Communication with drawings: Exploring children's and adults' understanding of drawings as communicative symbols

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‘‘That’s a picture . . . that’s someone’s mind being put on paper’’

(Freeman, 1995, p. 146).

ABSTRACT

Successful interpretation of referential communication requires understanding of mental states of others, or theory of mind. This thesis explored how children use their developing theory of mind to understand ambiguous referential expressions and ambiguous drawings. By identifying analogies between children's comprehension of verbal language and drawings, this thesis confirmed that drawings can be used as communicative symbols. Chapter 4 provided evidence that children's interpretation of drawings, parallel to understanding verbal expressions, requires inferring artist's mental states. Moreover, chapter 5 showed additional parallels with verbal language, showing that children generalise the meaning of ambiguous drawings in communication to the category of the drawn referent, which also reflected children's adherence to the artist's initial intent. Contrastingly, Chapters 3 and 6 together demonstrated children's and adults' egocentric interpretation of symbols, showing that they are not sensitive to partner-specific meaning of the ambiguous symbol. The inconsistencies in children's and adults' utilization of their mindreading skills in communication in different empirical chapters call for assessing the benefit of considering others' mental states in particular communicative contexts. The findings contributed to the understanding of how children and adults resolve the meaning of ambiguous symbols and coordinate simultaneous perspectives. Moreover, they showed the richness and complexity of using mindreading skills in interaction with others. Future research of communication with ambiguous symbols should consider the interplay of communicative context, the benefit of considering others' mental states, and executive function skills.

Keywords: drawings, referential communication, theory of mind, ambiguous symbols, conceptual pacts

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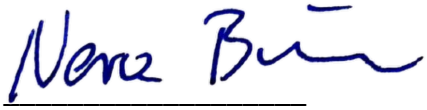
Declaration

I declare that this thesis is my own work carried out under the normal terms of supervision.



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CHAPTER 1: GENERAL INTRODUCTION

In our communication with one another, we spend a substantial amount of time considering the perspective of the other: what is she thinking about? What information do the two of us share? What does she mean when she says that? These types of questions require us to think about the contents of her mind. For smooth and effective communication, we rely on our understanding of mental states of others, what some researchers call our Theory of Mind. Our ability to consider what others know, feel, and believe develops through childhood, and is reflected in our use of communicative symbols – language, drawings, and gestures. This reasoning is especially important when communicative symbols are ambiguous. In my doctoral research, I am exploring the extent to which children aged three through five can use their developing theory of mind in interpreting others' ambiguous communicative symbols, including drawings and language. My thesis explores how children and adults recognise and show sensitivity to speaker's communicative intentions and other underlying mental states. I aim to integrate two normally different areas of research – verbal language and drawings – in order to advance our understanding of children's social communication and mental reasoning.

1.1. Symbolic representation

Symbols enable us to represent; that is, to use a form to represent meaning (Callaghan & Corbit, 2015; DeLoache, 2004; Peirce, 1965; Uttal & Yuan, 2014). The noun "juice" refers to the liquid drink; the red light on the traffic lights informs the driver to stop the car, and a drawing of a circle on a stick might represent a balloon. A challenge for developing children is that they need to learn to understand the difference between

the form (e.g., “juice”), the meaning (e.g., the liquid drink) and the relationship between the two (e.g., the word “juice” refers to the drink) (Perner, 1991).

There are two views of how symbolic representation originates and develops (Callaghan & Corbit, 2015; Müller et al., 1998; Müller & Racine, 2010). Empiricism explains representation as a passive process in one’s mind (view by Locke, Hobbes, Descartes see C. Taylor, 1995). The representational relationship between the form and meaning is therefore causal. The mind is like a camera that is passively receiving the picture of reality (Müller et al., 1998; C. Taylor, 1995). This view gives no role to human agency or intentionality when establishing meaning of symbolic representations.

By contrast, constructivism describes mental representations as an active system, where the person is constructing representations (view by Leibnitz, Kant, Hegel see Overton, 1998). Because the representations are directed towards things, they are intentional. Meaning of the representation depends on the underlying intention. Therefore, the connection between the meaning and form is made by the mind (Callaghan & Corbit, 2015; Müller et al., 1998). From a social constructivist perspective, the mind constructs meaning with social interactions (Tomasello, 2003).

1.2. Communication

The ultimate goal of symbolic systems is communication (Callaghan & Corbit, 2015; Tomasello, 2003). When wife says “I love you” to her husband, she uses language as a symbolic system to express her emotions for him. We use language to transfer meaning (Grice, 1975; Korta & Perry, 2010; Shannon & Weaver, 1949). Following a social constructivist perspective, this meaning is not transferred by words alone, but something that speakers do by uttering words. It is not about the literal translations of words, or meaning of symbols, but the speakers’ intentions.

1.3. Sensitivity to one's mental state

How and when do children understand other's mental states? Understanding the knowledge, intention, desires, hopes, and beliefs of others are considered to be skills that require a 'theory of mind' (ToM) – that is, the capability to assign mental states to self and others (Doherty, 2009; Lang & Perner, 2002; Premack & Woodruff, 1978).

One of the mental states that children understand very early is intent. Research has showed that infants first develop some understanding of intentional actions at about nine months (Behne et al., 2005), one-year olds were shown to understand the intentionality in parent's speech (Pan et al., 1996) and three year olds already understood some non-verbal communicative intentions (Jaswal, 2004; Moore et al., 2013). That is – infants can already understand that communicative actions have purpose.

However, to fully understand communicative intentions, listeners also have to understand the speaker's knowledge and belief. For instance, if Zara speaks about the "the good US president", the listener has to know whether Zara likes the current president (Trump), or if she has some other president in mind (Obama). Therefore, the listener has to take into account Zara's knowledge and belief when interpreting her utterance. Accordingly, I will next describe when children come to understand other's knowledge and belief.

1.3.1. Understanding knowledge

Understanding knowledge incorporates understanding the causality between (perceptual) information access and knowledge state (Beaudoin et al., 2020; H. Wimmer et al., 1988). For example, Beth can only know what is going to be for dinner, if her mother tells her what she is going to cook. Many studies (e.g., Marvin, Greenberg, &

Mossler, 1976; Miller, 2000; Sodian & Wimmer, 1987) have evaluated when children can attribute knowledge to a person who sees an event and attribute ignorance to another who does not. The majority of studies conclude that children between three and four years of age already understand that perceptual access leads to knowledge (Bradmetz & Bonnefoy-Claudet, 2003; Harris et al., 2017; Hogrefe et al., 1986; H. Wimmer et al., 1988). Hence, children at around three can already show some understanding that information access leads to knowledge.

1.3.2. Understanding belief

The above described understanding of knowledge requires inference (what leads to knowledge), but does not require understanding representations (Keenan et al., 1994). In contrast, beliefs are mental states that are intended to represent the way the world is (S. A. Miller, 2000). These representations or beliefs can be true (Anna believes there are Smarties inside the box because she saw them inside) or false (Anna believes there are Smarties inside the box, but her mother put pennies inside instead. Anna did not see her mother do that so she still believes there are Smarties inside). Therefore, beliefs can also misrepresent the reality, especially when reality is changed without the knowledge of the beholder of the belief. In contrast with knowledge and ignorance, beliefs are representations of reality, which can also be false (Perner, 1991).

The tasks examining belief understanding (Baron-Cohen et al., 1985; H. Wimmer & Perner, 1983) were focused on investigating understanding of false beliefs. The two most commonly used tasks (Wellman et al., 2001) are change of location task (H. Wimmer & Perner, 1983) and unexpected contents task (Perner et al., 1987). In both tasks, one of the observers of the narrative is ignorant about a new, changed location of an object (change of location task) or does not know that a box contains unexpected

objects (unexpected contents task) – the observer holds a false belief. However, another observer or the participant holds a true belief – knows that the object was moved to a new location or knows that a box contains unexpected objects (unexpected contents task). Therefore, the tasks present participants with scenarios where different observers hold different beliefs based on their knowledge. The participants have to predict the behaviour of the observer (e.g., "Where will Sally look for her marble?"). A meta-analysis showed that children's ability to correctly attribute false belief develops between three and five years of age (Wellman et al., 2001).

To summarize, research shows that children begin to understand other's knowledge and belief between 3- and 5-years of age. Designing studies for children in this age range might therefore show whether these skills are required and used in communication.

1.3.3. Verbal language is not the only communicative symbol

Research with symbolic communication has been dominated by studies with verbal language (Callaghan & Corbit, 2015). However, verbal language is just one of many symbolic systems that are used in communication. There are other means of communication such as gestures, signals, drawings (Callaghan & Corbit, 2015; Dalgleish et al., 2002; Fay, Walker, Swoboda, Umata, et al., 2018; Healey et al., 2007). Both verbal language and other symbols recognise the difference between meaning and form (Bezemer & Jewitt, 2009; Kress, 1993, 2010). In verbal language, the meaning is expressed with words – form of letters or sounds. In drawing, the meaning is expressed with visual shapes on paper.

1.3.4. Drawings are more iconic than words

Both drawings and verbal language can be used as communication symbols but drawings are inherently different from language. Verbal language is most commonly **arbitrary** (Hockett, 1960; Levelt et al., 1999; Markman, 1976) – has no obvious physical or sound similarity to its referents. For example, the word "lamp" has no auditory or written similarities with the actual referent – a lamp. The meaning of words is assigned by speakers of the same language through conventional use (H. H. Clark & Carlson, 1981; Garrod & Anderson, 1987). Speakers of the same language share the knowledge of what particular words mean. Therefore, acquiring the meaning of words is learned.

The meaning of drawing however, is usually based on **iconicity** – the degree to which the picture and the referent look alike (Callaghan, 2000). The ability to label drawings based on their iconicity or resemblance to real world referents is not learned (Hochberg & Brooks, 1962). A drawing of a lamp resembles an actual lamp. However, the degree if iconicity differs depending on how well a drawing is made. A drawing of a lamp drawn by a three-year-old might not look like a lamp versus a drawing of a lamp by an adult can look like a two dimensional picture of a lamp. Children interpret a high-iconicity picture (e.g., a photograph) more easily than a schematic drawing, because it is more similar to a real world referent (M. C. Wimmer et al., 2014).

1.3.5. When do children start appreciating the symbolic nature of drawings?

Drawings are symbols; they are both lines on paper and they represent something real in the world (DeLoache, 2004). A drawing of the Statue of Liberty is both a drawing of New York's icon and also just a product of multiple strokes with a pencil. Their dual nature was explored by Preissler and Carey (2004) who showed that infants as young as 18 months understand that the label of the drawing of an object refers to

the object, not to the picture itself (confirmed also by Ganea, Allen, Butler, Carey, & DeLoache, 2009). Preissler and Bloom (2007) further showed that two-year-olds and adults already distinguish that a drawing's label (e.g., "This is a dax.") refers only to the represented object, but property statements (e.g., "This is my favourite.") can be applied to both drawings and depicted referents. These findings suggest that two-year olds are therefore already able to use and understand the dual nature of drawings.

Although infants potentially understand the dual nature of pictures at an early stage in ontogeny, available data suggests their full understanding of drawings develops gradually. The first factor that determines the meaning of a drawing is its resemblance to real world referents (Hopkins, 1998). A drawing depicting circles could represent anything round – snowflakes, potatoes, balls or even pennies. Resemblance is usually the first cue for the interpretation of a drawing. However, that is not always sufficient for interpretation of drawing's meaning (Browne & Woolley, 2001; Myers & Liben, 2012). One must also understand that not only the shape but the creator's intent must be taken into account (Allen & Armitage, 2017; Bloom, 1996; Freeman, 2008; Hartley & Allen, 2014b). If the drawing of circles was made with the intent of representing pennies, then it should be labelled as a drawing of pennies. Therefore, the artist's role in interpretation and labelling of a drawing should also be taken into account (Allen & Armitage, 2017; DeLoache, 2004; Freeman & Sanger, 1995).

1.4. Freeman's intentional theory of pictures

Full understanding of pictures was clearly described by Freeman in his intentional theory of pictures (Freeman, 1995, 2008; Freeman & Sanger, 1995). The intentional network theory (see Figure 1) connects the artist (A), his drawing (D), what

the drawing represents (R), and the viewer (V). The interconnection between each of the four entities contributes to full pictorial reasoning.

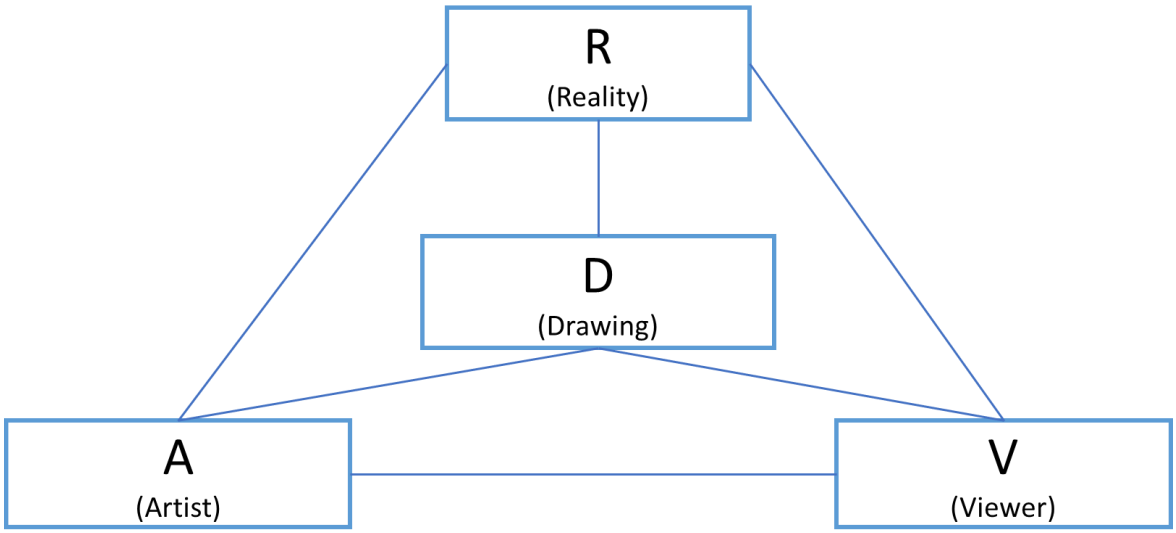


Figure 1. Freeman's(1995, 2008; Freeman & Sanger, 1995) intentional network theory describing the full understanding of pictures.

Research to date usually focused on one particular link between the four entities (Vivaldi et al., 2020). The D-R link explores how do children map the picture to their referent based on resemblance (Callaghan, 2000; DeLoache et al., 1998; Elizabeth J. Robinson et al., 1994). Studies looking at how many different interpretations can the viewer infer about a drawing (Allen et al., 2016; Ostrofsky et al., 2017) are focusing on the D-V link. And the research focusing on the A-D link investigates the influence of artist's mental states in the understanding of drawings (Hartley & Allen, 2015; Preissler & Bloom, 2008; Vivaldi & Salsa, 2017).

In a drawing, the artist expresses their view of the world with a picture. The relationship between the drawing and the world can be evaluated according to the resemblance of the drawing and the real world item (D-R link). For example, we know that a drawing of a swirl with a snake-like body probably represents a snail. If the

resemblance between the real world item and the drawing is clear, the viewer can easily understand the meaning of the drawing.

However, the artist can also draw an imaginative item or something, that does not correspond with the real state of the world. In that case, the artist's drawing is their manifestation of the mind (A-D link). The only way for the viewer to understand the picture is to understand the artist's intent. Freeman (1995, 2008; Freeman & Sanger, 1995) emphasizes that the artists are the one who convey meaning while the viewers try to make inferences about the artists (Vivaldi et al., 2020). Ambiguous drawings especially are one type of drawings that require the viewer to see beyond just the appearance of a drawing, but try to make inferences about the artist's intentions.

1.5. Ambiguous drawings

Drawings' interpretations are led by two main cues – their appearance and artist's intention (Armitage & Allen, 2015; Browne & Woolley, 2001). Especially when a drawing can represent multiple referents (drawing is ambiguous), the drawing's appearance is not sufficient to determine its identity. Evaluation of artist's mental states is particularly important when resolving pictorial referential ambiguity (Allen & Armitage, 2017; Armitage & Allen, 2015; M. C. Wimmer & Doherty, 2011). For instance, a line drawing of a circle can represent a ball, a pizza, an orange or anything round. Therefore, the mental state of the artist – her intent, knowledge and beliefs are essential for interpreting her drawing of a circle. Almost all the studies cited above exploring whether children take into account the artist's intent, knowledge or beliefs used ambiguous drawings (Browne & Woolley, 2001; Perner & Davies, 1991; Richert & Lillard, 2002; M. Taylor, 1988).

To understand ambiguity, the viewer first has to understand that the drawing can represent multiple meanings and secondly, can take into account and switch between multiple meanings of a drawing, depending on the context or the artist's mental state (M. C. Wimmer & Doherty, 2011). For example, a child has to understand that a drawing of a balloon also looks like a lollipop, but if it was created with the intent to represent a balloon, then it should be labelled as a balloon. Four year old children already show the representational flexibility that an ambiguous drawing can be given two interpretations, but they favour the artist's original intent (Allen et al., 2016).

