 91% of them between 9 and 13 months.

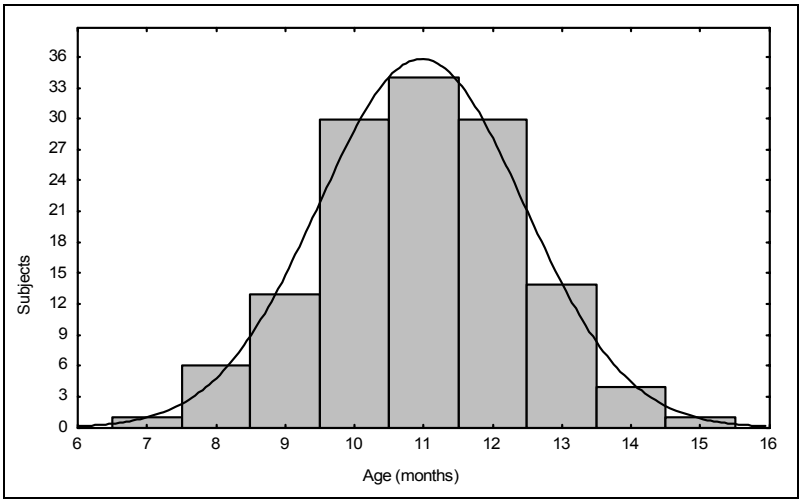


Figure 4.2 Onset age of pointing gesture in 133 children from the QPOINT (Camaioni et al., 2004).

On the basis of the relationship between pointing and language, it could be argued that comprehension emerges before production. This possibility has been not yet confirmed, with the exception of Carpenter et al. (1999), who found that the comprehension of pointing gesture emerged about one month before the production. In the same direction, Camaioni et al. (2004) found that at the age of 12 and 15 months infants are more able to understand than to produce pointing.

As discussed previously, pointing and other gestures can be paired with an imperative intention when the main goal is to obtain a desired object or event. Differently, pointing is used in conjunction with a declarative purpose when one has the intention to share interest or attention with another person. Thus, it may be argued that this ability involves an implicit notion of "intentionality", which is a fundamental characteristic of mental states. In other words, when the child produces a declarative pointing gesture, the child initiates an intentional and attentional relation to the world that may be shared with others. Perucchini (1997) conducted a longitudinal study in order to investigate the emergence of the pointing gesture with an imperative and a declarative intention. Children were tested at 11 and 14 months of age, using a task devised for the evaluation of the production and comprehension of the pointing gesture with imperative and declarative intentions, respectively. The majority of infants produced and understood imperative pointing before declarative pointing.

Recently, Liszkowski, Carpenter, Henning, Striano and Tomasello (2004) investigated the declarative pointing gesture production of twelve-month-olds. Children were presented with hand puppets appearing from window openings in a screen. Four conditions were used. In the joint-attention condition, the experimenter looked back and forth between the event and the infant face, commenting the stimulus and on the fact that they were seeing it together. In the face condition, the experimenter looked at the infant's face but not at the event, and talked only about the infant. In the event condition, the experimenter looked only at the event and she never looked back at the infant. In the ignore condition, the experimenter looked only at her hands, and never looked at the infant or at the event. Children produced the highest number of pointing gestures in the joint-attention condition, indicating that their motivation to point was elicited by the adult's reaction. In the same condition children produced the least number of points per trial. Thus, when they got the look and the comment of the adult they also curtailed their own pointing. The longest duration of pointing was in the event condition. Thus, children alternated their gaze between the event and adult most often when the adult was only looking at the event. In this study, it is clear how children, already at the age of 12 months, are able to produce a pointing gesture with declarative intent. This gives evidence for infants' ability to appreciate a situation in which they share attention to an interesting event in the world with somebody else. However, only declarative pointing was investigated in the Liszkowski et al. study, thus it is not possible to affirm that children do not have the same behavior in an imperative situation.

Camaioni, Perucchini, Bellagamba and Colonnesi (2004) conducted a study on children's ability to produce and to understand pointing gestures with imperative and declarative intentions. The study had two main purposes: (1) to examine the hypothesis that declarative gestures emerge later than imperative gestures; (2) to examine the relation between the ability to produce the pointing gesture and the understanding of others' intentions. In the present paragraph, only the first goal will be discussed. The second purpose of the study will be considered in the Paragraph 4.4. Forty children were observed at two points in time, at the sample-mean ages of 12 and of 15 months. The sample was selected on the basis of the QPOINT questionnaire (Perucchini & Camaioni, 1999). Only children that had already started to produce the pointing gesture participated in the study. The experiment was conducted in a university laboratory. Children were administered a pointing task (Perucchini, 1997) and an intention understanding task (Meltzoff, 1995). In the pointing task four specific abilities were investigated: (1) comprehension of imperative pointing; (2) production of imperative pointing; (3) comprehension of declarative pointing; (4) production of declarative pointing. Results

confirmed the authors' hypothesis with regard to the two intentions implicit in pointing gestures. Infants at 12 months understood and produced more imperative than declarative pointing. Three months later, their understanding and production of declarative pointing had increased.

According to Werner and Kaplan (1963), there is a strong relationship between pointing and language. In fact, pointing could be considered as a referential act produced in a social context. Thus, it represents a first step in the ability to produce symbolic representations. Many studies have reported a correlation between pointing and language (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Camaioni, Castelli, Longobardi & Volterra, 1991). This relation was so strong that this ability has subsequently been included in many language tests, such as Bzoch and League's (1980) Receptive-expressive emergent language scale or the MacArthur Communicative Development Inventory: Infants by Fenson and Dale (1990). Some other authors have argued that the pointing gesture could facilitate language, not because they are part of the same cognitive system, but because both provoke social and verbal exchanges. Petitto (1988) conducted a study on deaf children and found that the ability to point did not facilitate to the later learning of personal pronouns in American Sign Language. Petitto's concluded that spontaneous pointing is not easily transferred to a linguistic system. Some other studies have given support for this position. Bruner (1978) reported that children often produce pointing in a context in which the adult names what the child is pointing, for example during the reading of a book together. In the same direction, Hannan (1992) observed that children's pointing is often accompanied by naming, and also that a common response of the adult is to name what is pointed at by the child.

Resent research has considered the possibility that the pointing gesture is an important precursor of theory of mind (Camaioni et al., 2004; Baron-Cohen, 1991; Carpenter et al., 1998). In fact, as reported in the first part of the present dissertation, even children and infants construe actions as purposive and goal-directed. This means that they can interpret others' actions in an intentional way (Wellman, 1990). The pointing gesture is an important goal-directed action. The person who points, thinks about a referent, and desires to share it with us has some expectations about our reaction. Infants are able to understand this gesture early in their second year of life. This means that the understanding of pointing gestures can be considered an early understanding of intentionality (Baron-Cohen, 1991; Wellman, 1993).

Although there is general agreement that declarative pointing gestures emerge at about 12-15 months of age and could be considered as a precursor to theory of mind, there are also different positions (Barresi & Moore, 1996; Corkum & Moore, 1998; Moore & Corkum, 1994;

Moore & D'Entremont, 2001). Critics claim that declarative pointing in the beginning of the second year does not involve infants' understanding that people are intentional agents. Moore and D'Entremont (2001) investigated infants' production of pointing in two groups of infants: 10-15-month-olds and 22-26-month-olds. They found that both groups of infants produced more pointing when the adult was looking at the same object. However, the older group produced more pointing gestures than the younger group in a situation in which the adult was looking away. The authors' conclusion was that only this last kind of pointing gesture is an attempt to direct another's attention. At the younger age, infants produce the declarative pointing gesture to direct the attention of other persons, instead of to share interest about an object. Corkum and Moore (1995; 1998) claim that only the production of the declarative pointing gesture at the end of the second year reflects the understanding of intentions in others.

Baron-Cohen analyzed the importance of the declarative pointing gesture with autistic children (1989). The study began with the idea that, with the declarative gesture, the child is able to understand that a person is focusing his or her attention on a specific object or event (Baron-Cohen, 1995). Autistic children fail to develop declarative pointing gestures. It may be argued that they lack the ability to comprehend that somebody can ascribe a different valence (e.g., interesting or not interesting) to the same object. Baron-Cohen claims that this assumption can be applied to both the comprehension and the production of the declarative pointing gesture. In production, the child tries to influence the attention of another person toward an object. In comprehension, the child understands that the other person is representing an object as interesting or not.

In conclusion, the pointing gesture may be considered as a way in which children start to appreciate the other person's psychological experience. This ability might thus signify an emergence of theory of mind.

4.4 The understanding of intentions

The understanding of intentions has already been addressed in paragraph 2.3 with regard to the childhood period. In this paragraph they are considered during infancy. During the first year of life, children begin to understand that people differ from objects. At the end of the first year, they also become able to understand how people relate to objects. Flavell (1999) proposes that there is a special relation between people and objects called "aboutness" or "intentionality". This means that when a person behaves with an object, perceptually attends to it, labels it, thinks

about it, wants it, or fears it, in short this person is experiencing some psychological state with regard to the object.

Already during infancy, children are able to show a kind of precursory awareness of intentionality. Already at the age of 9 months infants show a sensitive causal movements of objects (Schlottmann & Surian, 1999) In the case of joint attention, children look, point, or vocalize about a specific object or event, and afterwards they check whether the other person looks at, comments on, or responds to it in one way or another (Bates et al., 1976). When the other person does not respond by sharing the object/event, children can persist with that behavior in order to catch her attention (Liszkowski et al., 2004). In fact, there is evidence that children show this kind of behavior only toward other human beings. With regard to imitation, Legerstee (1992) found that babies would imitate mouth opening and tongue protrusion produced by a person, but not by an object.

Phillips, Wellman & Spelke (2002) conducted a research, consisting of 4 studies, on early intentional understanding, based on infants' recognition of actions as purposive and goal-directed. The authors started with the assumption that intentional acts are, in general, directed toward certain target objects, and that intentions are indicated by the actor's gaze, facial expressions and vocalizations. Thus, they evaluated whether infants were able to recognize that a person who looks at an object with positive regard will grasp that object rather than another. The "Referential looking task" was used in this research. In their first study by Phillips et al., 8- and 12-month-old infants were presented with three kinds of events, one with an adult and two with stuffed animals (an orange and a grey kitten). In the *habituation event,* the adult first looked to one of the two toys with an expression of interest and joy and verbally expressed pleasure. Afterwards, a screen was drawn to conceal both the adult and animals. When the screen opened again the adult was looking down at, and holding to her chest, the same kitten to which she had been looking in the first phase. After the habituation event followed the two test events. In the *consistent event,* the adult repeated the same behavior as in the habituation condition, but now toward the other kitty, and after the screen closed and opened again the adult was holding the same kitty she was looking at before. In the *inconsistent event,* the adult first looked at and emoted about the same kitty as in the habituation event, but after the screen opened again she was holding the other kitty. In every condition, infants' looking was coded as a measure of their attention. It was expected that children would look longer at the inconsistent situation than at the consistent one. This expectation held true for 12-month-olds but not for 8-month-olds. Thus, the results confirmed that, from the age of 12 months, infants begin to understand the connection

between intentional behavior and perceptual-emotional states. The same result was also obtained in a second study, when an inconsistent situation was used as the habituation event. Infants who saw an inconsistent habituation event did not later show a longer looking time for the consistent event. An interesting result was found in Study 3. Infants at 12 months did not see the action (grasping the kitty) during the habituation event, but only the adult looking, producing facial emotional expression and pleasant vocalization toward an object. Infants did not look longer to the inconsistent event. Thus, they failed to recognize the functional connection between perceptual-emotional states and action. However, 14-month-olds were able to do this (Study 4). This research clearly shows the developmental sequence of infants' coming to understand intentional actions. This ability does not seem to be present at 8 months; rather, it appears to start at 12 months and develops at 14 months of age.

Carpenter, Akhtar and Tomasello (1998) investigated 14- and 18-month-olds' understandings of intentional and accidental action, using an imitation task. Infants were shown an adult performing some two-action sequences on objects. One action was vocally marked as intentional with the expression "There!" and the other was marked as accidental with the expression, "Woops!". Infants imitated the intentional action instead of the accidental action, indicating that they were able to differentiate between the two types of actions, and that they were able to reproduce what the adult was *trying* to do, not the objective behavior that was actually performed.

Meltzoff (1995) conducted an important series of studies in this direction. In the first study, 18-month-olds were presented with an adult who merely demonstrated an intention to act in a certain way. Different control groups were administered four conditions, in order to exclude effects due to other possible variables: (1) Demonstration (target) - the experimenter modeled the specific target act; (2) Demonstration (intention) - the experimenter was seen by the infant trying but failing to achieve the specific target act; (3) Control (baseline) - the adult did not produce any demonstration; (4) Control (adult manipulation) - the experiment manipulated the object without showing either the target act or the failed attempt. The following is an example of demonstration of intention: one object was a dumbbell-shaped toy that could be pulled apart and put back together again. It consisted of two wooden cubes, each with a length of plastic extending from it. In the demonstration of the intention, the experimenter picked up the toy by the wooden cubes and tried to pull the ends apart, but repeatedly failed in this attempt (three times). Thus, the intended action was never accomplished and remained unobserved by the child. Afterward, the experimenter gave the toy to the child. Children were asked to "read" the

actor's intention and to produce the action that the adult was trying to do, so to re-enact the failed attempt. Eighty percent of the children demonstrated the ability to reproduce what the adult intended to do, even though the adult's attempts failed. This result supports the idea that children see the adult as a source of information about what to do with the object, and the adult's behavior (failed attempt) gives information about the adult's intentions. In the second experiment, children's reaction to the same action performed by a person versus an inanimate object was evaluated. A machine used in this experiment performed the same movements through space as the human hand. As expected, children did not produce the intended action when observing the inanimate device. In sum, children at the age of 18-months are already able to interpret people's behavior in a psychological way, instead of in terms of purely physical movements or motions. Returning to Seale's distinction between prior intentions and intentions-in-action, this experimental procedure investigated how children are able to interpret the intention of a person during an action, thus how children come to understand the action that the person is doing as a "failed attempt". The second experiment provides evidence that children make different attributions to people compared to objects.

The first experiment of Meltzoff (1995) was replicated by Bellagamba and Tomasello (1999), who evaluated the same ability with 12- and 18-month-olds. Their aim was twofold. First, they wanted to evaluate children's performance when a new condition was presented. Second, they wanted to evaluate whether 12-month-olds showed evidence of understanding others' intentions. In the new condition, the demonstrate-end-state, the experimenter hid the object behind her back and restored it to its initial state (the child did not see the restorative manipulation) and offered the object to the child. Children's ability to perform the target action in this condition may suggest that they are able to imagine, only by seeing an interesting object configuration, the intentional action that they must perform to reproduce the configuration. Results showed that 12-month-olds did not produce the intentional acts when they saw the adult trying but failing to perform. Investigators interpreted this result by referring to 12-month-olds' inability to see unsuccessful, goal-directed behaviors as intentional. More interesting, 18-month-olds' performance in the demonstrate-end-state condition was worse than in the demonstrate-intention condition. This result is consistent with the idea that this task evaluates children's ability to perceive human behavior as intentional.