The ability to detect ambiguity is also an important aspect of what a person must know in order to comprehend language (Shultz & Pilon, 1973). To interpret the correct meaning of a word, the speaker and the listener resolve the meaning by taking into account the context and also other interlocutors' mental states (H. H. Clark & Marshall, 1981; Garrod & Anderson, 1987). For instance, if the listener wants to figure out what does the speaker mean when he is saying "bat", he has to consider that the speaker is a baseball player and is most probably talking about a baseball bat, and not about a mammalian bat. Analogous to interpretation of ambiguous drawings are linguistic phenomenon - homonyms (M. C. Wimmer & Doherty, 2011). A "bat" is a homonym because it has two meanings, similarly as a drawing of a circle on a stick can be lollipop or a balloon. To correctly interpret any of these symbols requires understanding the speaker's/artist's mental state. Therefore, ambiguous symbols are a good research tool to explore some underpinnings of communication.

1.5.1. Recognising artist's intent when labelling a drawing

Bloom and Markson (1998) showed that three year olds already take intention into account when naming a drawing that is unrecognisable by shape (a drawing of a

lollipop could only represent a lollipop, but not a balloon). Similarly, Gelman and Ebeling (1998) found out that two to three year old children name intentionally created drawings based on their shape more often than if the same shape was created accidentally. This shows that understanding and interpreting a drawing goes beyond recognizing the shape, and more research confirmed that two year old children are already able to recognize the intention of the artist and name the drawing accordingly (e.g., Hartley & Allen, 2014; Preissler & Bloom, 2007). It is not clear however, to what extent children and adults take into account an artist's knowledge state and belief, when labelling a drawing.

1.5.2. Recognising artist's knowledge when labelling a drawing

To date, only three studies have explored when children take the artist's knowledge into account when labelling a drawing (Armitage & Allen, 2015; Browne & Woolley, 2001; Richert & Lillard, 2002). Browne and Wolley (2001) explored influence of the artist's knowledge on children's labelling of drawings with four-year-olds, seven-year-olds, and adults. In one of their tasks, a puppet announced the intention to draw a bear, but produced an ambiguous drawing that looked somewhat like a bear and somewhat like a rabbit. In one condition, the experimenter told the participants that the puppet did not know the difference between a rabbit and a bear – the puppet was ignorant – and in the other condition, the participants had no information about the puppet's knowledge state. Only seven-year-olds and adults seemed to take the puppet's ignorance into account by labelling the drawing according to the puppet's intent ("this is a drawing of a bear"), but relying on intent significantly less when the puppet was ignorant (they were equally likely to label it a bear or a rabbit) (Browne & Woolley, 2001). Similarly, Richert and Lillard (2002) conducted a study in which four- and eight-

year-old children were introduced to Luna, who lived in a Land of trolls and has never seen or heard of lollipops. Luna intended to draw a red balloon, but her drawing looked like a lollipop. When asked what Luna had drawn, children in both age groups incorrectly reasoned Luna was drawing a lollipop. These two studies, together with the study by Armitage and Allen (2015), show that even eight year old children have difficulties taking into account the artist's knowledge state when labelling their drawing. That does not reflect the findings of when do children understand knowledge states of others more broadly (see 1.3.1. Understanding knowledge).

Moreover, these studies have several limitations. The previously described tasks with drawings present children with a hypothetical situation, where the character is 'ignorant' and does not know about conventional objects (e.g., "Luna doesn't know what lollipops look like"). Although this reflects limited access to the relevant information and leads to ignorance, it is not something children encounter in their everyday lives. Moreover, the storyline emphasizes two contrasting interpretations of the same drawing. For example, the experimenter in the study from Browne and Wolley (2001) said: "So he wanted to draw a bear, and it looks like a rabbit." Similarly, the experimenter in Richert and Lillard's (2002) said: "She wants to make a red balloon … Her picture looks like a lollipop. Lollipops look like that." Both stories suggestively emphasize the resemblance to the non-intended referent. This might have an effect, similar to negative priming (Tipper, 1985), where the inhibition of momentarily distracting information creates impairment when reasoning about the relevant information (McLennan et al., 2019; Tipper, 1985). When Richert and Lillard mention another shape (lollipop) that the artist is ignorant about, they divert attention to the non-intended referent of a drawing. Therefore, it is possible that responding correctly

to the question “Is this a drawing of a lollipop?” requires more than just understanding of the artist’s knowledge. Children’s correct response also requires inhibition of the emphasized non-intended referent, which diverts the objective of measuring children’s understanding of artist’s knowledge.

1.5.3. Recognising artist’s (false) belief when labelling a drawing

Only a few studies have explored whether children incorporate an artist’s belief when interpreting their drawing. Studies have primarily focused on the drawing’s appearance and connecting it to other ToM tasks, but have not explored the role of the artist’s belief when labelling the drawing. Some researchers (Doherty & Wimmer, 2005; Gopnik & Rosati, 2001) tried to connect ToM with understanding ambiguous figures. They showed that recognising and switching between two interpretations of an ambiguous drawing (e.g., rabbit or duck) is correlated with performance on false belief tasks (Doherty & Wimmer, 2005). Similarly, the ‘droodle’ task was correlated with false belief reasoning (Perner & Davies, 1991; M. Taylor, 1988). “Droodles” are small, non-descript portions of line drawings. The results using “droodles” showed that most five–year-olds understood that a person seeing only a portion of a drawing cannot know what the whole drawing depicts (Perner & Davies, 1991; M. Taylor, 1988). Therefore, five-year-olds successfully inhibited their knowledge about what a drawing depicts and contributed a false belief to an ignorant observer, who had only seen an unidentifiable part of the same drawing. Although both the droodle task and reversing ambiguous drawings task seem to be correlated with false belief reasoning, none of these tasks requires understanding of an artist’s mental state.

One attempt of involving an artist’s belief when labelling a drawing was introduced in a false drawing task (Charman & Baron-Cohen, 1992). The false drawing

task was created as a non-mental equivalent to the regular false belief task (H. Wimmer & Perner, 1983), which requires some level of meta-representation. The experimenter in the false drawing task showed three- and four-year-olds an object and named it together with the children. The experimenter made a drawing of that object and put it on the side, face down. After the experimenter had put the drawing away, the drawn object was replaced with a new object. First, the experimenter asked the children "What is this?" (*reality question*) and finally, the experimenter asked the *test question*: "What is in the picture?". Four-year-olds correctly answered this question, even though they did not look at the drawing when the question was asked. The children performed better on the false drawing task compared to the regular false belief tasks. The authors accounted for this difference by emphasizing the importance of involving physical representations (drawings) instead of using mental representations (Charman & Baron-Cohen, 1992). However, it is not clear how this task is related to any person's belief. The question of what is in the picture reflects children's memory of what the experimenter drew rather than anyone's belief. Moreover, the test question is asking about the correct representation of what is on the drawing, and the drawing does not misrepresent current reality as a false belief does (S. Leekam et al., 2008). Therefore, correctly naming the drawing in this task does not represent the ability to understand artist's false belief.

Although there were more attempts of connecting drawings with understanding beliefs (Doherty & Wimmer, 2005; Gopnik & Rosati, 2001; S. Leekam et al., 2008), a recent systematic review shows that no other research used drawings as expressions of artist's belief (Vivaldi et al., 2020). Therefore, one of the empirical

chapters in this thesis also explores children's ability to label drawings as reflections of artist's beliefs.

1.6. Language skills are connected with ToM skills

Listeners make inferences about speaker's intentions, knowledge and belief when resolving meaning. Therefore, successful communication is connected to coordination of perspectives and ToM skills (knowledge, belief) (Diesendruck & Markson, 2001; Maridaki-Kassotaki & Antonopoulou, 2011; Resches & Perez Pereira, 2007; Sidera et al., 2016). Consequently, many studies tried to correlate language skills with theory of mind (B. P. Ackerman et al., 1990; Resches & Perez Pereira, 2007; Sidera et al., 2016; Walker & Murachver, 2012). A meta-analysis by Milligan, Astington & Dack (2007) showed that verbal language development is correlated with the false belief reasoning. Moreover, this relation has also been found in deaf children (Jackson, 2001; Lederberg et al., 2012; Schick et al., 2007), who do not use verbal language, therefore the connection between language abilities and understanding false belief extends to non-verbal language as well.

However, it is not clear whether language abilities aid the development of ToM skills (e.g., de Villiers & Pyers, 2002) or if emerging ToM skills enhance language abilities (e.g., Tager-Flusberg & Anderson, 1991). Since many of ToM measures rely on language, it is possible that higher language skills would enable better performance on ToM tasks (Milligan et al., 2007). However, several other authors suggest that in order to understand interlocutor's communicative intentions, basic skills of attributing mental states to others are required (Bosco & Gabbatore, 2017; Rubio-Fernández, 2018; Sperber & Wilson, 2002). Although the direction of the connection has not yet been resolved, ToM and language skills develop in parallel (Milligan et al., 2007).

1.7. Exploring communicative skills provide insight into interlocutor's mental states

Rubio-Fernández (2018) highlighted the possibility to simultaneously investigate language and ToM skills. She suggested that studies of communication could provide a rich insight into implication of ToM skills in everyday situations. In fact, the research field of experimental pragmatics has emphasized the role of social context and the speakers' intent in interpreting the meaning of communication (Grice, 1975; Sperber & Wilson, 2002). A clear case of such pragmatic process is *reference resolution*, where the listener has to choose the intended referent among a range of linguistically possible referents.

One way to do this is to keep track of the knowledge and perspective of the communicational partner. For instance, when the child says to his mother "give me the red one" when they are preparing to leave the house, his mother has to infer what "the red one" means. Since both the child and the mother know that the child has a red and a blue cardigan, the mother makes an inference based on the knowledge she shares with the child and reasons that the child wants the red cardigan. In this particular example, the mother resolved the meaning of the reference ("the red one") on the basis of the knowledge she shared with the child. The knowledge that interlocutors share is referred to as common ground (also mutual knowledge (H. H. Clark & Marshall, 1981; Garrod & Anderson, 1987).

Taking into account what is mutually known between interlocutors is promoting efficient communication (Wilkes-Gibbs & Clark, 1992). Once the intended referent in communication is identified, interlocutors show a tendency to re-use the same referring expressions. For instance, if the child from the previous example continues "I love the pockets on the red one" the mom will expect that the child is talking about the red

cardigan the child mentioned before. This consistent re-use of terms in communication is called lexical entrainment (Garrod & Anderson, 1987).

Lexical entrainment is one of the principles in communication that speakers follow to avoid ambiguity. There are many more principles and rules (Brennan & Clark, 1996; Garrod & Anderson, 1987; Grice, 1975), and I will address them in more detail in the next chapter. However, although a lot of research has been conducted on forming principles in verbal communication, this thesis will also explore whether some of principles in verbal language hold in communication with drawings.

1.8. Attempts to use drawings as communicative symbols

A lot of research that explored drawings as communicative symbols stems from experimental semiotics (Galantucci, 2009; Galantucci et al., 2012; G. Roberts & Galantucci, 2016). Experimental semiotics is a relatively new line of research that attempts to research human communication more broadly, rather than focusing on verbal language. It follows core assumptions explored in experimental pragmatics. Many studies in experimental semiotics adapted communication tasks from experimental pragmatics, but restricted the use of spoken language (Fay, Walker, Swoboda, & Garrod, 2018; Galantucci, 2005, 2009; G. Roberts & Galantucci, 2016).

Most relevant for this thesis are graphical communication tasks (e.g., Healey, Swoboda, & King, 2002; Healey et al., 2007), where pairs of participants describe a referent to their partner by drawing it. Majority of findings with these graphical communication tasks show important parallels between communication with verbal language and communication with drawings. For instance, interlocutors take turns in making drawings (Umata & Shimojima, 2003), they adopt to each other by re-using previously produced shapes for referents (Healey et al., 2007; Healey, Garrod, et al.,

2002), and develop increasingly simpler graphical forms with repeated reuse (Healey, Garrod, et al., 2002).

1.8.1. Children using drawings as communicative symbols

Although there seem to be many parallels between verbal language and communication with drawings, research from experimental semiotics with drawings is separated from all the research that is looking at the role of artist's intent and factors that guide the labelling of drawings. Moreover, the studies in experimental semiotics with graphical communication tasks were done with adult participants only, so the underlying skills and abilities needed for communication with drawings are less clear.

The ability to understand ambiguous drawings and flexibly think about their interpretations develops between three and five-years of age (Allen et al., 2016; M. C. Wimmer & Doherty, 2011). Furthermore, ToM skills, which are connected to successful communication, also develop between three and five years of age (Milligan et al., 2007; Wellman et al., 2001). Considering that the relation between the form and meaning in drawing is not arbitrary, but intended (Kress, 1993), taking into account the mental states of others in communication with drawings might have even more weight than with verbal language.

Moreover, the majority of research using drawings as communicative symbols was focusing on production (Callaghan et al., 2012) or on production and comprehension (Callaghan, 1999; Fay, Walker, Swoboda, & Garrod, 2018; Fay, Walker, Swoboda, Umata, et al., 2018; Micklos et al., 2020). They used pairs of participants and investigated their development of graphical symbols. However, when children are developing their abilities to communicate, they show the comprehension-production lag, where the nature of their comprehension dictates their productive abilities

(Callaghan, 2005). Therefore, evaluating children's comprehension abilities in communication with drawings can represent the first step to exploring their full abilities to communicate with drawings. This thesis aims to take into account findings from research about labelling of drawings and the role of the artist to explore children's comprehension in communication with ambiguous drawings.

1.9. Thesis overview

To explore children's comprehension in communication with drawings, and in particular, look at the utilisation of ToM skills in communication, this thesis first reviews children's reference resolution in verbal language. One particular communication principle that also requires using ToM skills are conceptual pacts. Conceptual pacts are a particular form of lexical entrainment, but are specific to communicational partners (Brennan & Clark, 1996). In other words, conceptual pacts are tacit agreements with particular partners about how to refer to a referent (e.g. referring to the computer as the "smart machine"). These pacts shape any subsequent references to the same referent, but only with the same communicational partner. **Chapter 2** presents the review of the literature on sensitivity to conceptual pacts with children from three to five, which also address the sensitivity of keeping track of the knowledge and perspective of the communicational partner. In particular, I systematically examine how children adhere to conceptual pacts, outline the main findings whether children utilize ToM skills in verbal communication, and create future guidelines for research with children. Moreover, following the definition of conceptual pacts by Brennan and Clark (1996), I propose a new approach of testing sensitivity to conceptual pacts, which enables testing the same communication principle outside of language – with drawings.

Before testing children's understanding of drawings in communication, I test children's sensitivity to conceptual pacts in verbal language with the new approach in **Chapter 3**. Testing the new approach with verbal language enables me to create parallels in following chapters with drawings. Since research has shown that understanding drawings requires reasoning about artist's intent, but resolving reference in verbal language can rely on arbitrariness (Kress, 1993), sensitivity to conceptual pacts with drawings might show different results than with verbal language.

The next two chapters present experiments which explore some characteristics of communication with drawings which gradually lead up to the last chapter which is testing children's sensitivity to conceptual pacts with drawings. Since successful communication with verbal language is connected to understanding ToM skills (Milligan et al., 2007; Resches & Perez Pereira, 2007; Sidera et al., 2016), **Chapter 4** investigates whether understanding drawings also entails taking into account artist's ToM, namely – knowledge and belief. Furthermore, **Chapter 5** investigates additional parallels between drawings and verbal language, exploring whether children generalise the meaning of drawings in communication in a similar manner as they do in verbal language.

Lastly, **Chapter 6** tests whether children and adults show conceptual pact sensitivity in communication with drawings, using a new design, proposed in chapter 2. Together, this thesis aims to establish parallels between children's comprehending of verbal language and understanding drawings as communicative symbols. It aims to add to the developing field of experimental semiotics, and examine the utility of ToM skills in communication with symbols.

CHAPTER 2: DO CHILDREN SHOW REFERENTIAL PACT SENSITIVITY? A SYSTEMATIC REVIEW

This chapter will explore a particular form of lexical entrainment specific to interlocutors[1] in a given context – this partner specific lexical entrainment is defined as **conceptual pact** (Brennan, 1996). Conceptual pacts are therefore temporary implicit agreements between specific interlocutors, which are observed as reused referential expressions limited to the interlocutors who created the pact. Although the majority of research with conceptual pacts has been conducted with adults, children's sensitivity to conceptual pacts is particularly interesting as sensitivity to a speaker's referential expressions does not only reflect memory skills of previously used referential expressions (Pickering & Garrod, 2004), but also perspective taking skills and tracking an interlocutor's knowledge and belief (Wilkes-Gibbs & Clark, 1992). It is believed that children are developing their perspective taking skills from about three to five years of age, therefore some research has looked at their sensitivity to conceptual pacts (e.g., Graham, Sedivy, & Khu, 2014; Köymen, Schmerse, Lieven, & Tomasello, 2014). Accordingly, in the current chapter I will systematically review and describe all the research that explored sensitivity to conceptual pacts with children in this age range. I will outline the differences and similarities that could account for conflicting results from past work and also create guidelines for future research.