However, Huang, Heyes and Charman (2002) have a different interpretation of children's performance in Meltzoff's task. These authors argued that during the demonstration, the spatial contiguity of the relevant parts of the objects might provide sufficient stimulus enhancement to

induce the infant to perform the target act later. In other words, according to the emulation learning strategy (Tomasello, 1990; 1996) the infant may be able to understand, through the observation of possible changes to the state of the object, the correct act to produce. In Meltzoff's task, it may be that the observation of the demonstrated failed-attempt communicated to infants the causal structure of the test materials. The study of Huang, Heyes and Charman (2002) extended Meltzoff's failed-attempt paradigm by examining the roles of emulation learning and stimulus enhancement. In the first experiment, children at 19 months of age were administered the three conditions of Meltzoff's study (demonstration-target, demonstration-intention, and adult-manipulation) and a new condition, the emulation-learning condition. In this condition, infants were exposed to both the initial and end states of the target display, but not to the experimenter's manipulation. Results showed that children's production of the target act in this new condition was similar to the production of the target acts in the demonstration-target and demonstration–intention conditions. In the second experiment another new condition was introduced, the spatial-contiguity condition, in order to examine whether infant's performance of the target act after watching the failed–attempt display was attributable to a form of stimulus enhancement. In this condition the experimenter moved the two individual parts of the object set, in order to bring them in close proximity, so that the target-relevant parts were spatially contiguous with each other. Seventeen-month-olds produced, in a 20-second response period, the same proportion of target actions as in the failed-attempt, emulation-learning, and spatial-contiguity conditions. Thus, it could be argued that children understood the afforded end state of the target act, just by observing the track of object movement. This result suggests that both emulation learning and stimulus enhancement may account for infants' performance of target acts after observing failed attempts within the behavioral-reenactment paradigm. The study of Huang et al. demonstrates the difficulty in investigating children's understanding of mental states during the pre-linguistic period. The necessity of using children's behavior as an indicator of their understanding of mental states does not exclude alternative interpretations.

Camaioni, Perucchini, Bellagamba and Colonnesi (2004) conducted a study in order to assess a possible relationship between infants' declarative pointing task and their ability to understand intentional actions, as measured by the Meltzoff's task. The main aim of the study was to investigate whether a relationship exists between children's capacity to produce and understand the declarative pointing gesture, and their capacity to reproduce others' intended acts after witnessing failed attempts. The main hypothesis was that the two abilities share a common mechanism that enables infants to understand others' intentions. This study has been described

previously, in paragraph 4.3 with regard to specific aspects related to the pointing gesture. In terms of intention, at both ages (12- and 15-months) children with high intention-understanding ability produced more declarative pointing than children with a low level of intention understanding. Thus, a concurrent association between these two abilities was found. Taking into account the high socio-communicative character of the pointing gesture, it is possible to argue that at the root of both these abilities lays a basic understanding of intentionality. These results yielded indirect proof of the validity of Meltzoff's task, and more important, give some evidence about a common mechanism that underlies these two abilities. Indeed, when children are able to interpret a person's actions within a psychological framework involving goals and intentions, they also seem able to share interesting aspects of the world with others and to influence other people's attentional states toward the world. Thus, this study showed a relationship between a possible precursor of theory of mind, the declarative pointing gesture with a, and a measure of children's early understanding of mental states.

4.5 From precursors to a theory-of-mind

The studies on children's social-cognitive abilities are split into two main areas. On one side there are studies about children's meta-representative understandings, focused on false-belief understandings at the age of four. On the other side there are studies that investigate infants' earlier ability to understand others as intentional agents, claiming that these social-cognitive abilities are the bedrock of a developing theory of mind. Behaviors such as joint visual attention, social referencing, and proto-communicative acts like showing and pointing have been widely interpreted as indicating considerable social understanding. Many authors have considered this as signs of an implicit theory of mind (Bretherton, McNew & Beeghly-Smith, 1981). Only in the last 5 years an interest has developed with regard to finding continuity in the theory of mind from infancy to childhood. This emphasizes the necessity of identifying some abilities that are developmental "precursors" to a theory of mind.

As reported by Charman, Baron-Cohen, Swettenham, Baird, Cox and Drew (2000), there are two pieces of indirect evidence that support the possibility that joint attention, imitation, and play could be precursors to a theory of mind. First, there is evidence of a longitudinal association between these abilities and language development. Many studies have shown a longitudinal association between some joint-attention abilities, such as the production and the comprehension of declarative pointing and following gaze, and later language ability in

the second year of life (Carpenter, Nagell & Tomasello, 1998; Mundy & Gomez, 1996; Tomasello & Farrar, 1986). Some other studies showed a concurrent association between theory of mind emergence and language (Carlson & Moses, 2001; Charman & Schmueli-Goetz, 1998; Happe, 1995; Hughes & Dunn, 1998; Jenkins & Astington, 1996; Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003). All of this evidence is consistent with a possible relation between precursors, language, and theory of mind. Second, other evidence comes from the fact that children with autism are impaired in their development of theory of mind (Baron-Cohen, Leslie & Frith, 1989) as well as in joint attention, play, and imitation (Baron-Cohen, 1989; Rogers, Bennetto, McEvoy & Pennington, 1996). These children have also a general language delay (Tager-Flusberg, 1993).

Charman et al. (2000) probably conducted the first longitudinal study on joint attention, imitation, and play during infancy as precursors to language and theory of mind during childhood. A small sample of 13 children, aged 20 months, was administered a set of tasks: A spontaneous-play task, two joint-attention tasks (the active toy task and the goal detection task), and an imitation task. To the same group, at the age of 44 months (2 years later), another set of tasks was administered: a Level 1 visual perspective-taking task, a "seeing-leads-to-knowing" task, and a situation- and desire-based emotion task. At both time points, non-verbal ability was measured. The results revealed a longitudinal association between the joint-attention and theory-of-mind abilities at 44 months. This is consistent with the important, theoretical role of joint attention in the development of social-communicative competence and understanding of mental states.

Wellman, Phillips, Dunphy-Lelii and LaLonde (2004) administered to 18 children, who participated to the study of Phillips, Wellman and Spelke on the understanding of intentional actions during infancy (2002; described in paragraph 4.4.), a battery of five different theory-of-mind tasks (used also in Wellman and Liu, 2004) when children had an average age of 4 years and 3 months. The aim of the study was to relate infants' social-cognitive preferential looking (at 14 months of age) to preschoolers' advantages in theory-of-mind understanding (at 51 months of age). Children received a score ranging from 0 to 5, on the basis of how many tasks they solved. Children were also administered the Peabody Picture Vocabulary Test (PPVT), an easy-to-administer measure of preschool verbal intelligence. Results showed that infants' decrement of attention to displays of intentional action predicts later social cognition. These results are consistent with the hypothesis of continuity between an infant's ability and later theory of mind. No measure, either at 14 or 51 months of age, correlated with the PPVT

score. A weakness of this study is the large gap between the first (14 months) and the second observation (51 months). That is, there is a large period of development between the detection of precursor abilities and later capacities. However, it provides evidence for an empirical relationship between abilities that emerge during infancy and theory of mind in preschool-aged children.

4.6 Conclusion

Future research on theory of mind should address the possibility of a relationship between early socio-cognitive abilities during infancy and the later development of theory of mind during preschool age. In the present chapter, a general overview was presented of the abilities during infancy that may be considered as putative precursors. Special attention was dedicated to the pointing gesture and intentional understanding. In conclusion, the two studies of Charman et al. (2000) and Wellman et al. (2004) are a preliminary contribution to a contemporary picture of how infants develop understandings of their experiences and of persons as intentional actors. They also provide the first empirical evidence with regard to the relationship between socio-cognitive abilities during infancy and later abilities during childhood. More research must be conducted in order to define the trajectory of mental understanding from infancy to childhood. In Chapter 5, a longitudinal study with this purpose is presented.

Chapter 5

Second study: Pointing gesture and intention understanding as predictors of a theory-of-mind development in 3-year-olds

5.1. Aims of the study

When do children start to have some kind of representation of others' minds? Are the early social-cognitive abilities during infancy related to the later theory of mind in childhood?

In the first part of the present thesis, an investigation about the emergence of theory of mind at the age of three years was presented. However, recent research claims that it is possible to find the origins of children's theory of mind during infancy (Charman et al., 2000; Wellman et al., 2004). Chapter 4 presented several studies focused upon earlier abilities that emerge in the first two years of life. At this age infants are not able to report their understanding of mental states in a verbal way. This makes it difficult to test their understanding of mental states. However, there is a growing interest in investigating the 'aboriginal roots' of children's understanding of mind. Several abilities, presented in Chapter 4 have, been proposed as possible candidates for precursors of theory of mind, including joint attention and social referencing (Baron-Cohen, 1991; Butterworth, 1991; Wellman, 1990), pointing gestures (Camaioni, Perucchini, Bellagamba & Colonnesi, 2004), and understanding of intention (Meltzoff, 1995).

The main aim of the present longitudinal study was to investigate the relationship between some of the abilities that emerge at the age of 12 and 15 months and later abilities of understanding mental states at 39 months of age. The abilities examined during infancy were the comprehension and production of the pointing gesture with imperative and declarative intention (Perucchini, 1997), and the understanding of intentions using the behavioral re-enactment

procedure of Meltzoff (1995). These two abilities share the understanding of other persons as independent agents possessing intentionality (Camaioni, Perucchini, Bellagamba & Colonnesi, 2004). The abilities examined during childhood (39 months of age) were the understanding of perception and intention, and children's explanation of others' actions in terms of mental states. These three abilities were chosen as measures of the emergence of a theory of mind. Children understand perception when they take into consideration that somebody else may have a different point of view from their own, and this represents a starting point for the understanding of others' mental states (Flavell, et al., 1981). Children's ability to produce psychological explanations for others' actions is a basic mentalistic construal of persons (Bartsch & Wellman, 1989; 1995). Finally, a task that evaluated children's understanding of intentions-in-action (about an action that the child is currently doing) was used in order to evaluate the relationship between the precursors with a mature understanding of intention (Russell, et al., 2001).

Since the pointing gesture predicts later language (Desrochers, Morissette & Ricard, 1995; Mundy & Gomez, 1998), and theory of mind performances often correlate with language (Carlson & Moses, 2001; Happe, 1995; Ruffman et al., 2003), a measure of preschool verbal intelligence was included. Children were administered the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Italian version, Stella, Pizzoli & Tressoldi, 2000) in order to evaluate their receptive vocabulary. This would allow assessment for, and a control for, preschool verbal IQ, in order to examine more specific links between the abilities of pointing (at 12 and 15 months of age) and psychological explanations (at 39 months of age) with language. As well as the studies of Charman et al. (2000) and Wellman et al. (2004), data reported in this study were collected after a previous investigation (Camaioni, et al., 2004). However, differently from the previous research, the present study has a smaller sample of participants, and new data were collected in order to examine the relation between putative precursors and children's ability to understand mental states at the age of three.

In order to evaluate the longitudinal association between precursor abilities and the abilities at the age of 39 months, a synthesis of some variables was conducted. In contrast to the study of Camaioni et al. (2004), infants' pointing ability was not evaluated with a score indicating how many times the infant produced or understood a specific kind of pointing. In the present study, an ability evaluated on the presence/absence of specific kinds of pointing at 12 and 15 months of age was used. In the same way, the present study only considered children's ability to explain others actions in terms of psychological states. Thus, we did not evaluate children's desire-belief

explanations and the more specific inconsistent-desire and false-belief explanations. The main aim was to give priority to the evaluation of the general abilities instead of the sub-categories.

Starting with the hypothesis that the development of theory of mind is a continuum from infancy to childhood, it is interesting to evaluate through which measure these abilities are connected to each other. The main purposes of the study were (see also Figure 5.1):

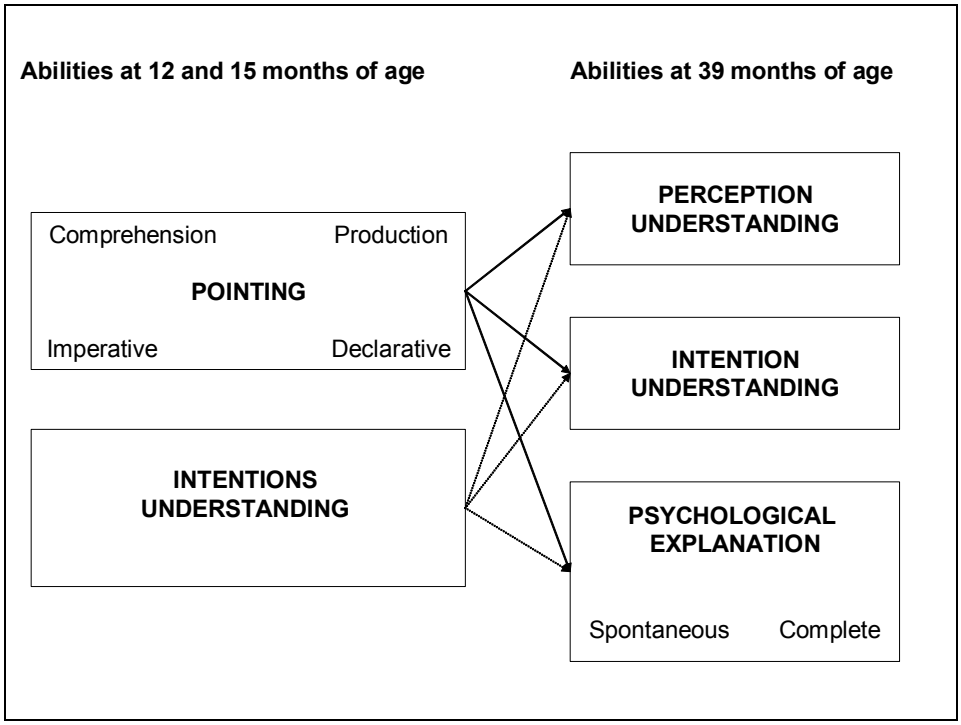


Figure 5.1 Relations between the abilities examined at 12, 15 and the abilities examined at 39 months of age on the basis of the hypothesis of the study.

1. *To evaluate whether children's ability in producing the pointing gesture at 12 and 15 months of age predicts their later theory of mind at 39 months of age.* The first main was to evaluate whether the general ability in pointing may predict the later understanding of perception and intention and the ability to explain actions in terms of mental states. In particular, children's comprehension and production of the pointing gesture, as well as

imperative and declarative intentions, were considered as precursors of the abilities at 39 months of age (see Figure 5.1.).

2. *To evaluate whether children's ability to understand intention at 12 and 15 months of age is related to their theory-of-mind ability at 39 months of age.* The second main was to evaluate whether the ability to understand what another person is trying to do (without succeeding) with an object at 12 and at 15 months of age can predict the later, and more advanced, understanding of perception and intention, and the ability to explain action in a psychological way.

5.2 Method

Subjects

Thirty-five children participated in the present study[6]. Thirty-three of them were also involved in Study 1 (Chapter 3). They formed part of the sample of an investigation on the role of declarative pointing in developing a theory of mind (see Camaioni, Perucchini, Bellagamba & Colonnesi, 2004). Children were recruited through day care centers and pediatrician's offices and were all healthy and developing normally. They all lived in the city of Rome and were of middle and middle-high socio-economic level. The participants' characteristics are shown in Table 5.1.

Table 5.1 Participants' characteristics at the first, second and third observations

Gender	Boys =17	Girls= 18	
Birth order	1°= 19	2°= 16	
	First observation	**Second observation**	**Third observation**
Age (months;days)			
Mean	11;24	14;24	38;22
SD	*(1;5)*	*(1;5)*	*(0;18)*
Range	9-14	12-17	38-40

[6] Two additional children dropped out of the study, one because he did not wish to participate and another for the experimenter's error.

Procedures and coding systems at 12 and 15 months

Infants who participated at the study were selected through the QPOINT questionnaire (Perucchini, 1999). The QPOINT questionnaire is a parent-reported measure of the production of imperative and declarative pointing. Parents received the questionnaire when their infant was about 7 months old, and they were asked to report as soon as their infants started to use the pointing gesture (i.e., within 2 weeks since the child's first use of pointing noted by the parent). Children were observed in the lab about a week after the parent had filled in the questionnaire.

Parents were contacted by telephone and invited to take part in the experiment. The first and the second observations were carried out in a laboratory room of the Faculty of Psychology at the University of Rome "La Sapienza". In each observation the child was tested while seated on a parent's lap, in front of a rectangular table. All the observations were videotaped. The laboratory was equipped with two cameras that were remotely controlled from a dark room located behind a one-way mirror. A generator that mixed elapsed time in seconds and milliseconds onto the video records electronically timed the experiment. Two research assistants, both women, served as experimenters. Each observation started with a warming-up period in which the child played with the experimenter until the infant seemed acclimated to the room and the experimenters. Two tasks were administered: a pointing task designed to evaluate comprehension and production of imperative and declarative pointing, and an intention-understanding task. Order of task administration was random, and sex of children was balanced across order.

Pointing task

In the pointing task, the experimenter sat on the side of the table (at 90° angle) facing the child. Camera 1 focused on the frontal view of the experimental setting, including the child, mother, experimenter, table and experimental objects. Camera 2 focused on the upper view of the infant's face and torso. Proximal stimuli used in the task were a wind-up toy car, a musical box, a toy telephone, and a toy horse. Distal stimuli used in the task were mobile airplanes, a mobile bird, a flashing light, and a multicolored picture on the wall (see Figure 5.2).

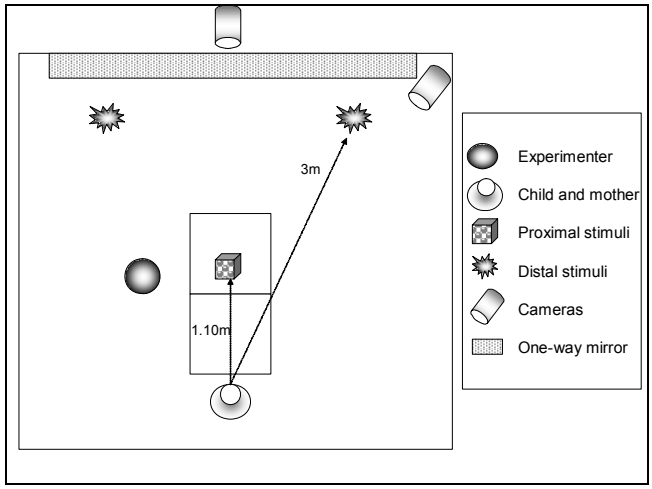


Figure 5.2 Experimental setting for the Pointing task.

The task was comprised of four experimental conditions designed to elicit imperative and declarative pointing, in terms of both production and comprehension. The four conditions were presented in a random order. Each condition had eight trials with two different stimuli; the first four trials with one stimulus and the last four trials with the other stimulus. At the beginning of each trial, the experimenter made eye contact with the child and asked for his/her attention.

Pointing production. The production of pointing was evaluated with an imperative and a declarative intention, respectively. In both conditions, proximal stimuli were used so that a manipulable object was located near the experimenter and far from the child. In every condition the experimenter repeated the procedure eight times (four times with one object, four times with a second object), in order to elicit the child's production of pointing.

- *Imperative production.* The experimenter activated a musical box/windup car (moving for about 10 sec and then stopping) and looked silently at the child for 15 seconds (waiting for the child's reaction). The experimenter then said, "Isn't it pretty? Do you like it?" and looked silently at the child for 15 seconds (waiting for the child's reaction). Then the experimenter gave the toy to the child.
- *Declarative production.* The experimenter surreptitiously activated a mobile (airplanes/birds) hanging from the ceiling in front of the child and behind herself, and looked silently at the child for 15 seconds (waiting for the child's reaction). The mobile moved for about 10 sec and then stopped. The experimenter then said, "What happened?" without turning

back to look at the mobile, and looked silently at the child for 15 seconds (waiting for the child's reaction). Then the experimenter looked at the mobile and named it.

Pointing comprehension. The comprehension of pointing was also evaluated with an imperative and a declarative intention, respectively. In both the conditions distal stimuli were used, so that an event occurred far from both the experimenter and the child. In every condition the experimenter repeated the procedure eight times (four times with one object, and four times with a second object), in order to elicit the child's production of pointing.

- *Imperative comprehension.* The experimenter showed the child a toy horse/telephone that could be pulled apart into two pieces and put back together. The experimenter gave a piece (the horse's tail/the phone receiver) to the child, looked at the piece in her hand and said, "Oops, there is no horse's head/push-button phone!" The experimenter pointed at the piece in the child's hand, looking at the child and at the stimulus. Then the experimenter looked silently at the child for 15 seconds (waiting for the child's reaction).
- *Declarative comprehension.* The experimenter pointed at a flashing light/a picture on the wall, looking at the child and at the stimulus. Then the experimenter looked silently at the child for 15 seconds (waiting for the child's reaction).

Children's pointing gestures were first evaluated as intentionally communicative, and then as imperatives or declaratives. Pointing was defined as arm and index finger extension in the direction of the stimulus (without touching it), while the remaining fingers were curled lightly or tightly under the hand (Franco & Butterworth, 1996). Any stimulus-directed pointing gesture produced by the child was coded as intentionally communicative when looking at the experimenter's face occurred within 2 seconds before/after pointing, or pointing and looking at the experimenter's face occurred simultaneously (following Franco and Butterworth, 1996). Only one pointing gesture produced by the child was counted in each trial. The communicative intent, whether imperative or declarative, of the child's pointing gesture was coded in each trial according to the following operational definitions:

- *Imperative production*. The child produced a pointing gesture in addition to at least one of the following target-behaviors: made a request gesture[7]; leaned forward or reached for the

[7] Request gesture, request vocalization and proto-word were defined as follows. Request gesture: arm extension with opening and closing of the hand (eventually repeated) towards the target object, or with hand open and palm up/down. Request vocalization: a bisyllabic sound (e.g., dada) used

stimulus; produced a request vocalization/a proto-word[2] or whined; pointed at the stimulus repeatedly (2 or more times).

- *Declarative production*. The child produced a pointing gesture in addition to at least one of the following target-behaviors: smiled and/or vocalized towards the stimulus; produced a proto-word or a word relative to the stimulus; re-enacted what the stimulus did.

In the pointing comprehension conditions, as in the production conditions, a two-step coding procedure was adopted. First, the child had to correctly localize the stimulus pointed at by the experimenter by looking at it (see in Figure 5.4 the different locations of distal stimuli). Second, comprehension of the communicative intent, whether imperative or declarative, of the experimenter's pointing was attributed to the child according to the following operational definitions (only one comprehension was counted in each trial):

- *Imperative comprehension.* After the experimenter's pointing, the child produced at least one of the following target-behaviors: gave the stimulus to the experimenter; refused to give the stimulus to the experimenter; said "Yes/No" or made the corresponding gesture with the head; left the stimulus on the table near the experimenter looking at her.
- *Declarative comprehension.* After the experimenter's pointing, the child produced at least one of the following target-behaviors: smiled and/or vocalized towards the stimulus; produced a proto-word or a word relative to the stimulus; re-enacted what the stimulus did while looking at the experimenter.

For the coding of the pointing task the presence (at least one time) of each specific ability was scored as 1 (present) or 0 (absent). Three different scores were used in order to evaluate infants' pointing ability: a general score and two partial scores.

- *General score:* This score was calculated in each observation by adding the abilities to understand and to produce the pointing gesture with imperative and declarative intention (range 0 to 4).
- *Modality score:* Two partial ability scores were calculated for "modality" of the pointing gesture: *Comprehension* (Imperative and Declarative) ranging from 0 to 2; and *Production* (Imperative and Declarative) ranging from 0 to 2.

repeatedly and insistently, with rising intonation. Proto-word: an onomatopoeic or idiosyncratic sound that has a specific meaning for the child and is associated with a specific referent (e.g. brum-brum for "car"; ca-ca for "duck").

- *Intention score:* Two partial ability scores were calculated, in each observation, in order to evaluate the "intention" of the pointing gesture: *Imperative* (Comprehension and Production) ranging from 0 to 2; and *Declarative* (Comprehension and Production) ranging from 0 to 2.

Intention-understanding task

In the intention-understanding task the experimenter sat in front of the child. Camera 1 focused on a lateral view of the child, experimenter and experimental objects. Camera 2 focused on the upper view of the infant's face and torso. Both perspectives were edited in the videotape (See Figure 5.3).

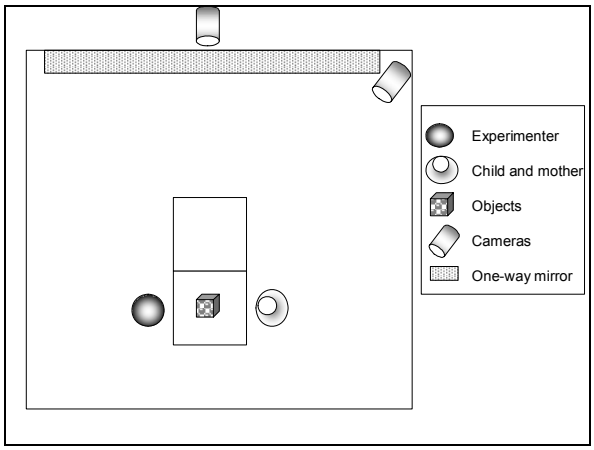


Figure 5.3 Experimental setting for the Understanding of intention task.

Stimuli used in the task were exact duplicates of those used by Meltzoff (1995). Five objects were used (description from Meltzoff (1995; p. 840):

1) *Dumbbell-shaped toy that could be pulled apart and put back together again.* It consisted of two 2.5 cm wooden cubes each with a 7.5 cm length of plastic extending from it. One tubular piece fit snugly inside the other so that it took considerable force to pull them apart.
2) *A small black box (16.5 x 15 x 5.5 cm) with a slightly recessed rectangular button (3 x 2.2 cm) on the top surface.* The button activated a buzzer inside the box. The box was supported by a base that tilted 30º off the table, so that the front surface was facing the child. The box was accompanied by a small stick tool, made of a rectangular block of wood, which was used by the experimenter to push the button.

3) *A horizontal prong and a nylon loop.* The prong was fashioned from an ornamental wooden piece with a bulbous end. It protruded horizontally from a background screen made of gray plastic (17 x 20.3 cm). The loop was made from nylon tied in a circle with a diameter of 7.5 cm.
4) *A cylinder with a flared base* (9.5 cm high with a 6.3 cm opening) coupled with a loop of beads (19 cm long when suspended).
5) *A transparent plastic square and wooden dowel.* The square (10 cm) had a 2.5 cm-diameter, round hole cut out of the center so that it could fit over the dowel. Thin plastic strips were glued along two edges of the plastic square to raise it slightly form the table so that children could pick it up. The dowel (2 cm high and 1.7 cm in diameter) was in an upright position in the center of a wooden base plate.

The child was tested on the "Demonstration of Intention" condition in the Re-enactment task (Meltzoff, 1995). The experimenter modeled the intention to perform the act for the child (i.e., the experimenter was seen trying, but failing, to perform the act on each of 5 objects). The order of presentation of the five objects was counterbalanced. The intention to produce the act was modeled 3 times and was followed by a 20 s response period for each object. The experimenter did not provide linguistic or facial expressions of failure.

In the intention-understanding task, the number of target actions produced by each child on all objects was scored. The operational definitions of performing the target actions for each set of objects were those defined by Meltzoff in the original work (i.e., the child pulled the object apart (dumbbell-shaped toy); the child used the stick tool to push the button and activated the buzzer (box with a stick tool); the child hung the nylon loop over the prong so that the prong protruded through it (prong and loop); the child lowered the beads into the cylinder (cylinder and beads); the child placed the plastic square over the wooden dowel so that the dowel protruded through the hole (square and post). The scores in this task ranged from 0 to 5.

Experimental procedures and coding systems at 39 months

Experimenters again contacted parents by telephone when children were about 36 months old. They were asked to allow experimenters to visit the child at home for an observation of about one hour and a half. The observation was carried out in a quite place of the house with the presence of a parent or a baby-sitter. After a warming-up period, three social-cognitive tasks were administered.

Visual-perception task

The procedure of the task is presented in Chapter 3, paragraph 3.2.2. Children were scores as answering correctly (a score of 1) every time they reported the figure they could see and the figure the experimenter could see. Children received a score ranging from 0 to 3 (three trials).

Intention-understanding task

The procedure of the task is presented in Chapter 3, paragraph 3.2.2. Children's answer about what they thought to draw was scored 1 if they referred to the previous drawing and 0 if they referred to the second drawing. Children received a score ranging from 0 to 4 (four trials).

Explanation task

The procedure of the task is presented in Chapter 3, paragraph 3.2.2. Children received a score ranging from 0 to 9, based on the number of spontaneous and complete psychological explanations in the 9 stories.

The three tasks were videotaped. After the administration of the three tasks and a break, children were administered the PPVT-R.

Reliability

Two independent observers coded a random selection of 28% of the videotaped observations. Reliability for the pointing task and for the intention-understanding task was calculated by Cohen's kappa. In the pointing task, reliability was assessed for each target behavior. For imperative production, kappa values ranged from .97 to 1.0, and for imperative comprehension they ranged from .90 to 1.0 in both observations. For declarative production, kappa values ranged from .94 to 1.0, and for declarative comprehension they ranged from .86 to 1.0 in both observations. Reliability was high across conditions. In the intention-understanding task, reliability was measured on the target action with a kappa of 1.0 at the first observation and .94 at the second observation.

Reliability for the observation at 39 months was assessed only for the explanation task. Two coders categorized the children's explanations. Reliability was assessed for 25% of the sample. Cohen's kappa ranged from .93 to .95. for the spontaneous psychological explanations, and from .92 to .95 for complete psychological explanations. In general, there was a good level of reliability.

Analyses

The results of this study are reported in two main sections. In the first section preliminary results are presented, in order to compare children's performance in all the tasks (at 12, 15 and 39 months of age) with previous studies (Camaioni et al., 2004 and the First study, Chapter 3). In addition to descriptive analyses (means, standard deviations, percentages and correlations), simple and repeated-measure analyses of variance were conducted in order to compare different abilities and the same abilities at different ages. In the second section, main results related to the 2 aims of the study are presented. In addition to descriptive analyses (means, standard deviations, percentages and correlations), simple and hierarchical regressions were conducted in order to evaluate the role of precursor abilities as predictors of theory of mind at the age of 39 months. All the analyses were carried out using SPSS 11.5 and Statistica 6 for Windows.

5.3. Results

Preliminary results

In this section, data for the precursor measures at 12 and at 15 months of age and data for abilities at 39 months of age are presented. The general aim is to confirm the same trends and results of Camaioni et al. (2004), and of Study 1 (Chapter 3), with a smaller sample of 35 children. Repeated-measure analyses of variance showed no effect of sex or order of birth[8], so these variables were collapsed for further analyses.

Pointing (12 and 15 months of age)

Children's scores in the pointing task give a measure of which abilities they were able to produce at 12 and 15 months of age. Table 5.2 reports means and standard deviations of the ability scores in the pointing task.

[8] *Between-subjects effects of gender at 12 and 15 months:* Pointing ($F(1,33)= 2.23$; $p = .145$; $\eta^2 = .063$); Comprehension ($F(1,33) = 1.86$; $p =.182$; $\eta^2 = .053$); Production ($F(1,33) = 1.49$; $p =.231$; $\eta^2 = .043$); Imperative ($F(1,33) = 3.37$; $p = .075$; $\eta^2 = .093$); Declarative ($F(1,33) = 0.68$; $p =.416$; $\eta^2= .020$); *Between-subjects effects order of birth at 12 and 15 months:* Pointing ($F(1,33) = 3.46$; $p = .072$; $\eta^2 = .941$); Comprehension ($F(1,33) = 3.28$; $p =.079$; $\eta^2 = .091$); Production ($F(1,33) = 1.92$; $p = .175$; $\eta^2 = .055$); Imperative ($F(1,33) = 1.83$; $p = .185$; $\eta^2 = .053$); Declarative ($F(1,33) = 3.28$; $p = .079$; $\eta^2 = .090$);

A repeated-measure analyses of variance including the pointing ability scores at Observation 1 and Observation 2 showed a significant effect of Observation ($F(1,34) = 13.14$; $p = .001$). Children's mean ability in pointing increased from 12 to 15 months of age (See Table 5.2).