[1] There are two synonyms consistently used in research that refer to speakers and listeners together: interlocutors (e.g., Garrod & Anderson, 1987; Horton & Keysar, 1996; Yoon & Brown-Schmidt, 2018b) or conversational partners (e.g., Heller, Gorman, & Tanenhaus, 2012; Keysar, Barr, Balin, & Brauner, 2000). I will use the term interlocutors to refer to active people in communication –speakers and listeners, but when referring to them individually, the terms *speaker*, *listener*, and *communication partner* will be used.

2.1. Introduction

There are many ways how speakers can refer to a particular object. A car can for example be referred as “the car”, “blue car”, “Volvo” or “the neighbour’s car”. When speakers repeatedly refer to objects, they tend to converge on the same referring expression (Brennan & Clark, 1996; Clark & Wilkes-Gibbs, 1986). That is, if a speaker refers to a car as “blue car”, then their communicational partner or the interlocutor will most likely reuse the same expression (“blue car”) when referring to the same object. With reuse, the interlocutors share the same perspective on the object (Brennan & Clark, 1996; Garrod & Anderson, 1987); this is called *lexical entrainment* (Garrod & Anderson, 1987). With lexical entrainment, the interlocutors work together to establish the meaning of referring expression. This is important, because higher level of entrainment shows more effective and accurate communication (Clark & Wilkes-Gibbs, 1986; Reitter & Moore, 2014).

In recent years, more research has looked at whether lexical entrainment is limited to familiar speakers only (e.g., Köymen et al., 2014; Ostashchenko, Deliens, Geelhand, Bertels, & Kissine, 2019). That is, whether speakers form conceptual pacts - create temporary agreements about how to conceptualize an object (Brennan & Clark, 1996). The conceptual pact paradigm suggests that when the agreement is established, the interlocutors expect and consistently use the agreed referring expression. For example, if two interlocutors are reusing the expression “blue car” to refer to the car, they create a temporary agreement about how the car is conceptualised. By reusing the same referential term and adhering to the agreement, interlocutors reduce referential ambiguity and facilitate comprehension (Knutsen & Le Bigot, 2017) and production

(Horton, 2007). If any new interlocutors join however, they are not expected to share the established agreement. Therefore, conceptual pacts are partner-specific.

2.2. Representing conceptual pacts: The Conceptual Triad

One way to represent conceptual pacts is **the conceptual triad**; a relationship between the referent, the expression, and the speaker (see Figure 2). When a speaker decides to use a particular expression for a referent (e.g., saying "spotty dog" when seeing a dog) and the reference is mutually accepted, then the conceptual pact with the listener is established. The established pact creates the conceptual triad by connecting the chosen referential expression, the intended referent and the interlocutors. The conceptual triad leads speakers and listeners in their communication, so that instead of choosing between various referring expressions for the same referent each time, they reuse the previously used expression.

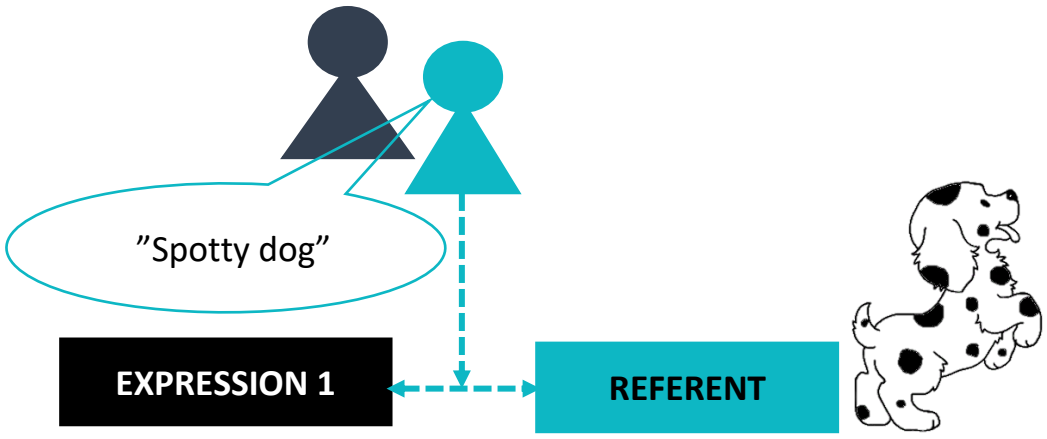


Figure 2. Representing Conceptual Pacts with the Conceptual Triad.

To test whether conceptual pacts exist, research has compared the effects when the conceptual triad is established with the effects when any of the three components of the conceptual triad significantly change (e.g., Barr & Keysar, 2002; Metzing & Brennan, 2003; Yoon & Brown-Schmidt, 2019). Since conceptual pacts should facilitate communication (e.g., Arnold, 2008; Brennan & Clark, 1996; Shintel & Keysar, 2007; Yoon

& Brown-Schmidt, 2013), any change in the conceptual triad should break the established conceptual pact, resulting in a delay in comprehension or in production, longer referring expressions (Yoon & Brown-Schmidt, 2014) or misinterpretation of the conversation.

Testing whether conceptual pacts exist begins with testing the general assumption whether interlocutors reuse the established referential expressions – lexical entrainment (Brennan & Clark, 1996; Garrod & Anderson, 1987). To test whether lexical entrainment exists, only the **referential expression in the conceptual triad changes**, but the other two other pillars (the referent and the speaker) of the conceptual triad stay the same. For instance, if a speaker violates the conceptual pact by unexpectedly using the expression "fluffy dog" instead of the previously established "spotty dog", a delay in comprehension is observed (e.g., Metzing & Brennan, 2003). This confirms that lexical entrainment exists and also demonstrates that a change of expression can break the conceptual triad.

Changing *only* the expression in the conceptual triad is a usual design of testing lexical entrainment. To test whether the reuse of referential expressions is partner specific, **interlocutors have to also be systematically manipulated**. Therefore, deploying the same change of referential expression with the same interlocutor, and with a new interlocutor. If a speaker suddenly does not speak to the same listener, but is speaking to a new listener, the speaker shows no preference to use a specific expression (e.g., Metzing & Brennan, 2003). This demonstrates that a change of partner can also break the conceptual triad and confirms the existence of conceptual pacts.

2.3. Two underlying accounts

There are two main factors explaining why interlocutors adhere to these partner-specific referential agreements. One factor proposes that interlocutors use referential precedents because of cue-based memory mechanisms (Horton, 2007; Shintel & Keysar, 2007). Associations between the referent, a referring expression and the context of use create memory cues which implicitly coordinate reference (Horton, 2007). That means that each time a listener hears the expression "blue car", they are more likely to use the same expression just because it is most available in memory. On the other hand, one factor proposes that interlocutors use referential precedents because they want to be cooperative and adopt to the created agreement by reusing the same referential expressions (Brennan & Clark, 1996; Brown-Schmidt, 2009). According to this assumption, each reused expression requires some level of perspective taking (Nilsen & Graham, 2009), and theory of mind, since the speaker has to accommodate their conceptualisation to the conceptualisation of the listener. In other terms, the speaker accommodates to listener's knowledge state and adapts communication accordingly. Both factors – the memory driven and the social-pragmatic account – most likely play a role reference resolution (Brown-Schmidt & Duff, 2016). However, there has been no consensus about their roles in communication.

Researchers have tried to dissociate the two accounts and evaluate the contribution of each, where developmental research is especially well positioned to contribute to better understanding of the two underlying accounts. According to the social-pragmatic account, to successfully show adherence to conceptual pacts, one has to know how to take a perspective of the interlocutor and understand their knowledge. Research with children shows that by the time they are four, they can understand that

others might have different knowledge and beliefs (Wellman et al., 2001). According to this account then, children should show sensitivity to partner-specific conceptual pacts around when they are four. If however, children can show partner-specific sensitivity in communication earlier, we could assume that showing adherence to conceptual pacts is largely driven by the memory accounts.

The majority of studies with adults are consistent in showing that they are sensitive to partner specific conceptual pacts (e.g., Brennan & Clark, 1996; Brown-Schmidt, 2009; Metzing & Brennan, 2003). However, research with children has not been so clear. Only a few studies have looked at children's use and sensitivity to partner-specific referential expressions. Although some show that even three year old children have adult-like understanding of conceptual pacts (Matthews et al., 2010), new studies with children do not confirm this pattern of behaviour (e.g. Ostashchenko, Deliens, Geelhand, Bertels, & Kissine, 2019a; Ostashchenko, Geelhand, Deliens, & Kissine, 2019).

In this review, I explore the study designs looking at conceptual pacts with children. I evaluate the empirical studies according to the structure of the conceptual triad and propose factors that contribute to differences in results. I identify the choice of referential expressions in study designs, and the form of interactivity between partners as significant factors for establishment of pacts. Although these factors have already been recognized as important in studies of conceptual pacts with adults, the factors identified in this chapter create more particular guidelines customized for research with children.

2.4. Exclusion criteria

Systematic search in PsychINFO and WEB of Science was conducted for all dates up to June 2019. The search terms addressed main concepts that conceptual pacts stem from. Since the focal characteristic of conceptual pacts and main distinction from lexical entrainment is **partner specificity**, the search was targeted with the emphasis on related terms. Since conceptual pacts have various interchangeably used terms, the first search terms comprised: a) referential precedents, b) conceptual pacts, c) referential pacts, d) partner specificity AND language, e) perspective taking AND precedents, f) lexical entrainment AND partner, g) lexical entrainment AND psycholinguistics, h) semantic priming AND different speakers, i) mutual knowledge AND precedent, j) common ground AND precedent (see Figure 3).

Initial review of titles excluded studies and articles that were clearly not related to the research topic in question (e.g., Using self-captured photographs to support the expressive communication of people with aphasia). All the remaining articles were reviewed and experiments described were included in the review if they suited the following criteria: Firstly, the experiments *had to test communicative interactions*. Conceptual pacts and lexical entrainment are phenomena that describe principles in communication. Therefore, I wanted to only include studies with the main focus on communication, and not e.g., on "trustworthiness" or "user satisfaction*".* Secondly, it was also important that studies included *a measure of either production or comprehension*. As discussed previously, conceptual pacts create expectations of reuse of established referential expressions (Brennan & Clark, 1996). These expectations are not exclusive to production neither to comprehension, thus I included studies focusing on either. Thirdly, the experiments had to use a *design with some type of entrainment* –

establishment of a precedent. Since conceptual pacts are jointly agreed, some process of the establishment of the conceptual triad was required. Most importantly, the included studies had to use a design where the entrainment phase and the test phase were not always tested with the same communicational partner – they had to *test partner specificity*. This important criteria helped to distinguish between study designs testing for lexical entrainment only, and study designs exploring partner specificity of conceptual pacts. This review focused of the latter. In addition, any work that formed a component of a PhD thesis, or that examined non-verbal communication (e.g., gestures, onscreen movements, or drawings) was excluded. I was only interested in verbal communication, as the definition of conceptual pacts was built on verbal referencing. Lastly, only the studies, which tested children between three and six years-of-age, were included. Since this is the age range when children are reaching important milestones in theory of mind skills (Wellman et al., 2001), their utility of conceptual pacts is particularly interesting.

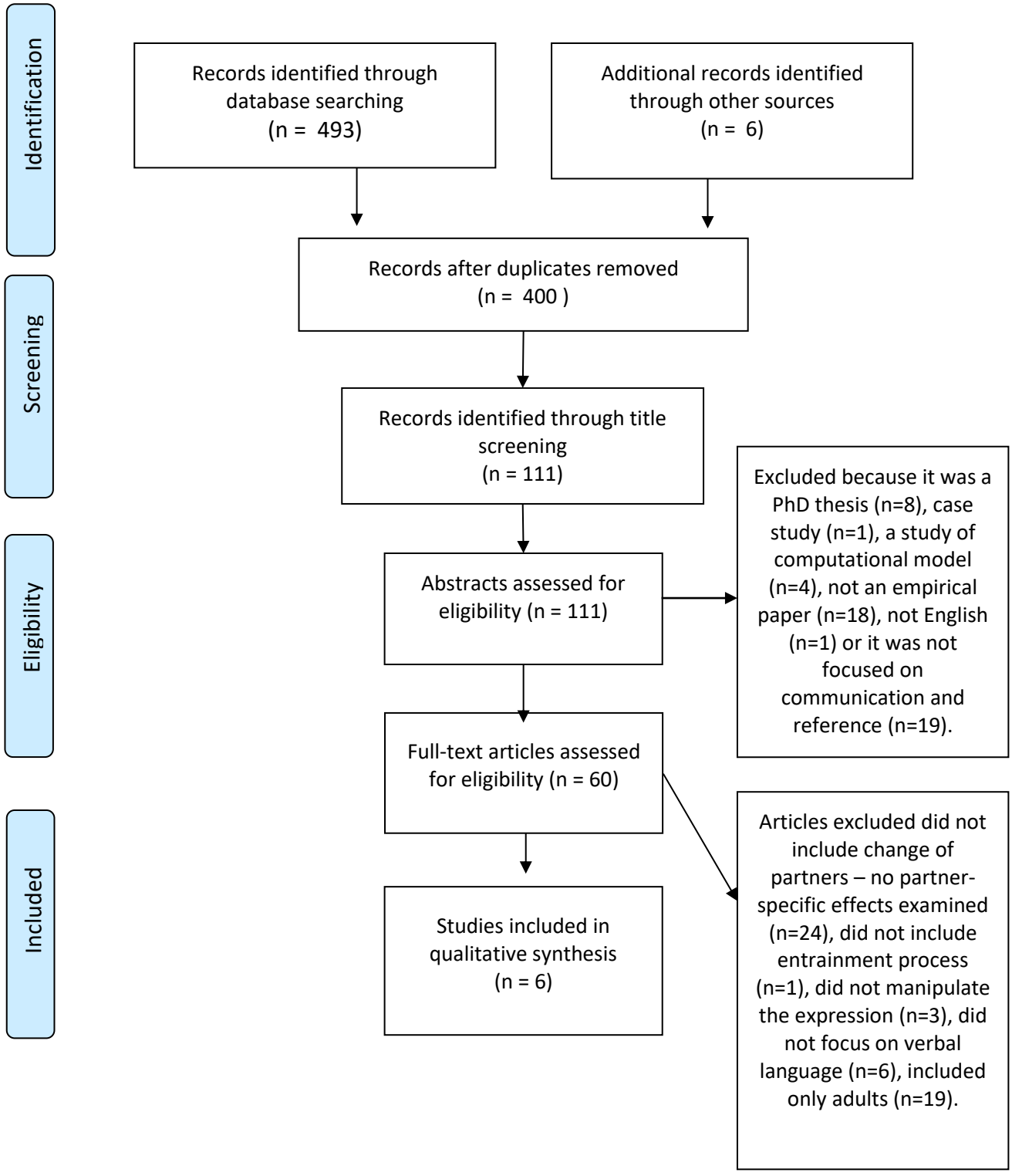


Figure 3. PRISMA Flowchart of Study Identification and Selection.

To summarise, this review includes all papers that investigated conceptual pact sensitivity with children. The aim is to review all the empirical papers up to date from the perspective of the basic theoretical explanations of conceptual pacts. I have adopted the structure of the conceptual triad (see Figure 2) as a framework to describe and compare the empirical research. In addition to the review, I will concurrently emphasize the scarcity of research of conceptual pacts with children, propose a new experimental approach, and suggest developmental study with a wider age-range for a better overview of children's understanding of conceptual pacts.

2.5. “Conceptual” pacts or “referential” pacts?

The theoretical assumption that lexical entrainment could be partner-specific was first introduced by Brennan and Clark (1996). They named these partner-specific agreements “conceptual pacts”. In studies with children however, researchers consistently adopt the term “referential pacts” (e.g., Graham, Sedivy, & Khu, 2014; Matthews et al., 2010). I will argue below why these two terms should not be interchangeably used and that more research is needed to determine the theoretical underpinnings of creating conceptual pacts.

Speech as an intentional act involves different stages (Levelt, 1989; Levelt et al., 1999) where we can differentiate conceptualisation from reference formation. Before a speaker actually produces a referring expression, they have to have an intention, select the relevant information, and monitor what was said before – this process is called conceptualization (Levelt, 1989; van Gompel et al., 2019). Conceptualisation results in a preverbal message, which is in the formulating stage shaped into a verbal referring expression (see Figure 4).