A Modality (Comprehension *vs.* Production) x Observation (12 *vs.* 15 months) repeated-measure analysis of variance for both the variables revealed a mean effect of Modality ($F(1,34) = 12.27$; $p = .001$; $\eta^2 = .26$) and of Observation ($F(1,34) = 13.14$; $p = .001$; $\eta^2 = .28$). Children's ability scores in Comprehension ($M = 1.74$; $SD = 0.48$) were higher, on average, than in Production ($M = 1.41$; $SD = 0.67$), and children's mean ability score increased between the ages of 12 ($M = 1.44$; $SD = 0.64$) and 15 months ($M = 1.71$; $SD = 0.51$).

Table 5.2 Means and SDs of the ability scores in the pointing task at 12 and 15 months of age.

	Abilities	**12 months**	**15 months**
General score (max score 4)	*Pointing* Mean	2.88 *(1.02)*	3.43 *(0.88)*
Modality score (max score 2)	*Comprehension of pointing* Mean	1.66 *(0.60)*	1.83 *(0.38)*
	Production of pointing Mean	1.23 *(0.69)*	1.60 *(0.65)*
Intention score (max score 2)	*Imperative pointing* Mean	1.68 *(0.53)*	1.71 *(0.52)*
	Declarative pointing Mean	1.20 *(0.72)*	1.71 *(0.52)*

An Intention (Imperative *vs.* Declarative) x Observation (12 *vs.* 15 months) repeated-measure analysis of variance[9] for both factors revealed main effects for both Intention ($F(1,34) = 8.57$; $p = .006$; $\eta^2 = .20$) and Observation ($F(1,34) = 13.14$; $p = .0009$; $\eta^2 = .27$). An Intention x Observation interaction was also found ($F(1,34) = 11.34$; $p = .001$; $\eta^2 = .25$). Figure 5.4 shows means of the ability scores for imperative and declarative pointing at 12 and 15 months of age.

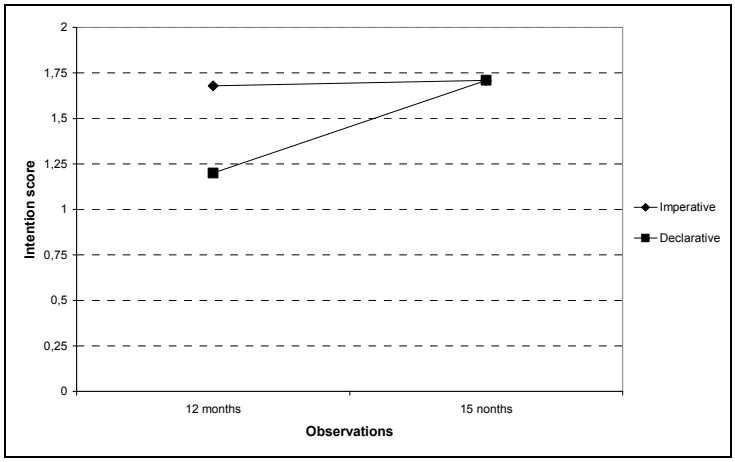


Figure 5.4 Means of the ability scores in the Imperative and the Declarative pointing at 12 and 15 months of age.

Test of Within-Subjects Contrast demonstrated that, at 12 months, the imperative score was significantly higher than the declarative score ($F(1,34) = 8.57$; $p = .006$). The scores for declarative ability increased from 12 to 15 months ($F(1,34) = 11.35$; $p = .002$), while scores for imperative ability remained almost unchanged. In sum, the ability to understand and to produce declarative pointing increased during this three-month time period, becoming equivalent to imperative pointing.

Intention understanding (12 and 15 months of age)

Children's mean number of target acts was 1.31 (*SD* = 1.08) at 12 months of age, and 3.06 (*SD* = 1.23) at 15 months. Twenty-nine percent of infants did not produce any target act at 12 months of age. More than half of the sample (54%) produced less than 2 target acts. In

[9] These two analyses give the same information as a 2 (Observation) x 2 (Modality) x 2 (Intention) analysis. The only effect that cannot be estimated is the three-way interaction. I decided to perform two separate\ analyses because of the small number of subjects and because the three-way interaction is not of interest to the current hypothesis.

comparison, 60% of infants produced at least 3 target acts at the age of 15 months. Preliminary repeated-measure analyses of variance showed no effects related to gender or to order of birth[10], so these variables were collapsed for further analyses.

A repeated-measure analysis of variance examining the target acts produced by children in the understanding-of-intention task, with Observation as a within-subject factor ($F(1,34) = 74.24$; $p = .0001$), revealed that children produced significantly more target acts at 15 months than at 12 months. The mean number of target actions produced at 12 months of age is similar to that reported in the previous study of Camaioni et al. (2004), and the one reported by Bellagamba and Tomasello (1999) with infants of the same age.

Correlation between measures at 12 and at 15 months of age

Figure 5.5 shows the correlations between measures at 12 and at 15 months in the pointing task and in the understanding-of-intentions tasks.

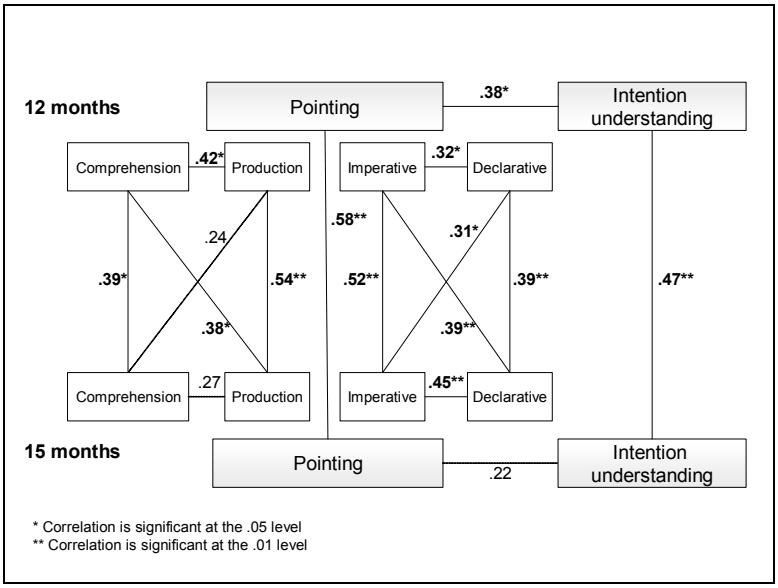


Figure 5.5 Correlations between measures at 12 and at 15 months in the pointing task and in the intention-understanding tasks.

[10] *Between-subjects effects of gender at 12 and 15 months on understanding of intention* ($F(1,33) = .08$; $p = .779$; $\eta^2 = .002$); *Between-subjects effects of order of birth at 12 and 15 months on understanding of intention* ($F(1,33) = .74$; $p = .396$; $\eta^2 = .022$);

As expected, pointing measured at 12 months was significantly correlated to the pointing measured at 15 months of age. In general, all the partial scores (comprehension, production; imperative, declarative) were significantly correlated in the same observation and between 12 and 15 months, with the exceptions of comprehension and production at 15 months and production at 12 months with comprehension at 15 months. A significant correlation was also found between intention understanding at 12 and 15 months of age, and between pointing and intention understanding at 12 months.

Visual perception (39 months)

Compared to the first study (Chapter 3), children in this smaller group had a better performance in the visual-perception task. Twenty-seven children (77%) answered correctly to all the three items, 5 children (14%) correctly answered two items out of three, and 3 children (9%) correctly answered to only one item. The mean number of target actions was 2.69 (*SD* = .63). Children's performance was not related to gender, birth order, or order of the questions[11].

Intention understanding (39 months)

Children's performance was similar to that reported in the first study (Chapter 3). Ten children (29%) correctly answered all four items, 6 children answered three items (17%), 12 children answered two items (34%), and seven children answered only one question correctly (20%). All the children correctly answered at least at one out of four items. Children's performance was not related to gender, birth order, or order of tasks (Transparent intention task / Explanation task)[12]. The 46% who answered correctly is greater than a chance expectation. This percentage is lower than the 50% of children in the first study, and confirms that this ability is still developing at the age of three years. The mean number of correct answers was 2.54 (*SD* = 1.20).

Explanation of actions (39 months)

The number of spontaneous and complete psychological explanations provided for the nine stories was evaluated. Preliminary analyses showed no significant differences due to gender or

[11] *Gender* ($F(1,34) = .510$; $p = .480$); *Order of birth* ($F(1,34) = 1.128$; $p = .296$); *Order of questions* ($F(1,34) = .355$; $p = .555$);
[12] *Gender* ($F(1,34) = .948$; $p = .337$); *Birth order* ($F(1,34) = 2.08$; $p = .159$); *Order of tasks* ($F(1,34) = .118$; $p = .733$);

to order of birth[13]. Children produced an average of 5.31 (*SD* = 2.31) spontaneous psychological explanations and 7.54 (*SD* = 1.67) complete psychological explanations. The number of complete psychological explanations was significantly higher than the number of spontaneous psychological explanations ($F(1,34) = 45.40$; $p = .001$).

Relation between precursor and theory of mind measures

In this section, the relations between the precursor measures (at 12 and at 15 months of age) and the theory-of-mind measures (at 39 months of age) are considered.

Pointing ability as predictor of perception understanding

In order to evaluate whether the pointing ability at 12 and 15 months of age predicted the later ability to understand visual perception, the correlations between pointing ability scores at both 12 and 15 months of age and the visual-perception scores were evaluated. Pointing ability at 12 and 15 months was not significantly correlated with perception understanding at 39 (Pointing 12 months: $r = .22$; $p = .106$; Pointing 15 months: $r = -.12$; $p = .245$). A linear regression analysis, with the pointing scores at 12 and 15 months as predictors and the perception understanding scores as the dependent variable, was only marginally significant ($R^2 = .14$; $F(2,34) = 2.53$; $p = .095$). In sum, pointing ability did not significantly predict later perception understanding.

Pointing ability as a predictor of intention understanding

Infants' pointing abilities at 12 and 15 months of age were not significantly correlated with their later performance in the intention-understanding task (Pointing at 12 months: $r = .16$; $p = .182$; Pointing at 15 months: $r = -.03$; $p = .423$). A linear regression analysis, with the pointing scores at 12 and 15 months as predictors and the intention-understanding scores as the dependent variable, was not significant ($R^2 = .05$, $F(2,34) = 0.82$; $p = .451$). In sum, children's pointing ability did not significantly predict their later intention understanding.

[13] *Effect of Gender:* Spontaneous psychological explanations ($F(1,34) = .421$; $p = .521$); Complete psychological explanations ($F(1,34) = .038$; $p = .848$);
Effect of Order of birth: Spontaneous psychological explanations ($F(1,34) = 1.68$; $p = .204$); Complete psychological explanations ($F(1,34) = .082$; $p = .777$);

Pointing ability as a predictor of explanations for actions

In order to evaluate whether the presence of specific pointing ability was a predictor of the later ability to explain action in a psychological way, the pointing ability scores at both 12 and 15 months of age were considered. Hierarchical multiple regression was used to explore how pointing ability scores predicted children's use of spontaneous and complete psychological explanations. Before doing so, simple correlations were computed to examine correlations between ability scores in the pointing task and the mean scores for spontaneous and complete psychological explanations. Table 5.3 reports these correlations.

Table 5.3 Correlations between ability scores in pointing task and spontaneous and complete psychological explanations

		Psychological explanations	
		Spontaneous	*Complete*
12 months	Pointing	**.35***	**.42****
	Comprehension	**.40****	**.40****
	Production	.17	.27
	Imperative	**.44****	**.40****
	Declarative	.17	**.30***
15 months	Pointing	.22	.07
	Comprehension	.23	.01
	Production	.16	.10
	Imperative	.25	.12
	Declarative	.13	.01

* Correlation is significant at the .05 level
** Correlation is significant at the .01 level

Two regressions were conducted, with the pointing ability scores at 12 and 15 months as predictors and spontaneous and complete psychological explanations as dependent variables. In the first hierarchical regression the dependent variable was children's spontaneous psychological

explanations. At Step 1, pointing ability at 12 months was entered as an independent variable. The model was significant (R^2 = .12; $F(1,34)$ = 4.66; p = .038). When pointing ability at 15 months was entered at Step 2, the equation was not significant (R^2 change = .12; $F(2,34)$ = 2.27; p = .120). Thus, pointing ability scores at 12 months predicted children's productions of spontaneous psychological explanations in Step 1 (Beta = .35; t = 2.16; p = .038), but it did not predict spontaneous psychological explanations when pointing ability at 15 months of age was included (Beta = .34; t = 1.66; p = .106).

In the second hierarchical regression, the dependent variable was children's complete psychological explanations, and in Step 1 pointing ability at 12 months was entered as the independent variable. The resulting equation was significant (R^2 = .17, $F(1,34)$ = 6.93; p = .013). When, at Step 2, pointing ability at 15 months was included, the equation remained significant (R^2 change = .21, $F(2,34)$ = 4.34; p = .021). Figure 5.6 shows the beta weights and t-values for the two predictor variables at Step 2.

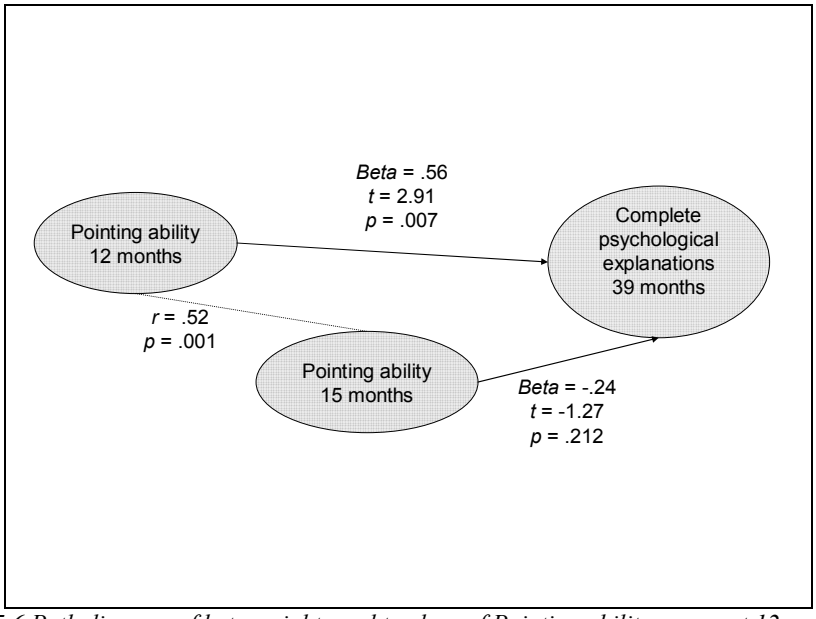


Figure 5.6 Path diagram of beta weights and t values of Pointing ability scores at 12 and 15 months of age as predictors of Complete psychological explanations at 39 months of age (Step 2).

Beta scores show that children's pointing ability at 12 months predicted their later complete psychological explanations when holding stable the effect of pointing comprehension at 15 months of age. Thus, the general ability to produce pointing at 12 months is related to the later ability to explain actions in terms of mental states. Following these general analyses, it is interesting to investigate which abilities utilized in the pointing task contributed to the relation, by considering the partial pointing abilities scores.

Pointing comprehension and production as predictors of psychological explanations. In order to evaluate how pointing comprehension and production at 12 and 15 months of age predicted children's spontaneous and complete psychological explanations, multiple regression analyses were conducted. Every regression analysis had two steps. At Step 1, comprehension or production ability at 12 months of age was entered. At Step 2, both the comprehension and production abilities at 12 and 15 months of age were entered. Table 5.4 reports the R^2, and *F*-values of the regression analyses, with the Beta and *t*-values for every factor entered into the regression.

Table 5.4 Hierarchical regression analyses results for spontaneous and complete psychological explanation as dependent variables and comprehension and production of the pointing gesture at 12 (12 m) and 15 (15 m) months of age.