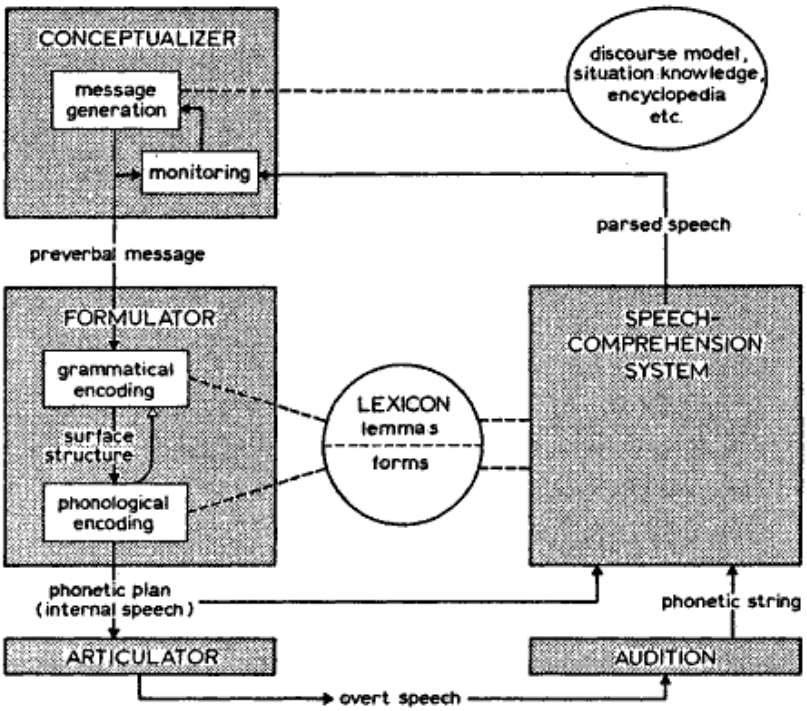


Figure 4. How Speaker Forms a Reference (from Levelt, 1989).

If conceptualisation and reference production represent two different stages of the referring process, it is prudent to ask why did researchers start using the term "referential pact" instead of "conceptual pact" when using child participants? The outcome of both processes is the same – we can behaviourally observe conceptual pacts with the choice of referring expression. However, the term "referential pacts" diverts the attention from the process of conceptualising, but focuses on formation of the referring expression. The focus of conceptual pacts should be in conceptualisation - tailoring the meaning and perspective of a referent for a particular addressee (Brennan, 1996). Following this logic, is it then the case that pre-school children are not capable of conceptualisation?

Children develop conceptual representations in their first 12 months and provide a general base for developing language (E. V. Clark, 1983). They map newly-learned words onto their conceptual representations (E. V. Clark, 2004). Gradually, they

develop distinctions between referring expressions and the ability to take different perspectives of the same object. Doherty (2000) showed that four year olds, but not three year olds, can understand that the same object can be referred to with more than one referential expression. However, for true conceptualisation, children have to understand that a referential expression refers to concepts, not particular exemplars of referents. That is, a referential expression such as "plate" does not refer only to plate that the child can see on the table, but to all plates that people eat from. Two year olds already show this understanding (Gelman & Taylor, 1984). Furthermore, this was even shown within conceptual pact research. Unpublished study from Lindsay, Hopkins, and Branigan (2019) illustrates that even three year old children understand that different referential expressions can refer to the same concept, not just particular exemplar. Children showed lexical entrainment that was not limited to specific exemplars of referents, but concepts. Children reused the expression "rabbit" even when they did not see that same brown rabbit as before but instead, a white rabbit. All this evidence shows that children are able to conceptualise at a pre-school age. Consequently, it is unclear why research looking at understanding of conceptual pacts with children should be discussed with different terms as it is with adults.

2.6. Summary of research with children

Research examining conceptual pact sensitivity with children followed experimental designs of many studies with adults (e.g., Kronmüller & Barr, 2007; Metzing & Brennan, 2003). That is, to establish a conceptual pact the participant and experimenter (E1) or two participants first entrain on a particular referring expression a few times in the entrainment phase (referring to the dog as the "brown dog"). In the test phase, to investigate whether the expectation of reusing the same referential

expression holds, E1 sometimes refers to the same referents with the entrained expression ("brown dog"), and sometimes refers to the same referents with a new expression ("skinny dog"). If participants are sensitive to lexical entrainment, they should be faster to understand the entrained expression than a new expression. Additionally, to test whether the lexical entrainment is partner specific, a new experimenter (E2) is introduced in the test phase. As with E1, E2 also refers to the referents with the established expressions or with new expressions. If the conceptual pacts are partner specific, then participants should not show a difference in understanding E2, regardless of which expression they use.

2.6.1. Comprehension studies

Matthews, Lieven and Tomasello (2010) were the first to investigate whether children are sensitive to conceptual pacts. The authors adapted Metzing & Brennan's (2003) task of moving objects to different locations to test 126 three and five year old children. In the entrainment phase, Experimenter one (E1) named the toys with the child participant to establish referential precedents (e.g., Move *car* next to the man./ Pick up the *bush.*). In the test phase, the E1 or Experimenter two (E2), who was not present for the entrainment phase, continued playing the game with the child. E1 or E2 referred to two of the familiar toys in the grid with an original expression (e.g., *car*) and to two with a new expression (e.g *tree*). Matthews et al. (2010) showed that even three-year-olds reacted slower only when E1 used a new expression compared to when E2 used a new expression, showing sensitivity to referential pacts. This difference in reaction times between using an established expression or a new expression was bigger with E1, which corroborates findings with adults (Metzing & Brennan, 2003). However, children also reacted slower when the new partner used a new term, suggesting hyper-

conventionality by expecting the old term to always be used for the familiar toy. Researchers noticed that 5-year-olds showed a more adult-like understanding of the referential pacts, by protesting only when the original partner used a new term. This indicates that they might have understood and connected the expression as the agreed term with the original partner.

More recently, Ostashchenko and colleagues (Ostashchenko, Deliens, et al., 2019b) explored the role of partner specificity with a modified procedure used by Matthews, Lieven and Tomasello (2010). They presented 65 three and five-year old children with a task on a computer screen. Children were required to follow instructions by an experimenter to choose two out of 12 items and pull them into a photo frame in the middle of the monitor. When the two referred items were correctly put into the photo frame, the sound of photoflash was produced. One experimenter (E1) referred to the target item with one of the possible synonyms (e.g., “sheet” or “paper”) to establish a pact. In the test phase, either the same (E1) or a new experimenter (E2) continued the game with the child. The target items were referred to with either the established expression (“sheet”) or with a new expression (“paper”). Both 3- and 5-year-old children were significantly delayed when hearing the new expression as opposed to the established expression, regardless of the experimenter. These findings do not support the results of Matthews’ et al (2010) study. The children were not sensitive to the identity of the partner and this result was also age-independent. Ostashchenko and other colleagues (Ostashchenko, Geelhand, et al., 2019) provided additional support for their results by replicating their experiment in a study with typically developing children and children with ASD. In a matched sample consisting of four and five year old typically

developing children, they found no evidence of partner-specific preferences for referential expressions.

Graham, Sedivy and Khu (2014) tested four year-olds following a similar paradigm. They did not use synonyms as in previous experiments (Matthews et al., 2010; Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019), but their original expression consisted of an adjective that was changed in the new expression condition ("the striped ball" vs. the "purple ball"). In the entrainment phase, the children had to point to the referent – a ball that was both striped and purple when they heard the expression "striped ball". In the test phase, the children heard either the E1 or E2 referring to the ball with the entrained expression as the "striped ball" or a new expression - "purple ball". Four-year-olds' behaviour was measured with an eye tracking paradigm and pointing. The results show that children were more accurate when pointing to the object when expressed by the entrained expression regardless of the speaker. Four-year-olds preferred to use consistent expressions for objects, and thus did not show partner-specific effects. However, when using an implicit measure (eye-tracking), a facilitation was noticed when E1 used the original expression ("striped ball") compared to when E1 used a new expression. This difference between using the entrained or new expression was not observed with E2. This finding corresponds with research with adults (Metzing & Brennan, 2003) indicating that four-year-olds showed partner-specificity, however only if implicit measures were considered.

Table 1

Characteristics of Study Designs From Experiments Measuring Conceptual Pacts With Children

Article	Participants	Ages	Entrainment	Comprehension, production	Context	Expressions	Items	Design
Matthews, Lieven, Tomasello, 2010	126	3 and 5	FOUR times	Comprehension	Constant	Common nouns in English	12 items in a plexi-glass grid	Within subjects (same vs. new partner)
Ostashchenko, Deliens, Geelhand, Bertels, & Kissine, 2019	65	3 and 5	THREE times	Comprehension	Constant	Common nouns in French	12 pictures in a computer task	Within subjects (same vs. new partner - experimental sessions divided by days)
Ostashchenko, Geelhand, Deliens & Kissine, 2019	36	4 and 5	THREE times	Comprehension	Constant	Common nouns in French	12 pictures in a computer task	Within subjects (same vs. new partner - experimental sessions divided by days)
Graham, Sedivy & Khu, 2014	72	4	THREE times	Comprehension	The array of toys changed for each trial	Expressions with adjectives	Pictures of familiar objects	Between subjects (4 separate conditions)
Koymen, Schmerse, Lieven, & Tomasello, 2014 (Study 1)	183	4 and 6	THREE times	Comprehension and production (the director and matcher swapped roles)	Entrainment with unique target referents (3x) and entrainment in non-unique context (3x). The test trials were in the unique context again.	Spontaneous expressions produced by children	Pictures of familiar objects	Mixed - children switched roles of matchers and directors

Koymen, Schmerse, Lieven, & Tomasello, 2014 (Study 2)	187	4 and 6	TWO times	Comprehension and production (the director and matcher swapped roles)	Game - with a picture book.	Common nouns or/and proper names	Pictures of familiar objects and a picture of a boy/girl	Mixed - children switched roles of matchers and directors
Lindsay, Hopkins, Branigan, in prep (Exp. 3 and 4)	20 in the same partner condition (Exp. 3) and 24 in the new partner condition (Exp. 4)	3 and 4	None - children named the objects in the picture book	Comprehension and production (the director and matcher swapped roles)	The entrainment was done with a picture book, the test phase was done as a snap game (same context) - targets were separated by 2 filler items	Common nouns (horse vs. pony)	12 pictures of conventional items on cards + 24 filler cards	Between subjects

2.6.2. Production studies

The three studies described above all looked at children's partner-specific comprehension however, Köymen and collegues (2014) looked at partner-specific production. They designed two experiments to test whether four- and six-year-old peers establish partner-specific conceptual pacts. In Experiment 1, pairs of peers had to refer to the target referent in a non-unique context (referring to "women's shoe" in a context with other types of shoes). After a pair of peers had established a pact ("women's shoe"), half of the children continued the experiment with the same partner and half of the children were paired with a new peer. In the test phase, children had to refer to the same target, but this time in a unique context (referring to the "women's shoe" in a context where there were no other shoes). Four-year-olds used contextually appropriate descriptions ("the shoe") regardless of the partner they spoke to, whereas six-year-olds continued to use the entrained expression ("women's shoe") only with the same partner, even if the expression was over informative. That suggests that four-year-olds did not show partner-specific use of referential expressions, but six-year-olds used conceptual pacts like adults (Brennan & Clark, 1996).

In Experiment 2 (Köymen et al., 2014), four and six year old children had to narrate with a picture book. The children agreed about the name of a character which represented a conceptual pact of a proper noun ("Emma"). In the test phase, children had to refer to the same character either with the familiar partner or with a new partner. Both four- and six-year-olds used the agreed conceptual pact of a proper noun only with familiar partners but switched to common nouns with new partners. In contrast with six-years-olds, who showed partner specificity regardless of whether the referential expression pact was a noun phrase ("women's shoe") or a proper noun ("Emma"), four-

year-olds showed partner specificity only when the pact was a proper noun. The researchers assumed that the young children's inability to show partner specificity in all contexts might be due to their inability to change perspectives. The research showed that four-year-olds are able to actively establish a pact with their peers however, only if using proper nouns and if the agreement of a pact is explicitly made.

To further examine children's partner-specific production of referential expressions, Lindsay and colleagues (Lindsay et al., 2019, Experiment 4) used a "snap" game with three and four-year-old children where the experimenter and the child alternated referring to familiar objects on cards. The experimenter (E1) and the child referred to the target item with a referential expression ("pony") in a few turns to create a pact. In the test phase, the child heard either the same experimenter (E1) or a new experimenter (E2) refer to the same target item on the card with either the established expression ("pony") or a new expression ("horse"). The authors analysed whether children were more likely to use a new expression after E2 has used it than after E1 has used it, showing that the established referring expression is partner-specific. Three- and four-year-olds were equally likely to produce a new expression with both E1 and E2, which speaks against the partner-specificity hypothesis. Children did not show any difference in production of referring expressions with either experimenters, which authors interpreted as partner-independent priming.

2.7. Discussion

The studies included in this review are focused on the children from three to six-years-of-age, which coincides with age of the development of theory of mind skills (Wellman et al., 2001). Theory of mind skills include understanding that different people might have different knowledge, emotions, beliefs and intentions (e.g., Baron-Cohen, Leslie, & Frith, 1985; Leekam & Perner, 1991; Wellman et al., 2001). This can be particularly important when cooperating in communication. To adopt to the conceptual pact by reusing the same expression and match conceptualisations of two speakers (Brennan & Clark, 1996; Brown-Schmidt, 2009), one has to have the understanding of interlocutor's knowledge and beliefs. Therefore, it is possible that sensitivity to conceptual pacts requires some level of theory of mind (Nilsen & Graham, 2009).

If partner-specific comprehension and production rely on the social perspective taking abilities (Brennan & Clark, 1996), then we could expect a development of sensitivity to conceptual pacts in that age range, particularly between three and five-year-olds. If however, the pattern of results shows that children from three to six-years of age prefer to use and hear established referential expressions, regardless of the partner they are speaking to, then we could assume that memory mechanisms play a bigger role. If children are relying on most available referential expressions in memory, then the development of sensitivity to conceptual pacts might develop at a later stage. Or as proposed by Kronmüller and Barr (2007) the partner-specific perspective is incorporated in after monitoring and reviewing referential communication especially when referring expressions are ambiguous (Sidera et al., 2016). Children might learn this disambiguating reference resolution later.

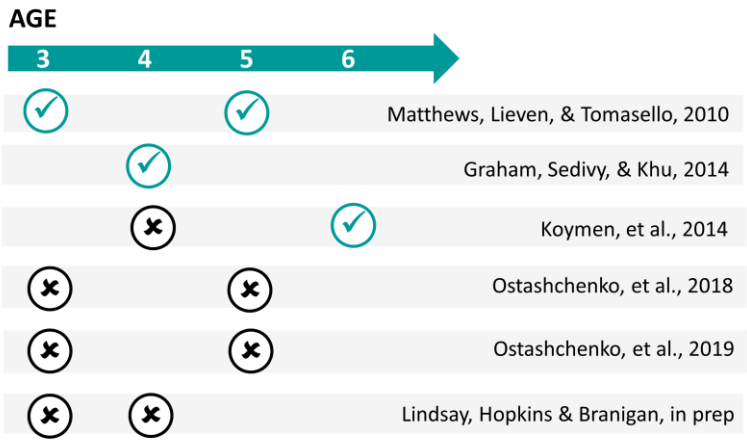


Figure 5. Sensitivity to Conceptual Pacts Across Age Range from Three to Six.

Overall, the research findings on conceptual pact sensitivity with children are not yielding clear results to show support for either of the two underlying mechanisms. Some comprehension studies show almost adult-like understanding of conceptual pacts even in three-year-olds (Matthews et al., 2010), where children expect that the same partner will reuse the previously used term, but do not show the same expectation with a new partner. However the work of Graham, Sedivy and Khu (2014) only partly supports these findings, demonstrating that only implicit, eye-tracking measures, show four-year-old's partner-specific expectations, but children do not show these expectations when pointing to the referent. Contrary to these two studies, Ostashchenko and colleagues (Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019) do not report about any partner-specific expectations with three- to five-year-olds. Ostashchenko and colleagues (Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019) show that children have a general expectation to hear previously used referential expressions regardless of whom they are speaking to. To sum up, comprehension studies with children do not show clear support for any of the theoretical underpinnings of conceptual pact.

The two studies examining children's partner-specific use of referential expressions show that neither three (Lindsay et al., 2019) nor four-year olds (Köymen et al., 2014; Lindsay et al., 2019) take into account the history of referential expressions with a particular partner, but use the most recently used referential expression regardless of the partner they are speaking to. Six year olds on the other hand, show almost adult-like production of partner-specific referential expressions when using modified noun phrases (Köymen et al., 2014). However, although four year olds do not show partner-specific production with nouns, they do show the same sensitivity to partners as six-year-olds when using proper nouns. We could infer that there is some development of production of conceptual pact sensitivity between four and six years of age, but the findings are not clear.

The studies looking at comprehension of conceptual pacts with children have opposing findings, however studies of production show more overlapping conclusions. To be able to fully understand whether and how children's sensitivity to conceptual pacts changes with age and their cognitive development, I examine the differences in experimental designs in the present review. I identify factors that influence partner-specific sensitivity and create guidelines to improve experimental designs when exploring conceptual pact sensitivity with children.

2.7.1. Age range of included children

When reviewing all the studies looking at conceptual pacts with children (see Figure 5), I see that none of them include children from more than two age groups. However, if I really want to track whether and how children's sensitivity to conceptual pacts changes with age and their cognitive development, it is necessary to include a wider age-range of children. Including children from three to six-years of age would give

us a good measure of performance of children from a wider age range on the same task. One could more reliably infer and relate their cognitive abilities (e.g., theory of mind and perspective-taking) with their chronological age. Moreover, taking into account some important factors that influence partner-specific sensitivity (outlined in following paragraphs), a valid measure of how children adhere to conceptual pacts would add to the existing unaligned body of literature.

2.7.2. Studies looking into referential pacts with children used different referring expressions

Since there are many ways of how to refer to a particular object (e.g., a rabbit can be referred to as “bunny”, “furry rabbit”, or “Softy”), studies have used different referential expressions. To date, four experiments with children have included **common nouns** (for a list see Table 1), one experiment has included **nouns with adjectives** (Graham, Sedivy, & Khu, 2014 used expressions such as "brown rabbit" and "furry rabbit"), one experiment has included **nouns with adjectives** (Köymen et al., 2014, Experiment 1), and one experiment has used **proper names** (Koymen et al., 2014, Exp. 2 used expressions such as "Softy" and "bunny"). Their choice of the type of referential expression is important because it influences ambiguity in reference resolution.

Figure 6. Specificity of Referential Expressions Used in Experimental Designs.

Although all types of referential expressions express a particular perspective the speaker has on the target referent, the specificity of meaning differs. When referential expressions are common nouns, the meaning usually represents a category of meaning (Gelman & Taylor, 1984; Katz et al., 1974). Two year olds already understand that a common noun refers to a category of objects (e.g., the expression "spoon" can be referred to all spoons) (Gelman & Taylor, 1984). When referential expressions are adjective-noun combinations, they represent a more specific and narrow category of meaning. The adjective expresses a referents' property (Hall & Moore, 1997), which more specifically defines the target referent of that expression. For example, the expression "spotty dog" does not refer to all dogs, as the expression "dog" does, but refers to only dogs with spots. Three year olds already understand that an adjective can be used to describe different referents with the same property (Hall & Bélanger, 2005). When referential expressions are proper names however, they designate individual referents (Markman, 1994). Two year olds already understand that a proper name expresses identity (Birch & Bloom, 2002). Also, they have a rudimentary understanding that a proper name is more likely to be used for an individual that a speaker is familiar with (Birch & Bloom, 2002).

2.7.2.1. More specific the referring expression, less ambiguous the intended meaning

To sum up, different types of referring expressions denote different specificity of meaning (see Figure 6). Ranging from common nouns, which refer to concepts, to using proper names, which refer to particular individuals. Referring to concepts is more ambiguous compared to referring to particular individuals. One can only use a common noun in a unique context; that is, when the target referent is the only target from the

same category in that context. If we want to refer to the shoe, we can only use the expression “shoe” if there is no other shoe in the context. That means that using common nouns is more context-dependent than using proper names. On the contrary, more specific the referring expression, less sensitive it is to change of context. Regardless of the context where we encounter Snoopy, we will always refer to it as Snoopy. However, if we use the referring expression “dog”, the expression might be under-informative if the target referent “dog” is presented in a context with multiple other dogs.

Developmental research exploring conceptual pacts suggests that a more specific referring expression creates a stronger expectation of a conceptual pact. Four (Graham et al., 2014) and six year olds (Köymen et al., 2014) are shown to successfully use and comprehend nouns with adjectives (“Stinky shoe”) as partner specific conceptual pacts (see Figure 6). On the other hand, when three, four, and five year old children hear or produce common nouns, they do not show partner specific sensitivity (Lindsay et al., 2019; Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019). These studies support the assumption that specificity of the referring expression can make a difference when establishing a pact. Or in other terms, more ambiguous and context-dependent referential expressions (common nouns) elicit a weaker tendency to adhere to a conceptual pacts. All but one study, included in this review, support this assumption. The study from Matthews and colleagues (2010) does not support this argument, showing that even three-year-olds are sensitive to conceptual pacts when using common nouns. Therefore, all the developmental studies to date cannot unequivocally support the assumption that a more specific expression

creates a stronger conceptual pact. However, more research and potential replications could help determine whether this assumption holds.

2.7.2.2. Proper names should not be considered as conceptual pacts

Only one study in this review established "conceptual pacts" with proper names. Koymen and colleagues (2014) designed a study using nouns with adjectives and proper names in order to test referential pacts sensitivity with four and six year old children. Six year olds showed partner-specific sensitivity with both nouns with adjectives and proper nouns, but four year olds were only sensitive to whom were they speaking to when using proper nouns. It seems like when a referring expression denotes the identity of the referent specifically, as proper names do, evaluating common ground between two interlocutors might be clearer in both production and comprehension. That would in turn enhance referential pact sensitivity, showing that even four year olds are sensitive partner-specific use of proper nouns. I believe this finding should not be interpreted as sensitivity to conceptual pacts.

Pacts are by definition conceptual (Brennan & Clark, 1996). For each expression that a speaker chooses to refer to a referent, they express their conceptualization or perspective on that referent (E. V. Clark, 1997). The proposal of the expression is temporary (Brennan & Clark, 1996). However, proper names do not align with this theoretical assumption. Proper names express identity (Markman, 1994) and are unambiguous regardless of the context. That also makes them indefinite referential expressions, excluding the possibility to categorise or establish them as conceptual pacts. Therefore, I believe that proper names should not be used in study designs looking at conceptual pact sensitivity.

2.7.3. Interactivity of the experimental design

The research on conceptual pacts with adults shows that interactivity is a very important part of establishing a conceptual pact. Research has shown that more interactive experimental task creates participant's stronger partner-specific expectations (Brown-Schmidt, 2009). Brown-Schmidt explored this factor when comparing face-to-face established referential expressions to referential expressions heard via headphones. Although the established expressions were identical in both experimental designs, Brown-Schmidt demonstrated that adults only showed partner-specific expectations when the pacts were formed in a more interactive design. Research with children however, might show us even a more refined view of interactivity in experimental designs.

All the studies in this review were interactive – that is, both communicational partners were present in the room during the communicational game. However, the study designs differed in how exactly communicational partners interacted. Three studies describe more interactive establishment of pacts (Köymen et al., 2014; Lindsay et al., 2019; Matthews et al., 2010), while the other three studies report about less interactive designs (Graham et al., 2014; Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019).

More interactive designs describe communicational games where communicational partners were facing each other and/or had the ability to ask for clarification and establish agreement. In study 1 by Köymen and colleagues (2014), the pairs of children were separated by a curtain. They established pacts by spontaneously describing pictures to each other, using questions, clarifications and confirmations. Despite being separated by a curtain, the possibility to spontaneously clarify referential

expressions enabled them to mutually establish referential expressions. Other designs included face to face communication between partners. The children established pacts in face to face communication with a picture book (Köymen et al., 2014), while moving the toys in a see-through grid (Matthews et al., 2010) and while playing a card game (Lindsay et al., 2019). These designs allowed a more natural communication.

In other three studies, the experimenter and the child were looking at a computer monitor (Graham et al., 2014; Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019). The communicational partners in these designs were not facing each other. The experimenter was seated behind the child, so that they could both look at the computer screen while the experimenter was instructing the child to click on the target referent. Since conceptual pacts should be mutually agreed referring expressions (Brennan & Clark, 1996), it is possible that the aforementioned experimental designs did not support the establishment of a conceptual pact. Collaboration and interactivity between communicational partners is vital to establish partner-specific effects (Brown-Schmidt et al., 2015). However, in the designs where communicational partners were looking at the screen while listening to instructions, the collaboration and interactivity between partners resembles natural conversation less than a communication design were partners are facing each other.

In summary, with regards to the theoretical assumptions of how a conceptual pact should be formed, I can conclude that more interactive designs support establishment of conceptual pacts (Brown-Schmidt, 2009; Brown-Schmidt et al., 2015). That is, if communicational partners are facing each other or have the possibility to clarify and confirm proposed referential expressions, the establishment of a conceptual pact is stronger.

2.7.4. New approach: Changing the conceptual triad by changing the referent

We know that changing the expression and changing the partner breaks the conceptual pact. What about changing the meaning of the referential expression, but keeping the referential expression constant? According to the Homonymy Assumption, every two meanings contrast in form (E. V. Clark, 1987). That means that with each new meaning, the interlocutors expect a new referential expression. If the same referential expression is used to refer to two distinct meanings, this causes confusion (E. V. Clark, 1987). According to theory then, could I expect that changing the referent, but keeping the expression constant would break the conceptual pact with a partner?

2.7.4.1 How could the referent be changed?

Firstly, pacts are by definition conceptual. Conceptualizing does not necessarily mean assigning one particular unique meaning to that expression, but assigning an array of content (Markman, 1994). Following the previous assumption, if I want to change the referent in the same manner the studies are changing the partner or the expression, I have to change the category of the referent (see Figure 6).

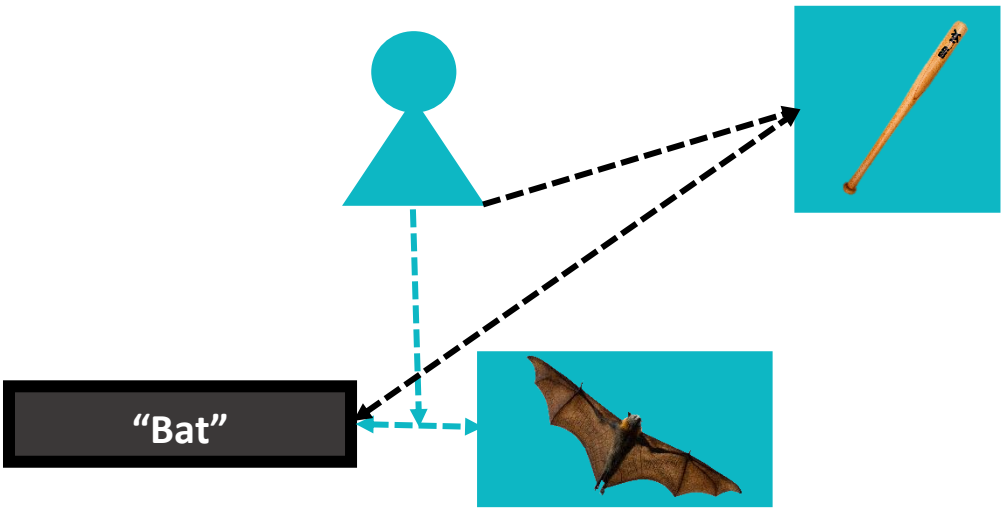


Figure 7. Testing the Conceptual Triad with Changing the Referent.

For example if a partner uses the expression “bat” to refer to a flying mammal in the entrainment phase, the conceptual pact in the test phase could be broken by either changing the referent, referring to the baseball bat instead of the flying mammal, or changing the communicational partner. With this design, I would clearly change the concept, but not the referring expression. To choose a referring expression to suitably refer to both different referents, I can use homonyms (such as “bat”) or referring expressions that can refer to more than one meaning (such as “flying thing” to refer to a bird or a kite).

According to conceptual pact definition and my assumptions, I would expect listeners to be faster when the speaker is referring to the established referent – the flying mammal, compared to when the speaker is referring to a new referent, a baseball bat. Moreover, if these expectations of consistency are observed only with the same speaker, but not with a naïve speaker, then I could claim that the conceptual triad represents a relationship between three equally important pillars: the speaker, the expression and the referent. Testing the conceptual triad by changing the referent would clarify the relationship within the conceptual triad. Also, it would contribute to a better understanding of the definition of conceptual pacts.

2.8. Conclusion

All studies in this review investigated conceptual pacts with children aged from three to six. Although a developmental change of conceptual pact sensitivity should be observed if partner-specific comprehension and production rely on the social perspective taking abilities (Brennan & Clark, 1996), the studies with children show contrasting results. Some experiments confirm that even three and four year old children show adult-like understanding of conceptual pacts (Graham et al., 2014;

Matthews et al., 2010), whereas others show that five year old children do not have partner-specific expectations (Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019). This review of research of conceptual pacts with children shows two factors that influence establishment of conceptual pacts and consequently, contribute to contrasting results.

All studies but one support the assumption that a more specific referring expression creates a stronger expectation of a conceptual pact. A more specific expression (e.g., “spotty dog”) is less sensitive to change of context and refers to a narrower category of meaning, thus creates a stronger pact. However, proper names as the most specific referential expressions should not be considered as conceptual pacts. Proper names express identity (Markman, 1994), but conceptual pacts should be referring to concepts (Brennan & Clark, 1996). Therefore, proper names should be avoided in conceptual pact research.

Although interactivity of the design has already been identified as an important factor in research of conceptual pacts with adults (Brown-Schmidt, 2009; Brown-Schmidt et al., 2015), experiments with children revealed that interlocutors have to be facing each other to support establishment of conceptual pacts. Allowing interlocutors to clarify and accept the proposed referential expressions makes the pact stronger.

To date, the conceptual triad has been tested with manipulating the referential expressions and interlocutors. But no research has examined whether conceptual pact can be broken by changing the referent. I believe this additional perspective would help determine if the conceptual triad is a good description of conceptual pacts. It would clarify the relationship between the three pillars - whether the partner, the expression and the referent have equal weights.

To sum up, although the study designs that investigate conceptual pacts with children were similar in structure, paying more attention to the interactivity between the interlocutors and the specificity of referential expressions could lead to more converging results. Nevertheless, the reviewed studies never included more than two age groups of children. To really test whether children's sensitivity to conceptual pacts changes with age and cognitive development, a study with a wider age-range of children should be conducted. Moreover, manipulating the referent as a novel way of testing the conceptual triad would bring more clarity to the definition of what conceptual pacts really are.

CHAPTER 3: CAN WE BREAK A PACT BY CHANGING THE REFERENT

This study was designed to empirically explore the definition of conceptual pacts. To date, studies have explored two facets of conceptual pacts – they tested the existence of pacts by changing the expression and by changing the partner (e.g., Brown-Schmidt, 2009; Matthews, Lieven, & Tomasello, 2010; Metzing & Brennan, 2003). As mentioned in chapter two, no study to date has tested the existence of pacts by changing the referent – the meaning of an expression. Moreover, studies with adults and children are detached and the same experimental design has never been tested on both age groups. In chapter three I empirically test the existence of pacts by changing the referent. The main focus is on children's performance, but I also test adults with the same experimental design to add a control group to children. Understanding children's conceptual pact sensitivity from three to five-years-of age is particularly interesting since they are still developing reasoning about others' knowledge, intentions, and beliefs. If conceptual pacts require this reasoning, children in these age groups could inform us about the mechanisms that underpin the emergence of conceptual pacts in communication.

3.1. Introduction

Linguistic communication is guided by conversational principles. Speakers follow these principles to avoid referential ambiguity, to transfer the intended meaning, and to facilitate listener comprehension (E. V. Clark, 1988; Grice, 1975). To explain how speakers coordinate and cooperate in linguistic exchanges, Brennan and Clark (1996) proposed the concept conceptual pacts. A conceptual pact is a mutual agreement between conversational partners about a referring expression that conceptualizes an object (e.g., calling a bat a "flying mammal"). Speakers take a perspective on that object

and implicitly agree how to refer to it (Brennan & Clark, 1996). According to the abovementioned definition, pacts should create expectations of a relationship between the individual, the expression, and the referent (e.g., you as the speaker, “spotty dog” as the expression, and dog as a referent). This relationship will be addressed as the conceptual triad (see Chapter 2, Figure 2 representing conceptual triad). When the conceptual triad is established, it guides conversational partners by creating expectations for future use.

3.1.1. Underlying theories of conceptual pacts

It is not yet clear why do interlocutors adhere to conceptual pacts. Two streams of theories have been proposed to explain this conversational principle. One stream explains that interlocutors adhere to conceptual pacts because of memory associations (Barr & Keysar, 2002), whereas other explanation assumes that speakers design their referential expressions for specific speakers (Brennan & Clark, 1996). On one hand, there is evidence that conceptual pacts are kept because of memory associations in the conceptual triad – between the speaker, expression and the referent (e.g., Barr & Keysar, 2002). On the other hand, there are some explanations that show that conceptual pacts are based on more than just memory associations. When interlocutors conceptualise a referent, they express a perspective of that referent (Brennan & Clark, 1996). With every subsequent reuse of the same referential expression, interlocutors show adaptation of their perspective and knowledge to that of a conversational partner (Brennan et al., 2010; Metzing & Brennan, 2003). This requires theory of mind skills, since interlocutors have to understand their partner’s perspective and their communicational intent (Resches & Perez Pereira, 2007). This alignment to

conversational partners is based on cooperative principle (Grice, 1975), where interlocutors adhere to conceptual pacts to avoid ambiguity.