	Spontaneous psychological explanations							
	Step 1				Step 2			
	R^2	$F_{(1,34)}$	Beta	t	R^2 ch.	$F_{(2,34)}$	Beta	t
Comprehension 12 m	.16	6.44**	.40	2.53*			.37	2.13*
Comprehension 15 m					.17	3.27*	.09	0.50
Production 12 m	.03	1.04	.17	1.02			.12	0.59
Production 15 m					.04	0.62	.10	0.48

	Complete psychological explanations							
	Step 1				Step 2			
	R^2	$F_{(1,34)}$	Beta	t	R^2 ch.	$F_{(2,34)}$	Beta	t
Comprehension 12 m	.16	6.39*	.40	2.53*			.47	2.70*
Comprehension 15 m					.19	3.66*	-.17	-0.97
Production 12 m	.07	2.64	.27	1.63			.31	1.54
Production 15 m					.08	1.34	-.07	-0.34

* Correlation is significant at the .05 level
** Correlation is significant at the .01 level

As table 5.4 shows, pointing comprehension at 12 months significantly predicted children's later ability to produce both spontaneous and complete psychological explanations. The equations also remained significant when comprehension at 15 months of age was entered. Beta scores show that children's pointing comprehension at 12 months predicted later spontaneous psychological explanations when holding stable the effect of pointing comprehension at 15 months of age.

In contrast, pointing production did not predict children's spontaneous or complete psychological explanations at Step 1 or at Step 2, respectively. In sum, only the comprehension of pointing gestures at the early age of 12 months significantly predicted the later ability to explain in a psychological way others' actions.

Imperative and declarative pointing as predictors of psychological explanations. Multiple regression analyses were conducted in order to evaluate whether either imperative or declarative pointing, at both 12 and 15 months of age, predicted children's spontaneous and complete psychological explanations (see Table 5.5).

Table 5.5 Hierarchical regression analyses results for spontaneous and complete psychological explanation as dependent variables and imperative and declarative intentions in the pointing gesture at 12 (12 m) and 15 (15 m) of age.

	Spontaneous psychological explanations							
	Step 1				Step 2			
	R^2	$F_{(1,34)}$	Beta	t	R^2 ch.	$F_{(2,34)}$	Beta	t
Imperative 12 m	.20	8.08**	.44	2.84**			.43	2.32*
Imperative 15 m					.20*	3.93*	.02	0.14
Declarative 12 m	.03	1.02	.17	1.01			.15	0.77
Declarative 15 m					.03	0.56	.07	0.36

	Complete psychological explanations							
	Step 1				Step 2			
	R^2	$F_{(1,34)}$	Beta	t	R^2 ch.	$F_{(1,34)}$	Beta	t
Imperative 12 m	.16	6.22*	.40	2.49*			.46	2.45*
Imperative 15 m					.17	3.27*	-.12	-0.66
Declarative 12 m	.09	3.23	.30	1.80			.35	0.19
Declarative 15 m					.10	1.82	-.12	-0.67

* Correlation is significant at the .05 level
** Correlation is significant at the .01 level

At Step 1, imperative or declarative ability at 12 months of age was entered. In Step 2, both the imperative and the declarative intentions at 12 and 15 months of age were entered. Table 5.5 reports the R^2 and *F*-values of the regression analyses, with the Beta and *t*-values for every factor entered into the regression.

Imperative pointing at 12 months significantly predicted children's later ability to explain others actions in both spontaneous and complete psychological ways. The equations also remained significant when imperative pointing at 15 months of age was entered. Beta scores show that children's imperative pointing at 12 months predicted later spontaneous psychological explanations, when holding stable the effect of imperative pointing at 15 months of age.

In sum, only pointing with an imperative intention at the early age of 12 months was a good predictor of the later ability to explain others' actions in a psychological way.

Language. All the children at 39 months of age showed a normal development on the basis of their performance on the PPVT-R test. There was not considerable variation on the PPVT; scores ranged from 67 to 97, with a mean score of 84.94 (*SD* = 6.54). Children's spontaneous and complete psychological explanations at 39 months of age were significantly correlated with their performance on the PPVT (Spontaneous psychological explanations: $r = .65$; $p = .0001$; Complete psychological explanations: $r = .38$; $p = .012$). On the other hand, no significant correlations were found between the PPVT scores and children performance in the visual-perception task ($r = .22$; $p = .212$) and intention-understanding task ($r = -.11$; $p = .522$).

Again no significant correlations were found between the pointing ability at 12 and 15 months of age and the receptive vocabulary evaluated through the PPVT at 39 months of age (Pointing at 12 months: $r = .24$; $p = .078$; Pointing at 15 months: $r = .13$; $p = .226$). For this reason no regression was conducted to evaluate the weight of language on the relation between the pointing gesture at 12 and 15 months of age and the explanation ability at 39 months of age.

Intention understanding at 12 and at 15 months as a precursor of perception understanding at 39 months of age

In order to normalize the distributions of infants' scores in the intention-understanding task, two groups of children were formed at 12 and at 15 months of age, respectively, on the basis of the median score. At 12 months of age, the Low group had a score of 0 or 1 (19 infants) and the High group a score above 1 (16 infants). At 15 months of age, the Low group had a score less than or equal to 3 (21 infants) and the High group a score above 3 (14 infants).

Children's understanding of intentions at 15 months of age was significantly and positively correlated with perception understanding at 39 months of age (r = .41, p = .014). In order to evaluate how intention understanding at 12 and at 15 months of age predicts visual perception at 39 months, a hierarchical regression was conducted with perception understanding as the dependent variable. When, at Step 1, understanding of intention at 15 months was entered, the equation was significant (R^2 = .17; $F(1,34) = 6.77$; p = .014). When, at Step 2, understanding of intention at 12 months was also entered, the equation remained significant (R^2 = .17, $F(2,34)$ = 3.38; p = .047). Figure 5.7 shows the beta weights and t-values, at Step 2, of intention understanding at 12 and 15 months as predictor variables of visual perception at 39 months of age.

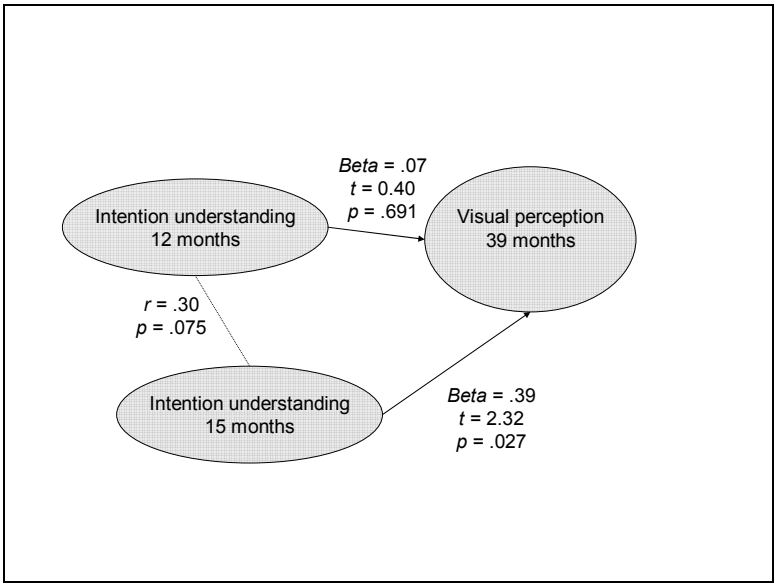


Figure 5.7 Path diagram of beta weights and t-values of intention understanding at 12 and 15 months of age as predictor variables of visual perception at 39 months.

Thus, intention understanding when children were 15 months old was a good predictor of their later ability to understand visual perception at 39 months of age, also when holding constant the effect of intention understanding at 12 months.

Intention understanding at 12 and 15 months as precursor of Intention understanding at 39 months of age.

In conducting these analyses, the same formation of groups was used. Only intention understanding at 15 months was significantly correlated to intention understanding at 39 months of age (r = .34; p = .047). Hierarchical regression analyses were conducted, with intention understanding at 39 months of age as the dependent variable. At Step 1, the understanding of intention at 15 months of age was significant for the model (R^2 = .11; $F(1,34) = 4.26$; p = .047). Understanding of intention at 15 months significantly predicted children's intention understanding at 39 months of age (Beta = .34; t = 2.06; p = .047). When, at Step 2, the understandings of intention at both 12 and 15 months of age were entered, the equation was not significant. In sum, understanding of intention at 15 months of age predicted the later understanding of intention at 39 months of age.

Intention understanding at 12 and 15 months of age as a precursor of Psychological explanations at 39 months of age

No significant correlation was found between infants' performance in the understanding-of-intentions task at 12 and 15 months of age and their ability to explain action in a psychological way at 39 months.

5.4. Conclusion

The present study was a pioneer investigation on the relation between two abilities that develop after the first year of life, and later abilities at the age of 39 months. The goal of the study was an ambitious one, with the basic presupposition that, behind these early precursors and the later abilities, there is the same socio-cognitive structure. This structure allows infants/children to understand that other people are intentional beings with their own mental states like attentions, desires, beliefs, and intentions. However, so far there is no way to test children's ability to understand the development of the mind as a continuum, from the second to the fourth year of life. We can only find several kinds of tasks able to evaluate, at different ages, different abilities that are considered manifestations of how infants and children understand the mind. Starting with this premise, the interest in conducting an investigation on the relationship between early social-cognitive abilities during infancy and theory of mind is evident. The results

of the present study confirmed results of the previous study by Camaioni, et al., (2004). Thus, the present group was representative of, even if smaller (5 subjects less) than, the complete sample. The understanding of pointing gestures emerges before production, and imperative intention emerges before declarative intention. To find a relationship between the pointing gesture and intention understanding was not a goal of the present study. However, a positive correlation between the two measures was found at 12 months of age.

Children's pointing ability increased from an average of 2.88 (at 12 months) to 3.43 (at 15 months). With regard to the modal abilities (comprehension and production), results confirmed the findings of Carpenter et al. (1999), with comprehension developing before production of the pointing gesture. With regard to the two specific intention abilities (imperative and declarative), results showed that at 12 months of age the imperative ability was higher than the declarative ability. At 15 months of age, these two intentions became equivalent. This result is consistent with the hypothesis of Camaioni (1993; 1997), and with the study of Perucchini (1997) that found a décalage between the emergences of the two intentions, with the imperative intentions developing before declarative intentions. However, Carpenter et al. (1999) found an opposite result, where imperative pointing emerged at 14 months of age, about two months *later* than the declarative pointing. The fact that, in their study, the pointing and the reaching gesture were both considered and coded within the main category of "pointing" could have determined this result.

As far as intention understanding is concerned, the ability to recognize other's intention to act (but failing) in a specific way with an object increased from 12 to 15 months of age. At 15 months of age the occurrence was greater than the change expectation of 50%. The poorer performance at the age of 12 months was consistent with Bellagamba and Tomasello (1999). Thus, while children at 12 months of age already showed good performance in pointing ability, their performance in intention understanding reached a good level only at 15 months of age. Moreover, this result is in accordance with infant's understanding of intentional actions, as investigated by Phillips et al. (2002). In their study, 14-month-old infants were better able than 12-month-olds to use combined information about the direction of gaze and emotional expressions to predict the action of another person.

Also, the abilities evaluated at 39 months of age in the present sample confirmed those of the complete sample of 80 children in Study 1 (Chapter 3). Thus, the present sample could be considered representative with regard to children's performance in the tasks at the age of three years. The most demanding task was the intention-understanding task that evaluated children's

comprehension of their intention-in-action (an action that they were currently performing). In contrast, children performed quite well in the perception-understanding task. As far as the explanation task is concerned, children produced a high number of spontaneous and complete psychological explanations in all the three kinds of stories. With regard to the relation between precursors and theory of mind abilities at the age of 39 months, Figure 5.8 reports the results found in the present study.

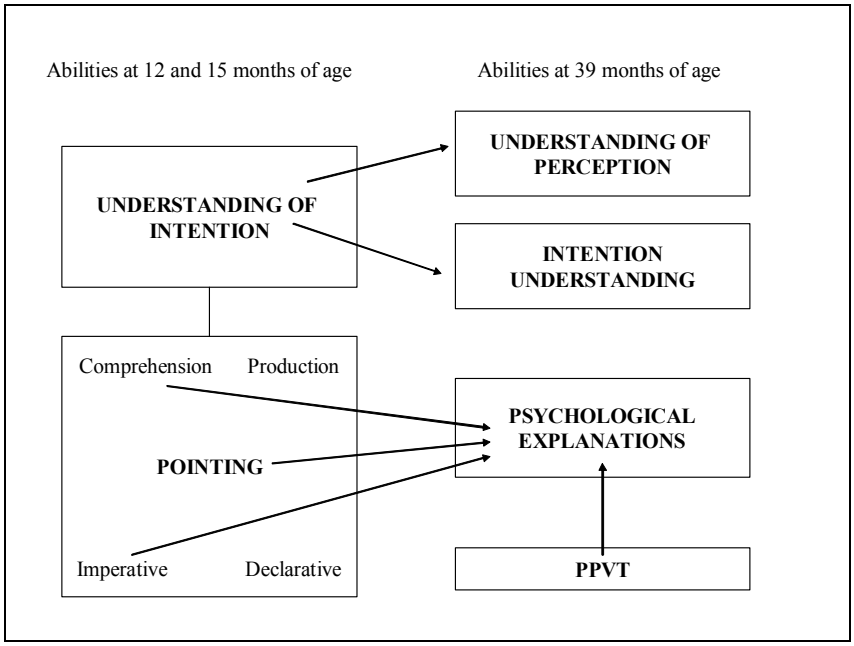


Figure 5.8 Relations found in the present study between the abilities at 12 and 15 months of age and the abilities at 39 months of age.

Children's ability to understand intention at 15 months of age predicted their later ability to understand both visual perception and intentions. This result confirms the presence of a common socio-cognitive ability at the base of these three tasks. This ability could be defined as the understanding of others' attentional states and intentionality. Looking closely to the relation between tasks, intention understanding at 15 months of age and visual-perception understanding at the age of 39 months share the necessary ability to understand the other person's point of view. Obviously, both of the tasks used to evaluate understandings of intentions at 15 and 39 months tapped children's comprehension of an intention-in-action. However, there is also a

large difference between these two tasks. While the task used when children were 15 months old evaluated their understanding of the intention of another person, the intention-understanding task used at 39 months evaluated children's own, previous intentions. Nevertheless, this did not compromise their relation. It is interesting that only the understanding of intentions at 15 months of age was a good predictor of children's ability at 39 months. This could be explained by the fact that infants' performance in this kind of task at 12 months of age was poor (Bellagamba & Tomasello, 1999). What these three tasks share is the understanding of the other person's point of view in a current situation.

Children's pointing ability predicted their later aptitude for explaining actions in terms of mental states at 39 months of age. This result supports the hypothesis that the pointing gesture is a precursor of children's later theory of mind. In other words, the relationship between pointing ability and the later use of psychological explanations is consistent with the idea that this ability, at the age of 12 months, is a predictor of the later appreciation of psychological states. This result stands in contrast to the claim of Moore and colleagues (Corkum & Moore, 1995, 1998; Moore & Corkum, 1994; Moore & D'Entremont, 2001), that gaze following (pointing comprehension) and declarative pointing (declarative production) at 12-15 months of age do not involve an understanding that people are intentional agents. Instead, it supports some other positions suggesting that pointing is an early form of sensitivity to mental states (Baron-Cohen, 1991; Camaioni et al., 2004; Carpenter et al., 1999).