Both explanations for conceptual pacts have been shown to be important. However, it is not yet clear whether conceptual pacts are first driven by memory, and attenuated at later stages to incorporate the partner's perspective (Barr et al., 2014; Kronmüller & Barr, 2007), or whether the two processes are simultaneous (Galati & Brennan, 2010). Nevertheless, the majority of studies to date support the view that both theory of mind skills and memory associations are necessary for understanding and forming conceptual pacts.

3.1.2. Breaking conceptual pacts with changing the expression and changing the partner

Researchers have most commonly explored the effects of breaking pacts with measuring reaction times of picking the target referent in the array (e.g., Metzing & Brennan, 2003). In the first phase – the entrainment phase, an experimenter established the pact by repeating a referential expression to refer to a referent (e.g., using "flying mammal" to refer to a bat). In the test phase, the same experimenter or a new experimenter used either the established expression (e.g., referring to the bat when using the expression "flying mammal") or a new expression to refer to the same referent (e.g., referring to the bat when using the expression "black bat"). I would expect that the listeners are faster to retrieve a referent when the same partner uses the established expression in comparison when he uses a new expression. However, I would expect no differences in reaction times with a new experimenter (see Chapter 2 for a more detailed description).

3.1.3. Conceptual pacts with children

The majority of research with adults has shown both that a pact can be broken when expressions are changed (Barr & Keysar, 2002; Horton & Slaten, 2012; Metzing & Brennan, 2003), and when partners are changed (Brown-Schmidt, 2009; Kronmüller & Barr, 2007). However, the existing empirical work examining conceptual pacts with children has not been that clear. The majority of studies including children from three to six years of age have shown that children perform similarly to adults with faster performance when hearing and producing established referential expressions as opposed to using new expressions (Graham et al., 2014; Lindsay et al., 2019; Matthews et al., 2010; Ostashchenko, Deliens, et al., 2019a).

A critical component of conceptual pacts is that they are partner specific, but it is not clear whether these expectations hold with young children. As discussed in detail in the previous chapter, some researchers have shown that three year-olds already show a difference in reaction time when the same partner uses the established expressions or new expressions, but do not show same differences in reaction times with a new partner (Matthews et al., 2010). However, more recent studies have shown that neither three, nor five year old children show any differences in reaction times when speaking to the same or a new partner (Ostashchenko, Deliens, et al., 2019a). Since sensitivity to change of partners would show that children do take into account the perspective of the speaker and the shared knowledge (Brennan et al., 2010; Metzing & Brennan, 2003), it could also reflect children's theory of mind skills.

Because children between three and five years of age are still developing their theory of mind skills (Wellman et al., 2001), they are particularly well-positioned to determine whether pacts primarily rely on skills of perspective-taking and common

ground, or on priming and other memory processes. Children's expectation of the same partner to use the established expression could indicate children's understanding of their referential history with that particular partner (Sidera et al., 2016). On the contrary, children's understanding that the partner they have not interacted with before could use any available referring expression, might also reflect on their understanding of using shared knowledge in communication.

3.2. Introducing the idea: breaking conceptual pacts with referring to a new referent

Thus, in the literature to date, the degree to which a conceptual pact has formed has been tested either by changing the specific referring expression (e.g., flying mammal vs black bat) and / or by investigating the degree to which changing the partner changes interlocutor's expectation. However, given that the conceptual pact represents a conceptual triad - relationship between the conversational partner, the expression and the referent, could conceptual pacts be also broken by changing the referent? No study to date has looked at the consequences of changing the actual referent (e.g., bat = mammal vs. bat = baseball bat). The latter issue is important because if a conceptual triad is indeed the best means of description the underlying representation of conceptual pacts, then changing the referent should also break this relationship (see Chapter 2). If changing the referent breaks a pact, then listeners should be slower when hearing the same expression used to refer to a new referent than when hearing this expression used to refer to the established referent (e.g., using the expression "bat" for a baseball bat, or "bat" for the already-established referent, the flying mammal).

3.2.1. Keeping the expression constant and changing the referent

In order to test whether changing the referent, but keeping the expression constant, could break a conceptual pact, I had to find referential expressions that can refer to more than one referent. Research showed children's understanding of words with two possible meanings could reflect on their theory of mind skills, given that understanding homonyms has been shown to be associated with theory of mind skills of preschool children (Doherty, 2000). As understanding of false belief, and following conceptual pacts requires taking into account and distinguishing two perspectives (one of true and one of false belief, one of same partner and one of new partner), so does understanding homonymous words require two different interpretations of the same expression. Since children (Doherty, 2004) have difficulty in inhibiting the non-preferred meaning for homonyms, I decided to avoid homonyms but use ambiguous expressions which do not have two preassigned conventional meanings. Following Graham et al. (2014), I used adjectives, but because the referents changed, I had to avoid using basic level nouns. Consequently, adjectives that denote physical characteristics (e.g., "round one" to refer to a ball and a plate) were used without specifying the referents they refer to. With using these ambiguous expressions, I ensured that both target referents were equally possible.

3.2.2. Reducing memory cues

The study designs in the previous research paired one referential expression with the same identity of target referent in both entrainment phase and the test phase (Matthews et al., 2010; Metzing & Brennan, 2003). That acts as a strong memory cue (e.g., Bögels, Barr, Garrod, & Kessler, 2015), and might lead the children's choice of a referent. That is most evident in the case when the pact is kept with the same partner,

because the listener has three memory cues: hears the same speaker utter the same expression to pick out the same referent (see Table 2 below). Showing a different exemplar of a referent when examining conceptual pacts could reduce the number of memory cues and show that conceptual triad represents a relationship which extends beyond memory (see Table 2 below). That is, if speakers really conceptualize an object with their choice of referring expression, then their expression should refer to concepts, not to particular exemplars of referents (see Chapter 2).

Table 2

Memory Cues in the Test Phase in Four Different Conditions

	Previous research		Present study	
	KEEP	BRAKE	KEEP	BRAKE
Same speaker	Speaker, expression, **referent**	Speaker, **referent**	Speaker, expression	Speaker, expression
New speaker	Expression, **referent**	**Referent**	Expression	Expression

In fact, Branigan, Tosi and Gillespie-Smith (2016) showed that children can entrain on particular referring expressions even with different exemplars of the same referent. Since this shows that children understand that repeated referring expressions refer to concepts, not particular identity of a referent, the present study tried to reduce the memory cues by offering different exemplars of referents in the test phase compared to the entrainment phase (e.g., showing a pink plate in the Entrainment phase and a yellow plate in the Test phase).

3.2.3. Measures of behaviour

Since this experimental design focused on manipulation of referents, my first question was whether participants could identify the target. Therefore, I first examined children's choices of referents. Other studies relied on low error rates (e.g., Metzing & Brennan, 2003), but the current design allowed me to probe more deeply into participant's expectations. Participant's responses allowed me to test the partner specific interpretation of ambiguous expressions and observe participant's flexible interpretation of ambiguous expressions (Backscheider & Gelman, 1995; Mazzocco, 1997). Upon hearing the ambiguous expression, participants could choose from four possible referents. They could choose:

a) *the target referent,* which was described by the ambiguous expression (e.g., plate),
b) c) *two thematically related referents* (each related to one of the interpretations of the ambiguous expression – e.g., spoon related to a plate and football shoe related to the ball) or
d) an unrelated referent (see Materials section for a detailed description).

If participants did not choose the target referent, their choice would still be informative of their reasoning process. I wanted to offer the participants the possibility to adhere to the perspective of the current conversational partner, even if that meant choosing another referent. With participants' choices of referent, I could explore the underlying reasoning for their interpretation of ambiguous expressions.

Moreover, following the designs of previous studies with conceptual pacts, the reaction time for participant's choices of referents were also measured.

3.3. Experiment 1

3.3.1. Method

3.3.1.1. Participants

Forty-six children participated in the Kent Child Development Unit at University of Kent. There were 17 three-year-old children (M_{AGE}= 3 years 5 months, SD_{AGE}= 3.9 months), 16 four-year-old children (M_{AGE}= 4 years 5 months, SD_{AGE}= 3.4 months), and 13 five-year-olds (M_{AGE}= 5 years 4 months, SD_{AGE}= 2.9 months). There were 22 boys (47.8%) and 24 girls (52.2%). The information about children's language was retrieved from our database. There were 80.4% monolingual children whose native language was English and 19.6% children were bilingual. Children were divided into two between-participants conditions such that in one condition participants communicated with only one experimenter throughout the experiment (N=24), and in the other condition participants communicated with two experimenters; a new experimenter replaced the first experimenter in the second phase of the experiment (N=22).

3.3.1.2. Design

The experiment used a mixed design, with change of referents (established meaning vs. new meaning) as within subjects variable and change of experimenters (same experimenter vs. new experimenter) as between-subjects variable.

Pairs of people, a participant and an experimental confederate, played the communication game together. The communication game had three phases: 1) the Entrainment phase, 2) the Interruption phase, and 3) the Test phase (see Figure 8). The participant's task was to find target objects verbally requested by the experimenter.

In the Entrainment phase the participant and the experimental confederate first had to establish conceptual pacts, using pre-chosen expressions. To express the experimenters' perspective of the target toy, the experimenter used the pre-chosen expression to ask the participant to pick the target toy from a box. The experimental confederate repeated the pre-chosen referring expression at least two times, to ensure establishment of conceptual pacts. This procedure was repeated with all four expressions until the expressions were entrained and the participant retrieved all four toys from the box. The Interruption phase followed to allow for change of experimenters. Half of the participants continued to the Test phase with the same experimenter, and half of the participants continued with a new experimenter.

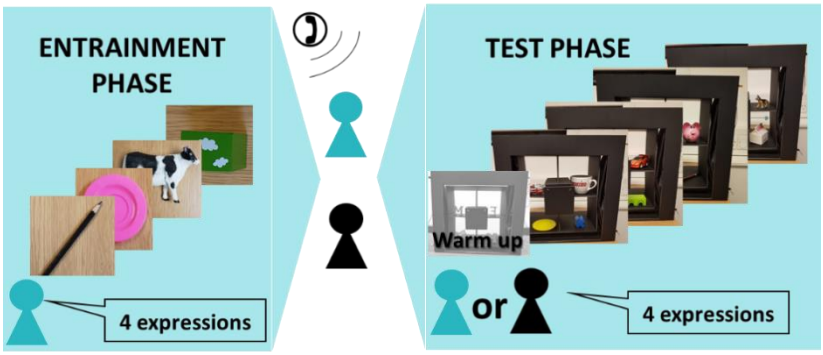


Figure 8. Schematic View of Two Phases of the Experiment.

The participant's task in the Test phase was to select the target toy in the grid among four offered toys upon hearing the pre-chosen expression. First, there was a warm up trial to make sure participant understood the task. There was one trial for each of the four established pacts with pre-chosen expression, adding up to four trials. In two trials the grid with toys contained a toy of the same category as established in the Entrainment phase (A), and in two of the trials the grid contained a new category of an object (B) – order ABAB. If participants establish conceptual pacts, they should be slower when the experimenter uses a pre-chosen expression to refer to a new category of an

object compared to when it refers to the same category of an object. Furthermore, if these pacts are partner-specific, this delay should be smaller with a new experimenter compared to the same experimenter.

3.3.1.3. Materials

Twenty-four objects were carefully chosen based on the descriptive pre-chosen referring expressions (see Table 3). In the Entrainment phase, four objects were used. Each object was represented felicitously by one of four pre-chosen referring expressions. The objects were a wooden block, a pencil, a cow and a plate (see Table 3). These four objects were seen by participants only in the Entrainment phase.

On each trial in the Test phase, the participant saw an array of four unfamiliar objects on each trial. For the warm up trial, the participant could choose between the zebra and three wooden letters. Following the warm up trial, there were four trials paired with four ambiguous expressions. In each trial, there was one target object and three other objects. **The target object** was manipulated to investigate the effects of changing the referent. In two of the four trials, the target object represented the established meaning of the expression (e.g., yellow plate). These trials allowed participants to keep the pacts. In other two trials, the target object represented a new meaning of the expression (e.g., ball). These trials represented cases where the pact was broken. Other three objects are described in the Table 3. Four experimental scripts were prepared, where the order of four pre-chosen referring expressions paired with four different trials was in a Latin Square design.

Table 3

Objects Used in the Entrainment and Test Phase of the Experiment

The Entrainment Phase		**The Test Phase**				
		Keep Pact		Break Pact		
Target Object	Expression	**Target:** Established meaning	b) Related to established meaning	**Target:** New meaning	c) Related to new meaning	d) Filler object
Green Block	*"Square one"*	Orange Block	Double bridge	Present	Bow	Car
Black Pencil	*"Long one"*	Brown Pencil	Rubber	Straw	Cup	Pig clock
Big Cow	*"Furry one"*	Small Cow	Milk	Dog	Bone	Rubik cube
Pink Plate	*"Round one"*	Yellow Plate	Mug	Ball	Soccer shoe	Blue cross

Note. Each row within the Test Phase represents an array of objects. The order of presented arrays was paired with the counterbalanced order of presented expressions.

In the Entrainment phase, the four objects were presented in a box. Whereas in the Test phase, a handmade theatre was placed between the experimenter and the participant. The theatre was made out of black foam board. It consisted out of a frame (33 x 33 cm) with black curtains and an insertable grid. The grid was arranged in 2 X 2 pattern however, it had an additional square in the middle of the grid. The curtains, which were attached to the frame of the theatre, could be opened with a pull of strings on the left and right-hand-side of the theatre (see Figure 9 below). Apart from the middle square of the grid, other squares were uncovered, so it was possible to see through each square to the other side.

For each pre-chosen referring expression, there was pre-assigned positioning of the objects in the grid. The positioning of the objects ensured that the target objects were at four different quadrants. This balanced participants' possible preferences for specific sides or quadrants.

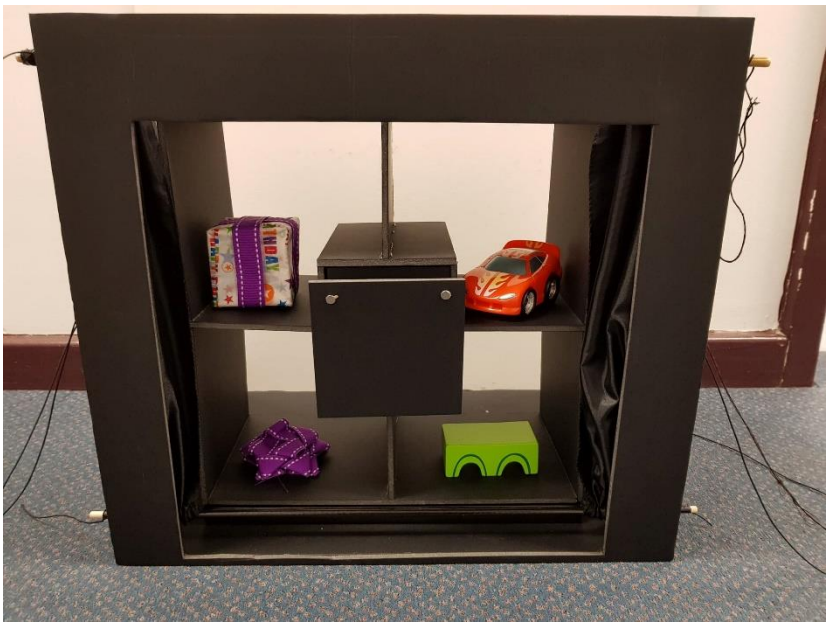


Figure 9. Participant's View of the Theatre. The target toy in this case represents the present which is referred to with an ambiguous expression: "the square one".

3.3.1.4. Procedure

The child and their caregiver were invited to the Kent child development Unit where the caregiver read and signed informed consent forms. Both experimenter 1 (E1) and experimenter 2 (E2) were present to answer any questions and briefly describe the study. This was planned to ensure that the child had met and established contact with both experimenters. After signing the consent form, the child was seated behind a table. There were two cameras used to record participant's reaction time (camera 1 from participant's left hand side) and to capture participant's choice of objects (camera 2 from participant's back).

In the Entrainment phase, E1 explained to the child that the goal of the game was to find the objects she (E1) will refer to. There was an open box on the table that contained (four) objects: a pencil, a pink plastic plate, a plastic cow and a green wooden block. The E1 asked the child to retrieve one of the objects using an ambiguous expression. The order of used ambiguous expressions was counterbalanced in a Latin square design. The ambiguous expression was repeated at least twice. The Entrainment phase lasted until all four objects were correctly picked out of the box.

Following the Entrainment phase, E1 coughed, making clear to E2 to interrupt the experiment. E2 came inside the test room with a phone call for E1. In the same experimenter condition, E1 postponed taking the phone call and continued communication game with the child. In the new experimenter condition, E1 would have taken the call and told E2 that they are about to play the theatre game.

The Test phase of the experiment followed. The experimenter explained to the child that they are going to play the theatre game. The experimenter put a pillow with a board attached to child's lap. The board ensured that child's hands were always in the same position before they picked an object out of the theatre.