More specific results indicated that, in particular, pointing comprehension, more than pointing production, predicts the later use of psychological explanations. This result confirms the findings of Charman et al. (2000), who reported a longitudinal association between joint-attention behaviors at 20 months and the theory-of-mind ability at 44 months. Moreover, imperative pointing, more than declarative pointing, is a predictor of children's spontaneous psychological explanations. This result is not consistent with what has been reported separately by Camaioni (1992; 1993; 1997) and Baron-Cohen (1991), both who consider only the pointing gesture with a declarative intention as a precursor to a theory of mind. Results found in the present study are more suggestive that general pointing ability (considering the presence of production and comprehension of pointing with an imperative as well as a declarative intention) is a good predictor of the later theory of mind. The fact that imperative, but not declarative, pointing predicted the children's later abilities should be considered with caution. The current data do not prove that declarative pointing is not predictive of a later theory of mind. In fact, the finding that only imperative pointing at the age of 12 months was a good predictor could be

related to the fact that the sample was selected on the basis of their emergence of pointing. It could be argued, in accord with the hypothesis that declarative pointing emerges after imperative pointing (Camaioni, 1993; 1997; Camaioni et al., 2004; Perucchini, 1997), that infants' declarative pointing at 12 months was not sufficiently developed in order to discriminate between children.

Why would intention understanding, but not pointing ability, predict the later comprehension of perceptions and intentions? And why does the pointing gesture, but not intention understanding, predict the later ability to explain others' actions in a psychological way? These two questions could be answered based on the nature of the two tasks. In fact, it may be argued that the pointing task and the explanation task share a more evident, communicative aspect that is not present in the other tasks. Moreover, they were, from a communicative point of view, more demanding than the intention-understanding tasks and the perception-understanding tasks. There is evidence in the literature about the longitudinal association between the pointing gesture and language (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Camaioni, Castelli, Longobardi & Volterra, 1991; Werner & Kaplan, 1963), even if in the present study this association was not found. However, a significant correlation was found between children's psychological explanations and their performance on the PPVT-R.

In the present research, there was a large lag between the first and second investigation and the third one (2 years). However, the fact that some relations between precursor abilities and later capacities were found was a clear demonstration of the presence of coherence in the cognitive structure. This coherence could be interpreted as a result of innate structures that made the child able to show specific abilities at both an early and a later age. However, this coherence could also be interpreted as a result of environmental influence (like the family's ways of communicating) that is supposedly the same at both ages. The present research did not have the goal of addressing a nature-nurture issue behind this relationship, but only of evaluating the possibility of an empirical relationship between socio-cognitive abilities during infancy and the emergence of theory of mind in preschool.

Chapter 6

General discussion

Introduction

The present thesis aimed to evaluate how social-cognitive understanding develops from the second to the fourth year of life. In the first part of the book (Chapter 1), after a brief description of what the theory of mind is, the main theoretical positions in the previous literature were considered. The aim was to give an overview of the research in the last 20 years and how, even if starting from a different perspective, researchers have been studying the same phenomena. The first part (Chapters 2 and 3) concerned children's ability to understand others' mental states at the age of three years. Their understanding of perceptions, beliefs, desires, and intentions were discussed in terms of the main studies published in recent years. The first study of the present thesis (Chapter 3) examined children's explanations of others' actions in terms of mental states. Moreover, it was evaluated whether this explanatory ability is attributable to the understanding of perception and intentions. In the second part (Chapter 4 and 5), infants' socio-cognitive abilities as precursors of a theory of mind were considered. In particular, the pointing gesture and intention understandings in the beginning of the second year of life were concerned. The second study (Chapter 5) evaluated the pointing gesture and intention understanding as potential precursors of the later abilities to understand perceptions and intention, and the ability to explain actions in a psychological way. Both of the two studies yielded some interesting results for the investigation of theory of mind and its emergence. Figure 6.1 displays a synthesis of the results of the two studies. In the present chapter, the main results of the two studies are synthesized and discussed.

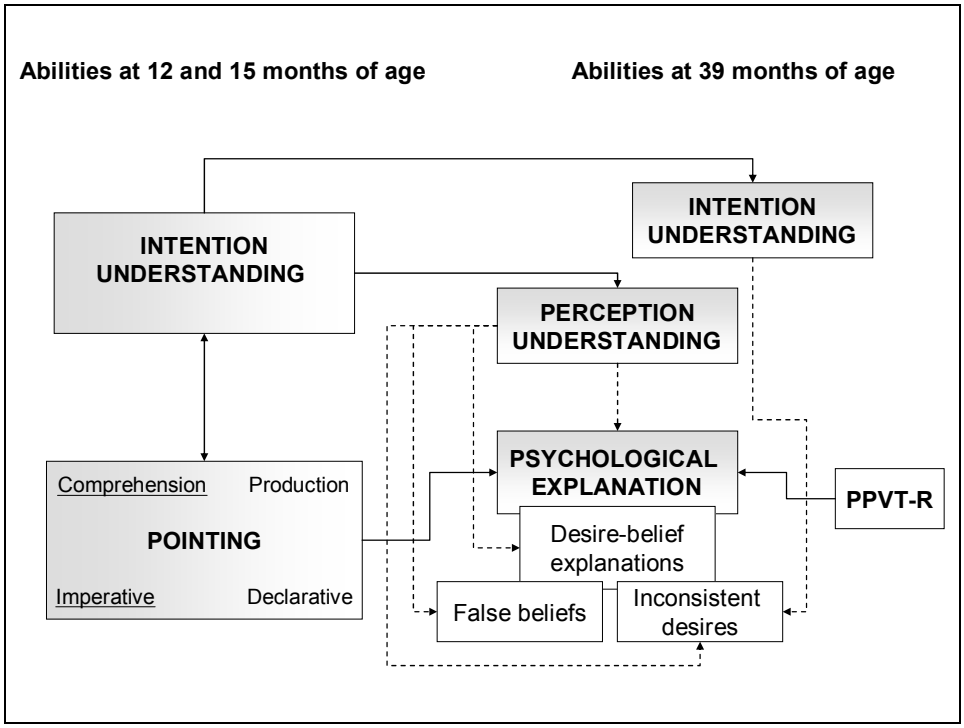


Figure 6.1 Synthesis of the main results of Study 1 (cross-hatched lines) and Study 2 (continuous lines).

Young children's understanding of mental states

In the first study, children's aptitude in explaining others' actions was examined using a very well known task developed by Bartsch and Wellman (1989). Children's explanations of human behavior may be considered one of the most effective ways to let them explicitly and spontaneously show how they interpret others' behavior. Moreover, explanation gives information about a specific ability free from the possibility that children randomly choose one answer instead of another, and without the "yes" bias of yes/no questions (Fritzley & Lee, 2003). The first study gave evidence that children prefer to explain behavior using psychological explanations instead of behavioristic explanations. A second, more analytic examination showed that, already at the age of three, children are able to talk about others' actions specifically in terms of their desires and beliefs. These two kinds of mental states, desires and beliefs, have been considered the basic mental states that people use in order to explain intentional actions

(Davidson, 1963; Wellman, 1990). There is evidence in literature that by the age of three children begin to use this kind of explanation. In particular, there is evidence in the literature, that desire explanations precede both belief and false-belief explanations (Bartsch & Wellman, 1989; Wellman & Bartsch, 1988; Wellman & Liu, 2004; Wellman, Phillips & Rodriguez, 2000). Results of the first study showed that three-year-olds' ability to use false-belief explanations is still developing; only 12% of children did so in a spontaneous way and 36% did so after the experimenter's prompt. This percentage is consistent with the one reported by Wellman et al. (2001). Children in that study found the same difficulty with another kind of explanation considered in Study 1, the *inconsistent-desire explanations*. Inconsistent desire refers to the ability to explain an action that is contradictory to the character's preferences. The child is asked to recognize the causal link between desires and actions considering the preferences of the character. Thus, the child cannot explain the desire of the character only on the basis of the action. Children's difficulty with this kind of explanations gives evidence that to also understand desires can represent a major challenge for children when they have a comparable level of representation with false beliefs.

Children's ability to use psychological explanations was influenced by their ability to understand perceptions and intentions. Children with a low understanding of perception produced fewer psychological explanations and desire-belief explanations. More interesting, they never produced both a false-belief explanation and an inconsistent-desire explanation. In contrast, intention understanding did not influence children's psychological explanations, in general, but only their production of inconsistent-desire explanations. This result may be explained by comparing inconsistent desires with false beliefs. Between inconsistent-desires and false-belief understandings, there are some basic similarities and differences. Both are more than mentalist explanations of human behavior, because they require a representation of the character's mental state instead of a causal link between the world and the agent (Perner, 1991, Gopnik et al., 1994). However, in recognizing false beliefs the child must understand that the agent's action is caused by the agent's beliefs, even if they are different from the reality of a situation, while in the inconsistent desire children must understand that the act of the agent is not directly caused by his or her related desires. This makes inconsistent desires very similar to intentions. In fact, the inconsistent desire can be considered a character's intention or plan that cannot be directly inferred only from an action. The results of the first study confirmed this relationship, as children's performance in the intention-understanding task determined their ability to explain actions in terms of inconsistent desires. Moreover, children's performance in

the intention-understanding task did not determine their ability to explain actions in terms of false beliefs. This result points to the possibility that desires are not always easier for three-year-olds than beliefs. Along with children's beginning to understand false beliefs after true beliefs (Wellman & Liu, 2004), children start to understand desires with a higher level of complexity (Moore et al., 1995; Rieffe et al., 2001) later than simpler desires. In these studies, as well as in the present one, three-year-old children had some difficulties in inferring the right desire of the character when there was a conflict with their own desire. In general, the first study pointed to the importance of the age of three for the emergence of a theory of mind. Children start to both explain and understand others' mental states and to deal with the first difficulties in creating accurate representations.

These results provide some challenges to all three theoretical positions reported in chapter one. Young children's ability to explain others' actions in a psychological way is in accordance with the position of Wellman and Bartsch, who claim that three-year-olds understand the existence and representational nature of mental states (Wellman, 1990). Moreover, the fact that children preferred simple-desire explanations instead of simple-belief explanations confirms the passage from a desire to a desire-belief psychology during this age (Bartsch & Wellman, 1995). However, children's difficulties with inconsistent-desire explanations prove that desires and beliefs may have a similar level of difficulty at a representational level. Thus, in contrast to Wellman's contention (1990, p. 29), it could be argued that not only beliefs are representational, but also desires. This possibility is in accordance with some other positions that consider children's ability to create metarepresentations of desires (Astington & Gopnik, 1991). With regard to the simulation theory, children's ability to explain others' actions in a psychological way confirms the idea that they interpret others' behavior by applying a simulation strategy. This might also explain children's failure to produce inconsistent-desire explanations. It could be argued that to find an explanation that was consistent both with the character's preference and action required a high level of simulation for a three-year-old child. The same difficulty is also present in understanding false beliefs (Harris, 1992). However, this explanation of the phenomenon does not explain its development. As far as the modularity theory is considered, children's ability to explain others' actions in a psychological way is due to the activation of a module dedicated to the understanding of knowing and thinking. In accordance with this position, this activation should occur around the beginning of the third year of life. Children with autism should be deficient in this kind of explanation because that module malfunctions. However, this position does not take into consideration the complexity of this development. For

example, it is not clear why children start explaining others' actions first in terms of desires and later in term of beliefs, inconsistent desires, and false beliefs. In sum, the mere activation of modules does not give a complete picture of exactly what is happening in children's theory-of-mind development at the age of three years.

From precursors to a theory of mind

The aim of the second study was to evaluate whether some socio-cognitive abilities present in the second year of life - the pointing gesture and intention understanding – may veritably be precursors of children's theory of mind at the age of three years. Children's perception and intention understandings, as well as their ability to explain others' actions in a psychological way at 39 months of age, were considered.

As expected, the pointing gesture predicted children's ability to use psychological explanations at the age of three years, confirming the hypothesis about it being a precursor to a theory of mind. However, in the literature very often only the declarative pointing gesture has been considered a precursor of the theory of mind and not the pointing gesture in general (Baron-Cohen, 1991; Camaioni, 1997; Camaioni et al., 2004). In the present research, it was the general pointing ability that predicted children's later ability. The pointing gesture encompassed the ability to understand and produce pointing with an imperative and a declarative intention. The result of the present study confirmed the hypothesis of Carpenter et al. (1999) that it is infants' socio-cognitive ability, in general, that predicts their later theory of mind. However, also the comprehensions versus the productions, as well as the imperative versus the declarative intentions, were considered in the present study.

The understanding of pointing was a better predictor than the production of pointing. Thus, infants' ability to understand that another person was trying to direct their attention (with an imperative or a declarative intention) toward a specific event/target predicted their later sensitivity to explain others' actions in a mentalistic way. This result is in accordance with Charman et al. (2000) regarding the relationship between joint attention and the later theory-of-mind ability at 48 months of age.

As far as the intention of the pointing gesture is concerned, only the imperative intention was a sensitive predictor of the later use of psychological explanations. This result could be due to methodological issues. In fact, infants' imperative pointing predicted their later explanation ability only at 12 months of age (first observation). It could be argued that, at this age, declarative pointing is not sufficiently developed to discriminate between children.

Infants' intention understanding predicted their ability to understand perception and intention two years later. It is important to say that whereas studies of young children 's understanding of other's intentions involve often explicit, linguistic explanations of behavior, studies of this understanding during infancy must involve more implicit measure (Carpenter, Akhtar & Tomasello, 1998). A longitudinal relationship between these abilities was found. This result not only confirms the validity of the task of Meltzoff (1995), but also provides evidence that infants' ability to understand an intentional action during infancy is related to their later perspective-taking ability and understanding of intentions. The fact that children's performance in this task predicted their later performance in the perception- and intention-understanding tasks is proof that their performance was not due to emulation learning or to stimulus enhancement, as reported by Huang, et al. (2002; see Paragraph 4.4).

It is important to say that there are different ways to evaluate children's understanding of mental states during infancy and childhood. Some of these methods are highly communicative in nature. This is true for the false-belief task, where the child has to understand all the information about the character using the object, leaving the object in one place and going away, and then coming back and looking for the object. The child must understand all of the information about the story in order to solve the task. Also, the explanation task used in the present study has a strong communicative aspect. The child is asked to understand information about the story and to explain verbally why the character is performing the action. For this reason it may be argued that this ability may be better predicted by the pointing ability than by intention understanding. Moreover, children's performance in the explanation task correlated with their scores on the PPVT-R. The role of language in theory-of-mind development should never be undervalued (Ruffman et al., 2003). However, it is also possible to evaluate how children understand others' mental states in a way that is not so strongly related to language. This is the case in the task on understanding of intention of Meltzoff (1995). In fact, this task was created in order to evaluate preverbal children's understanding of intentions. This task predicted performance on two other tasks administered to children, when they were 39 months old, which are not linguistically demanding. In fact, in both tasks the experimenter gives the child little relevant information, and the child can answer simply by pointing to the right figure. It could be argued that this is a pragmatic understanding of intention and perception.