The warm-up trial followed to practice the procedure of the game and make sure that the child reached the objects. The experimenter put the theatre on the table. The child was asked to *find the zebra*. As for all the subsequent trials, the experimenter counted to three and opened the curtains of the theatre to reveal the objects. If the child did not try to reach object, they were prompted to touch the zebra.

After the warm-up trial, there were four test trials. First, the experimenter placed the objects according to the prechosen condition while the curtains were closed. Then, the experimenter said: "On three, when I open the curtains, I want you to *find the long*

one." The experimenter repeated the request and opened the curtains. After the child had reached for one of the four objects, the experimented reacted with: "Good!/Well done!". If the child did not pick any object, they were prompted with " Can you find *the long one* for me?". If the child still did not pick anything, the experimenter proceeded with the next trial. The experimenter presented the child with four trials for four pre-chosen referential expressions. The whole procedure lasted for about seven minutes.

3.3.2. Results

Two measures participant's behaviour were obtained – results about participant's choices of objects and the reaction time analysis.

To check whether participants understood the task, their error rates were analysed. Systematic differences in participant's choices of objects depending on different conditions they participated in (same vs. new partner and established vs. new meaning) were examined.

Following the analysis of error rates, reaction time analysis is reported. Since reaction times were coded manually by multiple coders, I also calculated inter-rater reliability. For all the following analysis, only reaction times when participants chose the target objects (established or a new meaning) were used, therefore their performance could be compared. Subsequently, the main analysis which helps to determine whether participants were faster when choosing the established meaning compared to a new meaning, and whether this difference was evident only with the same partner is reported. Mixed effect models are recognised as an appropriate model for the analysis because it takes into account the missing data and considers potential variability between individuals and between different items.

3.3.2.1. Choice of objects

Participant's choices of objects were coded using videos that captured participant's behaviour from their point of view.

The choices of toys were coded as follows:

1) Target object (always suited the ambiguous expression)
2) Object related to established meaning
3) Object related to new meaning

4) Filler object

All the objects that are not considered target object are being referred to as erroneous choices. Children chose the target object in 75.0% of the trials. They chose the target object more likely than any other object in the array (χ^2 (3, N = 183) = 252.000, $p < .000$). I wanted to analyse their choices of objects in more detail and see whether there were any differences in different conditions.

When children did not choose the target item, they chose the item related to the established meaning (5.4%), item related to the new meaning (4.9%), filler item (14.1%), or they did not choose anything (0.5%). I performed a chi-square test to see whether children chose differently in the Same experimenter condition than in the New experimenter condition. There were not any differences in their choices (χ^2 (3, N = 183) = .258, $p = .968$). I performed another chi-square test to examine differences in children's choices when the pact was kept (e.g., children reached for the plate) and when the pact was broken (e.g., children reached for the ball). I found no differences in children's choices (χ^2 (3, N = 183) = .288, $p = .962$).

3.3.2.2. Reaction time

The reaction times were coded as a measure of comprehension of the ambiguous expressions. They represented the length of time it took the participant to retrieve the toy in the trial. The reaction times were only coded for the Test phase of the experiment.

The videos of participants retrieving toys from the theatre were coded using the annotation tool ELAN (Wittenburg et al., 2006). Using videos capturing each participant's hand movement from the left side, the reaction times were obtained. The onset of reaction time was the time point when theatre curtains completely opened and

the end of reaction time was marked as the child's reach into the theatre box, measured as the time point when participant's knuckles crossed the vertical line of the theatre. I as Rater 1, and two research assistants who were blind to experimental questions and conditions, Rater 2 and Rater 3, coded reaction times. All three raters coded 63% of all the trials to establish inter-rater reliability (all coded 116 out of 184 trials). Inter-rater reliability for reaction time was moderate ($ICC_{average}$ =.796, $p < .000$). The reliability suggests there was a minimal amount of coding error by independent coders. In all subsequent analysis, I only included reaction times for trials when children chose the target toy (for 75.0% trials), coded by Rater 1.

3.3.2.3. Analyses

To examine whether reaction times were different when participants reached for a new or the established object and to see whether there were any differences between the same or the new partner, I prepared the data to fit linear mixed-effect model (Bates et al., 2014).

Table 4 reports the mean raw reaction times for correct choices only. The raw data included some outliers, since I did not limit the time in which participants should pick the object. I wanted to address the outliers in the dataset, since mixed-effects models require a normal distribution of data (Singmann & Kellen, 2019).

Trimming and winsorizing have been proposed (Lien & Balakrishnan, 2005) to mitigate the effects of extreme values. Trimming the data means deleting the outliers based on a specific cut-out point, whereas winsorizing means replacing the outliers with expected values. I wanted to give less weight to the outliers so that they would not dominate the distribution however, since the dataset was relatively small, I did not want to delete them. Therefore, I winsorized the reaction time outliers. I replaced the outliers

with reaction times equal to two standard deviations from the mean (Ratcliff, 1993). I winsorized reaction times separately for four conditions: Keeping the pact-Same experimenter, Breaking the pact-Same experimenter, Keeping the pact-New experimenter, Breaking the pact-New experimenter. This procedure was shown to increase the fitting of linear mixed model (Yuliyani et al., 2017). Moreover, to improve model fit I did further analyses with logistic transformations of reaction times, as suggested by Baayen and Milin (2010).

Table 4

Children's Mean Raw Reaction Times (in Seconds) to Retrieve Target Objects

	Keeping the pact		Breaking the pact	
	M	*SD*	*M*	*SD*
Same experimenter	2.540	1.146	2.384	1.236
New experimenter	2.744	1.177	2.523	1.513

In order to examine possible significant predictors of participant's reaction time, I used linear mixed effects model lme4 package of R. The outcome measure of the model was log-transformed reaction time. The model fitting was performed with by-item and by-subject intercepts in the random structure. Pair of trials (First two trials vs. second two trials), experimenter (same vs. new partner), referent (same meaning vs. new meaning) and interaction between experimenter and referent were included as fixed factors within the model. This model was the result of backward selection removing predictors one at a time until the point when removing did not improve the model fit anymore (Baayen et al., 2008). Descriptive statistics for this model are provided in Table 5.

Table 5

Summary of the Converged Final Model Specifying Fixed Effects of a Mixed Liner Model Predicting Children's Reaction Times

Fixed Effects	Estimate	Standard Error	*df*	*t* value	Pr(>|*t*|)
(Intercept)	8.369	0.253	58.378	33.125	**0.000**
Pair of trials	0.044	0.066	92.193	0.664	0.508
Age	-0.014	0.004	35.859	-3.426	**0.002**
Experimenter	-0.010	0.108	75.010	-0.096	0.924
Referent	0.140	0.127	12.199	1.101	0.292
Experimenter*Referent	-0.054	0.132	91.800	-0.411	0.681

3.3.3. Discussion

The results demonstrate that children do not have specific expectations of meaning for a pre-chosen referential expression. Regardless of whether children could adhere to the pact, keeping the established meaning (e.g., reaching for the plate as "round one"), or when the pact was broken and the meaning changed (e.g., reaching for the ball as "round one"), their reaction times did not differ (see Table 5). To substantiate, the analysis of children's choices of referents did not differ when they could adhere to the pact or when the pact was broken. This implies that children are flexible when interpreting the ambiguous pre-chosen referential expressions.

When looking at partner-specific interpretations of pre-chosen referring expressions, mixed effects model did not show a significant influence of partner. That is, children did not show difference in reaction time for choosing the target referent with either the E1 or E2. This means that children's reaction times for choices of referents were not influenced by speakers' previous conceptualisations – whether speaker has

already used the same expression for a specific referent or not. Furthermore, children's choices of referents were not different when performed with E1 or E2. This demonstrates that children do not show sensitivity to partner-specific meaning of a particular referential expression.

Children chose the filler object in 14.1% of trials. This demonstrates that children might have had a difficulty understanding the task. However, research showed that if five to seven-year-olds are unable to identify a unique desired referent, they still tend to pick a referent (B. P. Ackerman et al., 1990). Hence, their choice of filler object could reflect their adherence to the instruction of the experimenter.

Mixed effect model showed a significant influence of children's age. This means that younger children needed significantly longer to reach the target item than the older children did. However, none of the children showed a difference in reaction time between E1 and E2. Therefore, children's partner-specific effects were not evident regardless of their age.

These results show that children followed a more egocentric communicative pattern. Children's responses were not partner specific (Brennan & Clark, 1996; Brown-Schmidt, 2009) but instead, relied on the availability of the most suitable referent regardless of who they were speaking to. It is possible that taking into account the speaker's perspective might develop later, as some of the most recent research claims (Lindsay et al., 2019; Ostashchenko, Deliens, et al., 2019a; Ostashchenko, Geelhand, et al., 2019). This means that taking into account the speaker's perspective might be a consequence of cognitive maturation, or only be observed with more sensitive implicit measures (Graham et al., 2014; Köymen et al., 2014; Ostashchenko, Deliens, et al., 2019a). Some researchers argue that the initial automatic processing in communication

is egocentric, but the perspective is optionally taken into account (Barr & Keysar, 2002). This optional adjustment to the speaker's perspective might only be developed gradually. If partner sensitivity is a process that develops with cognitive maturation, then adults might show a difference in reaction times between E1 and E2.

3.4. Experiment 2

Children's performance has not confirmed my hypothesis. They did not show sensitivity to change of partners they interacted with and also, they did not show sensitivity to change of referential meaning. They correctly chose the target referent in 75.0% of the trials, showing semantic flexibility regardless of the condition they were in. Children's performance shows some understanding of the task, however their choices of referents and reaction times did not inform us about expectations or preferences in such communicational settings.

Consequently, children's behavioural responses reflected an egocentric communicative strategy. If sensitivity to partner specific meaning is a consequence of cognitive maturation, then adults might show different results than children. It is possible that although children show some understanding of other's beliefs and knowledge with the classical theory of mind tasks by the age of five (Wellman et al., 2001), they might not be able to utilise these skills until a later age. If that is true, than testing adults with the same study design would show the difference in reaction times between E1 and E2.

3.4.1. Method

3.4.1.1. Participants

Twenty-eight undergraduates at the University of Kent participated in return for partial course credit (M_{AGE}= 19 years). Two students (7.1%) were male. Eighteen students were native English speakers (64%) and the others were non-native speakers of English. There were 22 Stage 1 students (79%) and 6 Stage 2 students. Participants were randomly divided into two between-participants conditions such that in one condition participants communicated with only one experimenter throughout the

experiment (N=15), and in the other condition participants communicated with two experimenters; a new experimenter replaced the first experimenter in the second phase of the experiment (N=13).

3.4.1.2. Design, materials and procedure

The experiment stimuli, design and procedure was the same as in the Experiment 1. The only difference in the design for adult participants, was implemented in the Test phase. An additional black box was put below the theatre so that the theatre was risen to the participant's eye level.

3.4.2. Results

3.4.2.1. Choice of Objects

Participants chose the target object in 97.3% of the trials. Since only two participants made errors, each in one trial only, I did not analyse whether there were any differences in different conditions. One participant chose an object, related to established meaning (0.9% - chose milk) in a condition with a new experimenter and new meaning of a referential expression. Also, one participant chose an object, related to the new meaning (0.9% - chose a bow) in a condition with the same experimenter and an established meaning of a referential expression.

3.4.2.2. Reaction time

The reaction times were coded in the same manner as they were for Experiment 1. I as Rater 1, and a research assistant who was blind to experimental questions and conditions, Rater 2, coded reaction times. Both raters coded 60.7% of all the trials to establish inter-rater reliability (both coded 68 out of 112 trials). Inter-rater reliability for reaction time was high (Pearsons r = .98, p>.001/ ICC =.98, p>.001). The high reliability suggests there was a minimal amount of coding error by independent coders. In all

subsequent analysis, I only included reaction times for trials when participants chose the target toy (for 97.3% trials), coded by Rater 1.

3.4.2.3. Analyses

Table 6 reports the mean raw reaction times for adult's correct choices only. Following the data preparation as in Experiment 1, I winsorized the reaction time outliers, and did further analyses with logistic transformations of reaction times (Baayen & Milin, 2010).

Table 6

Adults' Mean Raw Reaction Times (in Seconds) to Retrieve Target Objects

	Keeping the pact		Breaking the pact	
	M	*SD*	*M*	*SD*
Same experimenter	1.424	0.976	1.336	0.615
New experimenter	1.224	0.496	1.228	0.373

The linear mixed-effects model fitting was performed with by-item and by-subject intercepts in the random structure. Descriptive statistics for this model are provided in Table 7 on the next page.

Table 7

Summary of the Converged Final Model Specifying Fixed Effects of a Mixed Liner Model Predicting Adults' Reaction Times

Fixed Effects	Estimate	Standard Error	*df*	*t* value	Pr(>|*t*|)
(Intercept)	7.168	0.138	35.486	51.791	**0.000**
Pair of trials	-0.052	0.041	74.745	-1.285	0.203
Experimenter	-0.010	0.120	31.436	-0.079	0.937
Referent	-0.062	0.123	25.236	-0.506	0.617
Experimenter*Referent	0.083	0.081	74.842	1.016	0.313

3.4.3. Discussion

The analysis of reaction times did not show that adults, given the same speaker and same referential expression, have expectations of any particular referents. Firstly, I expected that the participants' reaction time will be longer when reaching for a new meaning compared to when reaching for the established meaning. However, regardless of whether participants could adhere to the pact, keeping the established meaning, or when the pact was broken and the meaning changed, their reaction times did not differ. This does not reflect differences in reaction times that are found when manipulating the expressions (e.g., Kronmüller & Barr, 2015; Metzing & Brennan, 2003) – facilitation when keeping the pact with the original expression, and delay when changing the pact with a new expression. This could mean that manipulation of the referent does not have an equal effect as manipulation of the referential expression. In other words, the results

demonstrate that participants did not show an expectation that the same expression will refer to the same referent. Moreover, adult's choices of referents corroborated with the reaction time analysis. Adults did not make significantly more errors when the pact was broken and the meaning changed.

I also wanted to examine whether adult's expectations of referents were different with the same experimenter compared with the new experimenter. If conceptual pacts are partner-specific, I would expect that the participants will be faster when reaching for the established meaning of the pre-chosen expression, but delayed when reaching for the changed meaning of the pre-chosen expression only with E1. They would not show this difference in reaction times between the established and the new meaning with E2. However, the results indicate that participants do not show any differences in reaction times with E1 or E2.

That means that neither children nor adults took into account the speaker's perspective when interpreting her reference. These results do not confirm the prediction that cognitive maturation results in speaker specific interpretation. It is possible that the new study design, where the referential expression is constant, but meaning of the referential expression is changed, involves different processes than change of the referential expression does. To substantiate on the conceptual triad – the results show that changing the speaker, the expression or the referent might not have equal effects in communication (more is explained in General discussion of this chapter).

Therefore, the results suggest that adults are flexible when interpreting pre-chosen referential expressions. Neither the established meaning, nor the partner who first uttered the expression had a significant effect on the interpretation of the pre-chosen expression.

3.5. General discussion

Both children and adults did not show partner-specific interpretations of specific referential expressions. Their reaction times did not differ when the established meaning was kept compared to when a new meaning was assigned. Children and adults showed semantic flexibility in interpreting the referential expressions. Moreover, neither children nor adults showed sensitivity to communicational partners. The participants did not show expectations that the same partner (E1) should continue using the same expression for the same meaning, but were flexible in changing the meaning with both experimenters.

3.5.1. Lexical properties of pre-chosen referential expressions

The observed flexibility when interpreting meaning might be due to the lexical properties of the pre-chosen referential expressions. The pre-chosen expressions were context independent words (Barsalou, 1982). The expressions were shaped into an adjective-noun syntactic frame (Hall & Moore, 1997, p. 239, e.g., "the round one"), where participant could extend the expression to any new object of a different kind that possessed the same characteristics as were described by the adjective. That created context independent referential expressions. Therefore, participant's interpretation could be guided more by the characteristics of the referents than the category of referents themselves. Indeed, previous research has shown flexibility in extending characteristics to other kind of referents (e.g., "blue one" for a blue square monster or a blue thin monster) for children as young as four (Hall & Moore, 1997). I extended on that finding, showing that not only adults, 4- and 5-year-olds, but also 3-year olds showed flexibility when interpreting expressions denoting specific properties – that is,

participants were equally successful when picking a ball or a plate upon hearing the expression “round one”.

However, I wanted to investigate whether this flexibility would be influenced by the speaker of the initial established meaning. I expected that participants would hesitate to choose a new referent with already established expression, especially when uttered by the same partner (E1). That would indicate that participants are taking into account the partner’s perspective and partners most available and recently used meaning of that expression. That would further reflect on the expectations that are created by conceptual pacts. However, conceptual pacts are defined as temporary conceptualisations of referents (Brennan & Clark, 1996). Yet, in this experimental design, the particular pre-chosen referential expressions were context independent – constant. It might be that these particular lexical properties did not allow the participants to form conceptual pacts. Instead of using ambiguous expressions in adjective-noun syntactic frame (e.g., “furry one” for a cow or a dog), pacts could more likely be formed with more specific referential forms (e.g., “spotty dog” as in Graham et al., 2014).