Considering the three main theoretical positions reported in Chapter 1, the results of Study 2 provide evidence for all them. In fact, although they propose different points of view regarding infants' emergence of socio-cognitive abilities, they all present evidence for the possibility of a

"theory of mind in infancy" or socio-cognitive abilities that can be considered precursors to a later theory of mind. On the basis of the modularity theory, the development of theory of mind is due to the activation of some specialized modules. According to Leslie (1994), the three modules (ToBy, $ToMM_1$ and $ToMM_2$) normally develop sequentially and they determine the development of a theory of mind. $ToMM_2$ develops at about 18 months of age and is responsible for metarepresentations. $ToMM_1$ develops at about 6-8 months and is involved in the processing of information about agents and their goal-directed actions. Thus, the modular system proposed by Leslie does not take into account all those important cognitive developments between 11 and 15 months of age and how they can influence the later theory of mind. Baron-Cohen (1995), in contrast, stresses the importance of the triadic interaction and above all of the declarative gesture as a precursor to a theory of mind. He starts with the point that the share-attention deficit is the earliest social deficit to appear n children with autism. The results of the second study are in accordance with the theory proposed by Baron-Cohen about the importance of share-attention behavior as a predictor of later social sensitivity. However, data did not confirm the importance of the declarative pointing gesture. In general, the result of the second study confirmed the modularity theory hypothesis that the emergence of specific modules at an early age is responsible for the emergence of later, related modules. The results of the study were also consistent with constructivistic theories**.** In fact, these theories take the view that the pointing gesture is a socio-cognitive ability during infancy that can predict later socio-cognitive abilities during childhood (Carpenter et al., 1999). In accordance with Frye (1991), behaviors that were observed in 12-month-old infants carried over to their discovery of the mind during childhood. Above all, it is important to note that the approximate age of 12 months is considered by many exponents of Piagetian theories to be an important period for the infant's discovery of the social world. It is equivalent to the 4^{th} and 5^{th} sensorimotor stages, with object and agents. During this period infants are able to differentiate in their behavior between means and ends, and this leads them to understand others' intentional activities (Tomasello, 1995). This point of view is strongly confirmed by the fact that children's pointing gestures during this age predicted their later ability to explain behavior in a psychological way. However, the intentional communication value of the imperative gesture was confirmed, instead of the declarative pointing gesture postulated by Camaioni (1992; 1995; 1997). Further evidence is required to make a more substantive claim.

The matching theories were also supported by aspects of the present research. In infants, the ability to understand the equivalence between the self and the other in actions directed toward

objects carried over to children's later understanding of both the others' perspective and their own mistaken intentions. In this case it was children's performance at the age of 15 months, and at 12 months. That was useful in predicting their later performance at 39 months of age. This result is consistent with others studies (Bellagamba & Tomasello, 1999; Wellman et al., 2004) arguing that infants' understanding of intentionality is not completely developed at the age of 12 months. However, children's performance in pointing at 12 months of age, and in intention understanding at 15 months, predicted their later performance at 39 months of age. This result supports the fact that, already before the age of 18 months, children are able to exhibit behaviors that are manifestations of their understanding of human intentionality.

Thus, in the present research, empirical evidence supported a connection between socio-cognitive abilities during infancy and theory of mind during the childhood. These results demonstrate the existence of a developmental dimension of children's theory of mind.

Directions for future research

Although the first study provided a description of some abilities that emerged at the age of three and how they are related to each other, it did not give information about the sequence of their development. To carry out an investigation with only three-year-old children does not allow an examination of age-related effects. Thus, in doing so we do not have information about the developmental trajectories of these abilities before and after this period. In the future, a longitudinal study might answer questions related to the development of these abilities. Moreover, a microgenetic design could lead investigators to follow children's performance (Siegler & Crowley, 1991). It is also relevant to evaluate, in a deeper way, the relationship between inconsistent desires and false beliefs with older children. With regard to the relationship between children's perception understanding and children's psychological explanations, in the present study only Level 1 was evaluated. Some important information about the role of perception could be obtained by evaluating children's understandings of not only the Level 1 of perspective taking, but also the Level 2. Pertaining to children's understanding of intention, it could be argued that the relationships between this ability and their false-belief and inconsistent-desire explanations could be clearer with children of four years of age. Finally, study 1 pointed to the necessity to explore further children's understanding of desires at the age of three years.

Future investigations on the relationship between precursor abilities and the later theory of mind should consider more than three time points. In particular, more accurate investigations on the role of declarative pointing are needed in order to evaluate the possibility that it is a

precursor of theory of mind. In doing so, it is necessary to evaluate this ability in a more accurate manner. One solution could be to select infants when they start to show the ability to understand declarative pointing gestures, instead of selecting them when they start to use pointing in general.

Final remarks

With regard to the first study, in the beginning of the research on the theory of mind the attention was focused on children's understanding of false beliefs. Previous literature pointed to the conclusion that children have a theory of mind when they are able to understand false beliefs, thus around the fourth year of life. However, it quickly became necessary to evaluate children's understanding of other mental states besides belief, and above all, children's understanding of mental states before the age of 4 years. The first study of the present research aimed to evaluate children's abilities in understanding mental states that precede the understanding of false beliefs. Already at the age of three years children are able to express verbally the way they interpret others' behavior. For research but also for parents and educators it is important to know how children are able to understand the social world as well as what they are not yet able to understand.

Concerning the second study, it could be argued that the relationship between infants' socio-cognitive ability and their later theory of mind might have some important use in clinical application. In fact, finding empirical evidence about the relationship between precursor abilities and the later theory of mind leads to the possibility that some behaviors during infancy can be considered as indices for the early diagnosis of certain developmental disorders, such as autism. Furthermore, it could be useful for the development of intervention programs. However, the present study was an investigation on normal development. The main assumption was that it is important first to know how a specific phenomenon relates to normal development before investigating its role in atypical development (Wenar & Kerig, 2000).

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Curriculum vitae

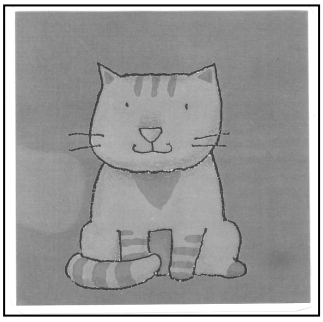
Cristina Colonnesi is born in Rome, Italy, on April 3, 1974. She completed the high school in Rome in 1993. She studied at the Faculty of Psychology in Developmental Psychology at the University of Rome "La Sapienza", Italy. She obtained her masters degree (cum laude) in 1999 with a master's thesis on children's persuasive abilities and theory of mind. In 2000 she did her Post-lauream training in the Neuro-psychology unit at the Public Hospital "Bambino Gesù" in Rome, and at the Department of Developmental and Social Psychology of the University of Rome "La Sapienza". In 2000 she was awarded a Ph.D. position (with a duration of 4 years) at the University of Rome "La Sapienza" under the supervision of Prof. Luigia Camaioni, and later under the supervision of Prof. Anna Paola Ercolani and Prof. Willem Koops.

Her main research theme is the emergence of a theory of mind in normal development, the role of pointing and intention understanding during infancy as precursors of a theory of mind, and children's persuasive abilities during childhood.

APPENDIX A

Drawings for the Visual-perception task

First card



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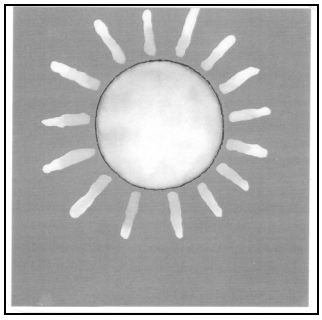

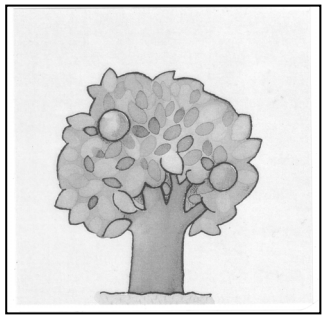

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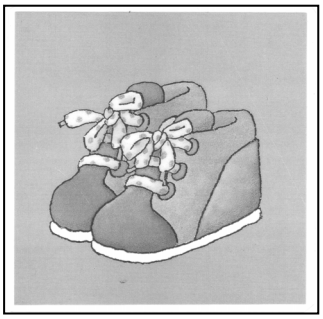

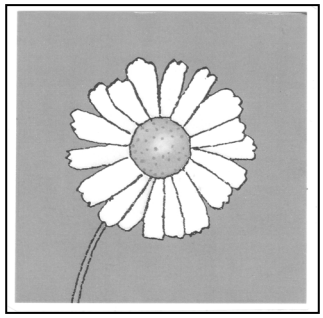

Drawings used for the intention-understanding task

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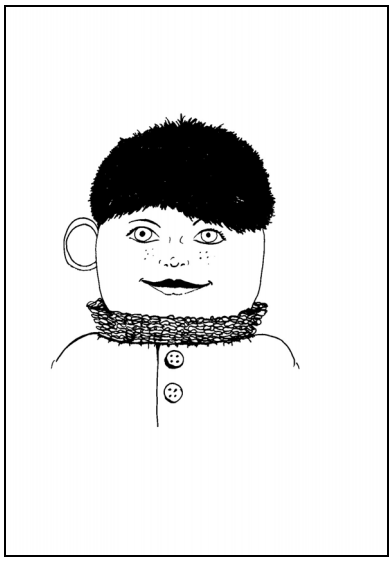

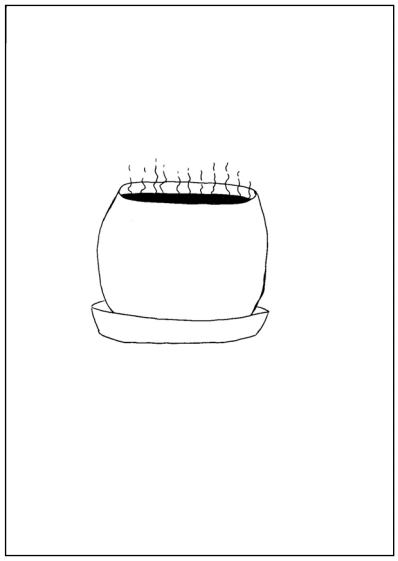

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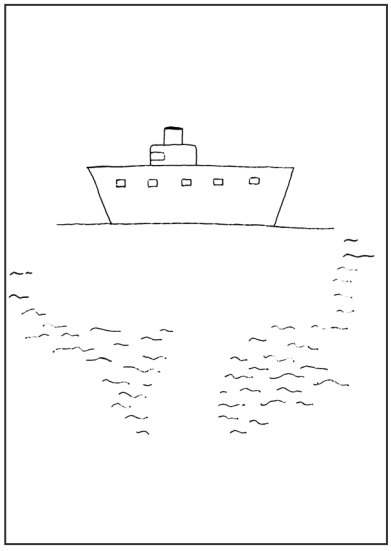

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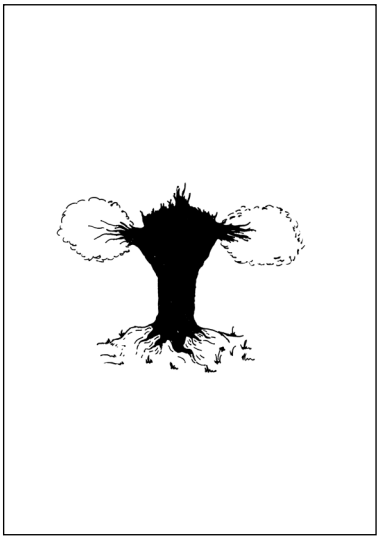
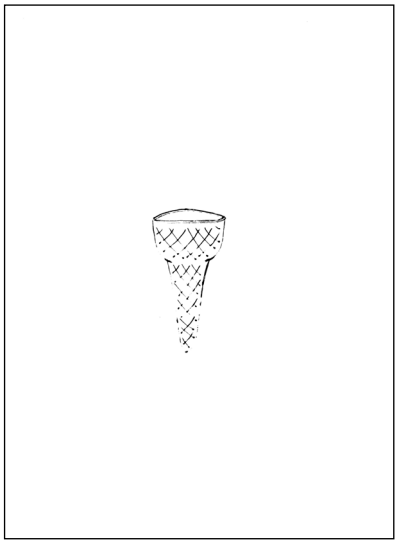
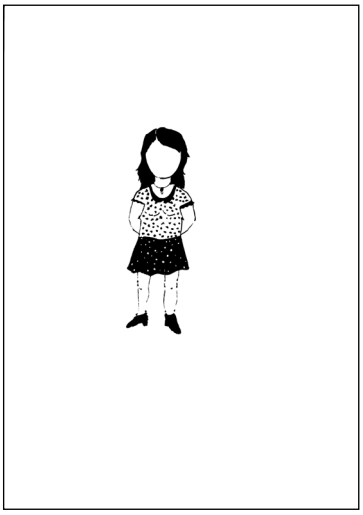
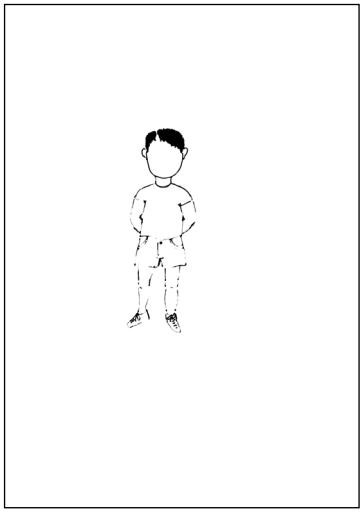




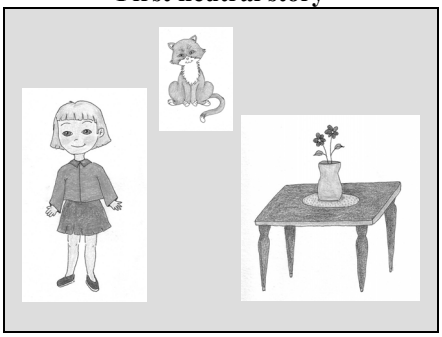
Forth drawing



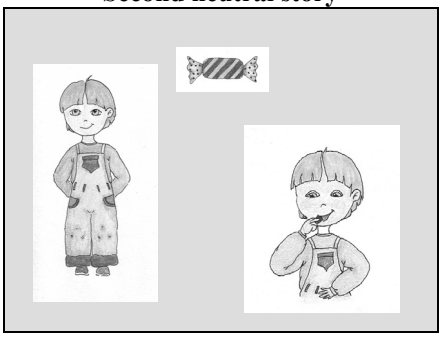


Drawings for the explanation task

First neutral story



Second neutral story



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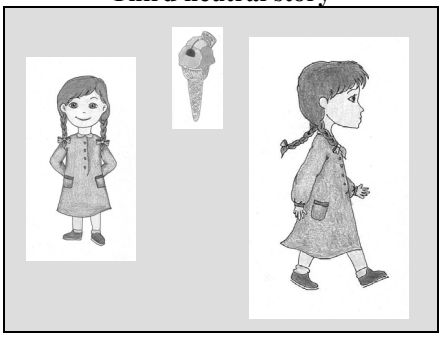
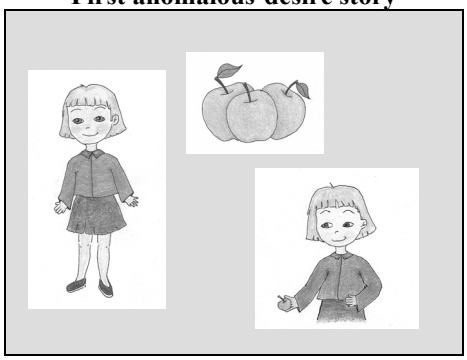
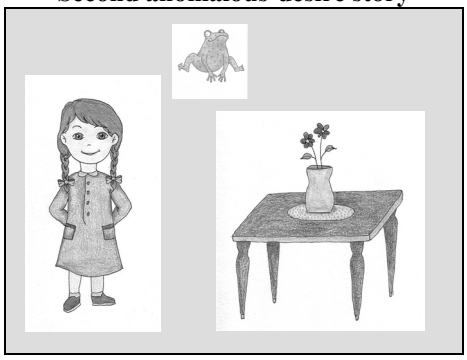


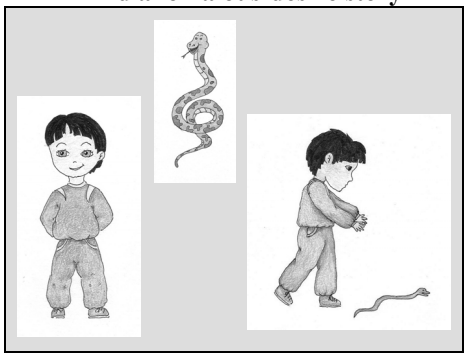
First anomalous-desire story



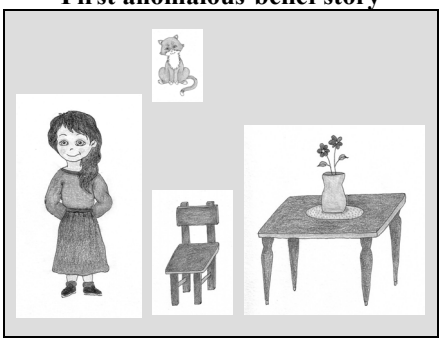
Second anomalous-desire story



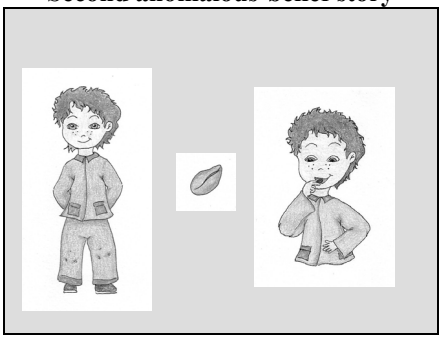
Third anomalous-desire story



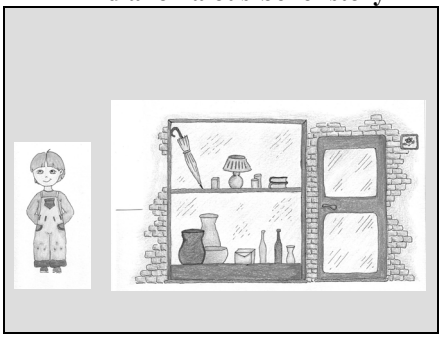
First anomalous-belief story



Second anomalous-belief story



Third anomalous-belief story



APPENDIX B

NEUTRAL STORIES – Spontaneous explanations

Beliefs	
Because he thinks it is there	Perché pensa che è li
Desires	
Because he wanted to eat it	*Perché se la voleva mangiare*
Because she wants to play with the kitty	*Perché vuole giocare con il gattino*
Because she wants it	*Perché lo vuole*
Because he wants to put it in his mouth	*Perché la vuole mettere in bocca*
Because she wants to have an ice-cream	*Perché vuole avere un gelato*
Because he wants to put it in his mouth but it will make him sick	*Perché se la vuole mettere in bocca ma poi gli fa male*
Because she wants to do that, because it is good, she wants to eat it all, so she does that	*Perché lo vuole fare, perché è buono, lo vuole mangiare tutto, allora lo fa*
Because she wants to look for it here (she points to the table)	*Perché vuole cercarlo qua (indica il tavolo)*
Because she wants to play with it	*Perché lo vuole giocare*
She wants to kiss it	*Lo vuole baciare*
Other psychological states	
Physiology	
Because she is hungry	*Perché aveva fame*
Because she has pain in her throat	*Perché gli fa male la gola*
Because she has pain in her belly	*Perché c'ha il mal di pancia*
Perception	
Because she sees it there	*Perché lei lo vede li*
Ehy, she didn't see it and she was scared	*Eh…perché non lo ha visto e si è spaventata*
Emotion	
Because she is happy	*Perché è felice*
Preference	
Because she likes it	*Perché gli piace*
Because she likes ice-creams very much	*Perché a lei gli piacciono moltissimo i gelati*
Because she loves it	*Perché gli vuole tanto bene*
Traits	
Because she is a little bit stupid	*Perché è un po' sciocca*
Obligations	
Because she has to look for it	*Perché lo deve cercare*
Because she must find it	*Perché lo deve trovare*
Non psychological	
Because she has lost it	*Perché lo ha perso*
Because ice-creams are in the ice-cream shop	*Perché i gelati stanno in gelateria*
Because he took the candy and after he was eating it	*Perché ha preso la caramella e poi se la mangiava*
It is here	*Sta qua*
Because it is hers	*Perché è sua*
Because there she can find it	*Perché li lo può trovare*
Because she can find it under the table	*Perché lo trova sotto il tavolino*

You said that it is there	*Hai detto che sta la*
Because one can eat candies	*Perché le caramelle si possono mangiare*
Because... she has lost the other one	*Perché… quell'altro lo ha perso*
One can eat candies	*Le caramelle si mangiano*
Because she is looking for it	*Perché lo sta cercando*
None	
Boo[14]	*Boo*
I don't know	*Non lo so*
Why he/she does it?	*Perché lo fa?*
(he/she changes the topic)	*(cambia discorso)*
(no response)	*(nessuna risposta)*

NEUTRAL STORIES – Prompt explanations

Beliefs	
She thinks that her kitty is under the table	*Pensa che il gatto sta sotto al tavolo*
He thinks that it is real but in fact it is fake	*Pensa che sia vera ma invece è finta*
She thinks that the kitty has run away	*Pensa che il gattino è scappato*
She thinks that the kitty is inside the plant	*Pensa che il suo gattino è dentro la pianta*
He thinks that one can eats it	*Lui pensa che si può mangiare*
Desires	
She wants to taste it	*Vuole assaggiarla*
She wants to eat it	*Vuole mangiarlo*
She wants the red one (he points the ice-cream)	*Quello rosso fuoco (indica il gelato)*
She wants the blue one, the red one and forest fruits and she puts the apple on the top	*Lei vuole quello blu, rosso e frutti di bosco e ci mette sopra la mela*
She wants to eat it in the park, but later the ice-cream will fall down	*Mangiarlo al parco ma poi il gelato gli cascherà*
He wants another one	*Ne vuole un'altra*
Other psychological states	
Because there is this apple (she points the ice-cream)	*Perché c'è questa mela (indicando il gelato)*
Non psychological	
She falls down and after she has pain	*Cade tutta e poi si fa male*
None	
I don't remember	*Non mi ricordo*
(he/she changes topic)	*(cambia discorso)*
(no response)	*(nessuna risposta)*

ANOMALOUS DESIRE STORIES – Spontaneous explanations

Inconsistent desires	
Because she wants to become big	*Perché vuole diventare grande*
She is taking that for her parents	*La sta prendendo per i suoi genitori*

[14] Italian way to say "I don't know

Because she wants to take a piece to put it here with the big apples	*Perché ne vuole prendere un pezzo per metterlo qua nelle mele grandi*
To put it in the pool	*Per rimetterla nello stagno*
Because she wants to give it to her mother, she likes frogs	*Perché la vuole dare alla mamma, che a lei gli piacciono le rane*
Because she wants to throw it in the water, frogs are in the water	*Perché la vuole buttare nell'acqua, le rane stanno nell'acqua*
Because he wants to take it and throw it away	*Perché lo vuole prendere e lo vuole buttare via*
Because she wants to try a piece of that	*Perché ne vuole provare un pezzetto*
Beliefs	
She thinks that it is there	*Pensa che c'è*
Because she thinks that maybe it is possible to eat it	*Perché pensa che forse si può mangiare*
Desires	
She wants the big one	*Vuole quella grande*
Because she wants to eat it. After she has eaten it, she says Blaaaa	*Perché la vuole mangiare. Dopo che l'ha mangiata dice blaaa*
Because she wants to eat it but she is not able to remove the skin	*Perché vuole mangiarla ma non è capace di togliere la buccia*
Because he wants to catch it	*Perché lo vuole acchiappare*
Because she wants to let it walk	*Perché lo vuole far camminare*
Because he wants it but he doesn't catch it	*Perché lo vuole, però lui non lo prende*
Because she wants to carry it to the public gardens	*Perché vuole portarlo ai giardinetti*
Because she goes there… she wants to take it but the frogs says bla bla bla	*Perché va la… la vuole prende ma poi la rana gli fa bla bla bla*
Non psychological	
Because she looks for apples	*Perché cerca le mele*
Because it is for her totally	*Perché è tutta per lei*
Because… because… because… it is good	*Perché… perché… perché… è buona*
Because it is here (he points the table)	*Perché è qui (indica il tavolo)*
Because it is hidden behind the plant	*Perché lui si è nascosto dentro la pianta*
Because this is hers	*Perché questa è sua*
Because there was	*Perché c'era*
Because… because… frogs do not go on the table but they go….on the ground	*Perché… perché… le rane non vanno nel tavolo ma vanno… nella terra*
Because he bought a snake	*Perché lui ha comprato un serpente*
Because snakes are wild	*Perché perché il serpenti sono feroci*
But the snake is wild… it is not good to catch it	*Ma è velenoso il serpente… non si prende*
Braaaaaaaaahh!! He takes it and he eats it	*Braaaaaahh!! Lo prende e poi se lo mangia tutto*
None	
Why is she doing that?… I don't know	*Perché sta facendo?... non lo so*
I like them	*A me mi piacciono*
So… let's see	*Allora… allora vediamo*
Boh…boh…	*Boh... boh...*

ANOMALOUS DESIRE STORIES – Prompt explanations

Inconsistent desires	
She wants to take it to give it to her mother	*La vuole prendere per darla alla mamma*
Beliefs	
She thinks that it is here…here (she points the table)	*Pensa che è qua…qua (indica sotto il tavolo)*
Desires	
He wants to take it	*Lo vuole prendere*
She wants a piece of apple	*Vuole un pezzo di mela*
She wants to eat an apple too but she doesn't like them	*Vuole mangiarsi pure lei una mela ma a lei non le piacciono le mele*
The banana… maybe the apple	*La banana… forse la mela*
She wants to catch a frog	*Vuole prendere una ranocchia*
She wants to look for it because it seems that the frog has run away	*Se la vuole cercare perché la rana sembra essere scappata*
She wants the frog and she is looking for it here	*Vuole la rana e la sta cercando qui*
He wants that the frog goes out of the pot	*Vuole che la ranocchia esca dal vaso*
He wants to catch this one (he points the snake)	*Vuole prendere questo qua (indica il serpente)*
He wants to cook it! With potatoes	*Lo vuole cucinare! Con le patate fritte*
Other psychological states	
Preference	
That she likes apples	*Che gli piacciono le mele*
Because because because she hates it	*Perché perché perché la odiava*
Non psychological	
Thus, there is an other Marta	*Allora ce n'è un'altra di Marta*
None	
I don't know	*Non lo so*
Nothing	*Niente*

ANOMALOUS BELIEF STORIES – Spontaneous explanations

False beliefs	
Because when he swallows it down he dies and after he thinks that it was this (he points the stone) no… and after he think that it is a nut but instead of a stone	*Perché quando lo ingoia muore e poi pensa che sia questo (indica il sasso) no… e poi pensa che sia una nocciola e invece è un sasso*
Because she didn't know that it was behind the chair	*Perché non lo sapeva che stava dietro la sedia*
Because he beliefs that there are balloons	*Perché lui crede che ci stanno i palloni*
Maybe because she was thinking it was there	*Forse perché pensava che stava la*
Because she thinks that it is hidden behind the table	*Perché pensa che è nascosto dietro al tavolo*
Because she doesn't know that the kitten is behind here (He points the chair)	*Perché non lo sa che il gattino sta qui dietro (indica la sedia)*
Because he doesn't know! He doesn't know! That it is a stone!	*Perché non lo sa! Non lo sa! Che è un sasso!*
Because she doesn't know that it is here instead of there	*Perché lei non lo sa che invece sta qui*

Beliefs	
She thinks it is behind the chair	*Pensa che è dietro la sedia*
Desires	
Because he wanted to eat it	*Perché se lo voleva mangiare*
Because she wanted to caress it	*Perché lo voleva accarezzare*
Because he wanted to eat it, but it is not possible	*Perché lo voleva mangiare, ma non si mangia*
Because he wanted to play with a ball	*Perché voleva giocare con la palla*
Ma it isn't here eh! Maybe he wants to buy a book	*Ma qui non c'è eh!! Forse vuole comprare un libro*
Because she wants to play with it and after she wants to sleep	*Perché vuole giocare con lui e poi vuole dormire*
Because he wants to put it in his mouth	*Perché la vuole mettere in bocca*
Because he wants a balloon	*Perché lui voleva un pallone*
Because after he tastes it is hard and then he doesn't want it anymore	*Perché poi sente che è duro e dopo non lo vuole più*
Other psychological states	
Perception	
Because he is hungry, he eats the stone but after he has pain in his belly	*Perché ha fame, mangia il sassolino ma poi ha il mal di pancia*
Boo… because after he has pain in a tooth	*Boo … perché dopo gli fa male un dente*
Preference	
Because he likes them	*Perché gli piacciono (i sassi)*
It is not good, he doesn't like it	*Non è buono, non gli piace*
Traits	
Because he is a child	*Perché lui era piccolo*
He is a glutton and he eats all the stone	*Lui è un mangione e lui lo mangia tutto il sasso*
Because he is a little bit stupid… I don't eat stones	*Perché è po' stupidino… io non li mangio i sassi*
Because he is a little bit idiot, he puts stones in his mouth, he puts in his mouth dirty things	*Perché lui è un po' sciocchino, mette in bocca i sassi, mette in bocca le cose sporche*
Obligations	
Because, if the kitten is here (she points the cat) she must come there (she points the chair) and after she takes it	*Perché se il gattino sta qui (indica il gatto) lei deve venire la (indica la sedia) e poi lo prende*
Eh! She can not looking for it here	*Eh! Non lo può cercare qua*
No. If he wants a balloon he should go to a shop where there are balloons	*No. Lui se vuole comprare un pallone deve andare in un negozio che ce li hanno i palloni*
Non psychological	
Because his kitten before was under the table with flowers	*Perché il suo gattino prima stava sotto il tavolo dei fiori*
He was here (she points under the chair) but she is looking under the table	*Stava qui (indica sotto la sedia) ma lei cerca sotto il tavolo*
Because she doesn't find her kitten	*Perché non trova il gatto*
But there is not!	*Ma non c'è!*
Because the stone is his	*Perché il sasso è suo*
Because she doesn't find it, she doesn't find the kitty because it is under the chair	*Perché non lo trova, il gattino non lo trova perché sta dietro la sedia*
But it is not aloud to put a stone in the mouth!	*Ma il sasso non si mette in bocca!*
After he will have all the ground in his mouth	*Poi gli viene tutta la terra in bocca*
Ah, he comes back, or he takes un umbrella	*Ah, torna indietro, oppure prende un ombrello*

None	
I don't know	*Non lo so*
Why he does it? He didn't go to buy a lamp?	*Perché lo sta facendo? Non è andato a comprare una lampada?*
He … Because it is so	*È… perché si*

ANOMALOUS BELIEF STORIES – Prompt explanations

False beliefs	
That it is a nut (she laughs)	*Che è una nocciolina (si mette a ridere)*
She thinks that it is here (he points the table) and on the other hand it is here (he points the chair)	*Pensa che sia qui (indica il tavolo) e invece sta qua (indica la sedia)*
He thinks that the balloon is here instead of another shop	*Pensa che sia qui il pallone ma invece è in un altro negozio*
He thinks that it is a nut	*Pensa che è una nocciolina*
That there are balloons	*Che ci sono i palloni*
That it was a nut… but on the other hand it was not, it was a stone	*Che era una nocciolina… ma invece non era, era un sasso*
Beliefs	
She thinks to her kitten	*Pensa al gatto*
He thinks that it is a stone	*Lui pensa che sia un sasso*
That her kitten is here (she points the chair)	*Che il suo gattino è qui (indica la sedia)*
That there isn't… also behind the chair	*Che non c'è… neppure dietro la sedia*
He thinks that there are no balloons but there is an umbrella	*Pensa che non c'è il pallone ma c'è l'ombrello*
Desires	
That he wanted to buy a little ball, but don't you see that there is not?!!	*Che voleva comprare una pallina, ma non vedi che non c'è?!!*
Maybe he wanted to buy an umbrella	*Forse voleva comprare un ombrello*
Other psychological states	
Emotions	
She takes everything… she removes all the flower and after she become angry	*Prende tutto… che toglie tutti i fiori e poi dopo si arrabbia*
Traits	
He is stupid	*Lui è tonto*
Non psychological	
Nooo, it is in an other street!	*Nooo, è un'altra la via!*
But one can not eats it	*Ma non si può mangiare*
None	
I don't remember	*Non mi ricordo*
Booo	*Booo…*
Let's see…	*Vediamo …*