It is also possible that the contextually independent expressions did not create the need for participants to take speakers’ mutual perspective into account. Although the referential expressions referred to more than one meaning, there was only one object in the array that corresponded with referred properties (e.g., “the long one” – only the straw corresponded with the adjective). These results might indicate that there was no reason to incorporate information about speaker’s perspective. This suggests that an automatic, egocentric phase in interpretation of referential expressions might come first, and is only attenuated in later stages according to speakers’ perspective. This

is known as perspective-adjustment model of interpretation (Keysar et al., 1998, 2000). The model explains that the perspective attenuation is effortful (Shintel & Keysar, 2009).

3.5.2. Memory demands and their influence on conceptual pact sensitivity

In the test phase of this experiment, all the objects in the array were unfamiliar. In other terms – even when the established meaning was kept, another exemplar of the same category was displayed in the test phase (e.g., pink plate in the entrainment phase and yellow plate in the test phase). This reduced the effects of memory (as described in section 3.5.2.), since participants could not just automatically pick the most familiar object. However, since no facilitation was observed in reaction time when participants reached for the established meaning compared to when they reached for a new meaning, I could assume that memory plays an important role in conceptual pact sensitivity. The studies that were manipulating expressions always used same exemplars of referents in the entrainment phase and in the test phase (e.g., Matthews et al., 2010; Metzing & Brennan, 2003). It could be that the facilitation they observed when the same expression was used in both the entrainment and the test phase, actually reflected the memory effects since both the expression and the referent could be cued from short term memory (Ostashchenko, Deliens, et al., 2019a; Shintel & Keysar, 2007).

To expand, these memory effects for the same expression and the same referent were even more emphasized when paired with the new experimenter. Therefore, the reaction time differences between the new experimenter and the same experimenter (e.g., Matthews et al., 2010; Metzing & Brennan, 2003) might have been observed due to difference in memory cues between these two conditions (same experimenter vs. new experimenter). As effects of memory were reduced, showing a different exemplar of the established referent, I could more thoroughly examine managing of speakers'

perspectives and knowledge. If their reasoning in the communication game heavily relied on considering speaker's knowledge and perspective taking abilities, then I should observe differences in participant's reaction times between the same and the new experimenter. However, I did not find such partner-specific effects with adults and children.

3.5.3. Breaking the pact: Changing expressions and changing meanings

If pacts reflect conceptualisations of referents, than any change of conceptualisation (as in this experiment – change of referent), should be reflected similarly as a change in referential expression. That is why I expected to observe similar differences in reaction times if either referential expressions (Matthews et al., 2010; Metzing & Brennan, 2003; Shintel & Keysar, 2007) or referents change. However, the current experiment demonstrates that the relationship between the expression and the referent might not have equal weights. It is possible that listeners pay more attention to the referential expressions than to their meaning when resolving reference.

Furthermore, the research to date has changed the expressions and the partners (e.g., Graham et al., 2014; Matthews et al., 2010; Ostashchenko, Deliens, Geelhand, et al., 2018), but kept the referent constant. It is possible that changing the referring expression causes a delay in response, because it indicates a change of referent (Shintel & Keysar, 2007). Therefore, change of expression indicates change of referent – has additional impact on reference resolution. In the current experimental design however, change of referent has no additional indications.

3.5.4. Further improvements

3.5.4.1. Testing whether the pacts were established

There is a possibility that participants did not establish pacts in the entrainment phase. Previous studies (e.g., Matthews et al., 2010; Metzing & Brennan, 2003) have made sure that the pacts are established by repeating the referential expression a few times in the entrainment phase. The pre-chosen expressions in the current experiment were also repeated at least two times. There is no specific number of repetitions that are required to form the pact (Geurts, 2018). Instead, it is more important that the proposed conceptualization, that is – referring expression with its meaning – is mutually accepted by both the speaker and the listener (Duff et al., 2006; Geurts, 2018). However, it is difficult to test whether the pact is actually established.

Kronmüller and Barr (2015) have already pointed out that referential precedent baseline would help assess whether pact is in fact established. By adding a baseline, where participants would entrain on other pre-chosen expressions, not used in the test phase, I could make inferences about the influence of the established pact and reason if the pacts were in fact established. That could improve the study design.

3.5.4.2. Adding an implicit measure – eye-tracking

As the experimental design in this chapter included interaction with actual objects, I was restricted in the variety of measures I could use. I followed the design of Matthews and colleagues (2010), capturing only children's choices and obtaining their reaction times. However, adding an implicit measure, such as eye tracking, could show additional information that I have not observed with behavioural measures.

Graham, San Juan and Khu (2017) reviewed research on pre-schoolers ability to track perspective of communicative partner to reason about their referential intent.

They found many studies are showing discrepancies between children's behavioural responses and their eye-gaze patterns. In fact, Graham, Sedivy and Khu (2014), who tested pre-school children with the conceptual pact paradigm, only found differences between experimenters when observing children's eye-gaze patterns (see also discussion in Chapter 2). They reported about facilitation when children fixated on the referent upon hearing the entrained expression with the same experimenter in comparison to fixation on the referent with the new experimenter. Therefore, incorporating eye tracking could provide additional insight into participants' thought process.

3.5.4.3. Limitations

Testing both adults and children was one of contributions to the field, because none of experimental designs looking at conceptual pact sensitivity tested the same design with both adults and children. However, creating an experimental design, which is appropriate for both age groups, is challenging. Since children have limited vocabularies, I was limited in what referential expressions I could use. Ideally, I could use homonyms – words that have more than one meaning. Using homonyms would also be more parallel to all the designs where the expressions are manipulated by using synonyms. However, the current experiment aimed to be interactive and use real-live objects, so finding homonyms that I could present as objects in the theatre display was difficult. For example, Garnham W., Brooks, Garnham A., and Ostenfeld (2000) used homonyms such as *nail* - *finger nail* and drinking *glasses* - *eye-glasses*. Although these particular homonyms are familiar to pre-school children, it is very difficult to find 3D objects that would correspond with the meaning. Therefore, I decided to use referential expressions with an adjective-noun form, with avoiding specifying the object.

3.5.5. Conclusion

The findings do not affirm the definition of partner-specific conceptual pacts. Conceptual pacts described as an established relationship between the speaker, the referential expression, and the referent should create preferences for future re-use of that particular relationship. This study however, suggests that the expression and the meaning have different weights in that relationship. This experiment did not demonstrate that listeners take into account speaker's perspective when determining the meaning of an ambiguous expression. It is possible that the pre-chosen adjective-noun phrases might have been too context independent for the listeners to rely on specific speaker's knowledge in their interpretation.

However, this study shows that both children and adults are semantically flexible when interpreting adjective-noun phrases. The results demonstrate that in communication, children as young as three are flexible enough to interpret a meaning of a given expression based on the current communicational context. This study contributes to the existing conceptual pact research. To date, no study has used the same experimental design with adults and children. This adaptation of the experimental design enabled me to observe and compare behavioural responses of both adults and children, showing that children's performance does not significantly differ from adult's performance in comprehending communicative principles as much as research suggests.

CHAPTER 4: CAN CHILDREN TAKE INTO ACCOUNT ARTIST'S KNOWLEDGE AND BELIEF WHEN LABELLING A DRAWING?

The previous chapter explored whether children and adults are sensitive to partner-specific meaning; that is, if listeners are sensitive to a speaker's communicative intent. The results showed that neither adults nor children show sensitivity to change in a particular speaker's communicative intent. Although adults and children did not show the expected results in verbal communication, their sensitivity to partner-specific meaning might be different in communication with drawings. This chapter introduces first steps towards the exploration of the same communication principles, but with drawings.

Communication is intentional – the core of communication is transmitting and understanding intentions (e.g., Grosse, Behne, Carpenter, & Tomasello, 2010; Scott-Phillips, 2015; Tomasello, Carpenter, Call, Behne, & Moll, 2005). However, there is much more going on in conversations. People are taking into account other people's knowledge and beliefs. If John is talking about Mr Musk to Sarah, John has to take into account whether Sarah knows about Musk and his company Tesla or whether she does not (see "mutual knowledge" in Clark & Marshall, 1981). Although these processes seem automatic, they require a lot of skill and coordination for communication to run smoothly (H. H. Clark & Brennan, 1991).

Although the main symbolic system for communication is verbal language, communication also uses gestures, icons and drawings (Peirce, 1965; Uttal & Yuan, 2014). In this chapter, I begin exploring how drawings can be used for communicative purposes and whether viewers can understand drawings as intentional symbols. In

particular, I investigate whether viewers can reason about artist's mental states, as they do in language.

Language development and understanding other's mental states have been shown to be connected (Brennan et al., 2010; Milligan et al., 2007). Therefore, using communicative symbols to understand communicative acts requires some level of mental state reasoning (e.g., Moore, Liebal, & Tomasello, 2013). Consequently, investigating whether viewers can reason about the artist's mental state is necessary for further investigation of drawings as communicative symbols.

4.1. Introduction

Studies considering artist's mental states, such as knowledge and belief when labelling their drawings has been scarce (e.g., Browne & Woolley, 2001; Richert & Lillard, 2002). Although there were some tasks attempting to examine reasoning about artist's knowledge when labelling a drawing (Browne & Woolley, 2001; Richert & Lillard, 2002), their tasks were complex and suggestive when asking about the drawing's label (see also Chapter 1, section 1.4.). There were also some studies examining belief understanding using signs (S. Leekam et al., 2008), photographs (Zaitchik, 1990), drawings (Charman & Baron-Cohen, 1992) and even ambiguous figures (Gopnik & Rosati, 2001), but none of them required understanding of artist's mental state for correct interpretation. Therefore, this chapter presents two tasks (understanding artists' knowledge and belief) that address the issues in previous studies and test whether children can take into account the artist's knowledge and belief when labelling their drawing.

4.1.1. Understanding artist's knowledge state

Understanding knowledge means understanding that access to information leads to knowledge (H. Wimmer et al., 1988). Previous tasks exploring children's

understanding of artist's knowledge have presented children with hypothetical situations (Browne & Woolley, 2001; Richert & Lillard, 2002). Characters in the stories were ignorant about the existence of conventional objects (e.g., "Luna doesn't know what lollipops look like"), but produced drawings that looked similar to the unknown objects (e.g.,Luna drew a drawing of a balloon that looks like a lollipop). Children were asked to label the character's drawing. In this conflicting situation Browne and Wooley (2001) found that some seven year olds were successfully labelling the character's drawing based on her knowledge (e.g.,she drew a balloon), but Richert and Lillard (2002) showed that even eight year olds incorrectly reasoned that the character drew the object she does not know of.

These results are not in line with studies that show that children can understand knowledge between their third and fourth birthday (Bradmetz & Bonnefoy-Claudet, 2003; Harris et al., 2017; Hogrefe et al., 1986; H. Wimmer et al., 1988). It seems like although children can already show some understanding of knowledge states at around three, they can not reason about artist's knowledge when labelling a drawing before they are seven.

4.1.1.1. Current knowledge understanding task with drawings

Since the mentioned tasks with drawings presented children with suggestive scripts and unconventional situations, it is possible that the tasks required more than just understanding of the artist's knowledge. In order to address this potential shortcoming of previous experimental designs, the current study included a less demanding task with drawings where children would have to use their understanding that informational access leads to knowing in order to correctly label the artist's drawing. Parallel to some verbal tasks of knowledge understanding, I designed a story

where a character either sees two cars (red and blue - knowledgeable) or only sees one car (red - ignorant). Regardless of the condition, the character produces a black and white drawing of a car. Depending on the character's knowledge, the car can be labelled either as "red" (when the character sees one car) or both "red" or "blue" (when the character sees both). If children do take into account the character's knowledge, then they should label the drawing as "red" more often when this was the only car the character saw. Labelling the character's drawing of a car according to character's perceptual experience could reflect on children's understanding of knowledge state of the artist.

I added a control group of adults to test whether children show an adult-like understanding of artist's knowledge when labelling her drawing. Adults were shown to take into account the artist's intent and knowledge when interpreting artist's drawing (Browne & Woolley, 2001), thus I expected adults to be successful when labelling Jessica's knowledge according to her knowledge state.

4.1.2. Understanding belief

One of the most common tasks used for evaluating when children understand other's belief is the unexpected contents task (Perner et al., 1987). The unexpected contents task is based on a procedure that uses a familiar box, like a box of Smarties. Although the children expect the box to contain the usual contents, like the round chocolate candy, there are unexpected items in the box such as straws. The children are then asked a series of questions involving their own initial false belief ("What did you think was in the box before you looked inside?"), another's false belief ("What will <name of friend> think is in here?") and a control question ("Can you remember what's inside here?") (Hogrefe et al., 1986; Perner et al., 1987). If children can reason about

false belief, they will inhibit their own knowledge about the unexpected items in the box (straws), and attribute false belief (Smarties chocolate candy) to an ignorant person, who has not seen inside the box. However, if children cannot yet attribute false belief to another person, they will make egocentric judgements, attributing their own knowledge of the true contents (straws) to an ignorant person. A meta-analysis showed that children's ability to correctly attribute false belief develops between three and five years of age (Wellman et al., 2001).

The false drawing task (H. Wimmer & Perner, 1983), which was aimed to be an equivalent of false-belief understanding measure, was one of the only tasks investigating children's false belief understanding with a drawing. In the task, the experimenter made a drawing of an object and put the drawing away. The drawn object was then replaced with a new object. The children were asked which object was drawn. Four-year-olds correctly answered this question, even when they did not answer correctly on the usual false belief task. The authors attributed the children's slightest better performance in the false drawing task to different manner of asking about false belief - the physically represented belief (with a drawing) in the false drawing task in contrast with the usual false belief question ("What did you think was in the box before you looked inside"). However, the drawing did not misrepresent the current reality, as false belief should, but served as a memory cue of the previously seen object in the false drawing task. Therefore, the drawing did not represent the artist's false belief, but the correct representation of the past state.

To summarise, the false drawing task (H. Wimmer & Perner, 1983) was one of few attempts where researchers tried to use physical representations to assess false belief understanding (for other tasks see also Leekam et al., 2008; Zaitchik, 1990).

However, none of these tasks used a physical representation as the expression of the artist's mental state. Therefore, I created a task where the correct interpretation of the artist's drawing would require understanding of artist's (false) belief.

4.1.2.1. Current (false) belief understanding task with drawings

The current task was based on the usual unexpected contents task (Hogrefe et al., 1986; Perner et al., 1987) and involved a Smarties tube. However, the usual procedure was adapted to allow for a more comprehensive evaluation of the artist's belief.

4.1.2.2. Adaptations of the usual Unexpected contents task

Since research shows (Rubio-Fernández, 2019; Rubio-Fernández & Geurts, 2013, 2016) that focusing on a narrative makes it easier for participants to track a character's perspective, the participant did not guess what was inside the Smarties tube, but instead, listened to a narrative. The task presented a narrative about one character, named Jessica, and, depending on the condition, allowed children to actively participate and explore the used materials.

Moreover, since the usual task creates a focus on the unexpected contents (seeing the unexpected contents), but offers no physical representation of the initial belief, children can be biased towards the incorrect response (the unexpected contents). Some studies tried to make answers equally salient – responding based on own knowledge (unexpected contents) or responding based on false belief (Smarties) (Freeman & Lacohée, 1995; Rubio-Fernández, 2019; Rubio-Fernández & Geurts, 2016; Zaitchik, 1990) – and found that children in these adapted tasks can reason about false belief earlier than with the usual procedure. The present study adapted the usual procedure in a relatable manner – the character produced a drawing of what is inside

the Smarties tube at the end of the narrative. Therefore, this made answers equally salient – children could respond based own knowledge (unexpected contents) or responding based on false belief (character's drawing as a physical expression of her belief).

The drawing was ambiguous, so labelling it did not require a dichotomous response, based on true or false belief, but whatever participants thought the character intended to draw. If participants took into account the character's knowledge and belief (see different conditions described below), they should label the drawing accordingly. The ambiguous drawing ensured that there was no particular bias for either the correct or the incorrect answer, as that is one of the difficulties in the usual false belief tasks (Rubio-Fernández, 2019; Rubio-Fernández & Geurts, 2016).

4.1.2.3. Conditions in the current (false) belief understanding task

The narrative in the present task described a character Jessica who saw a Smarties tube. Depending on the condition, the participant and the character either had matching beliefs about the contents of the tube (they both looked, or neither of them did), or their beliefs were different (the participant looked but the character did not). Regardless of the condition, the character drew what is inside the Smarties tube at the end of the narrative. The participants were asked to label the character's drawing.

By manipulating participants' and characters' belief and knowledge, four conditions were designed (see Table 8 below). The aim of the study was not only to test participants' performance to chance on each condition (Wellman & Liu, 2004), but also to make pairwise comparisons between conditions (Buttelmann et al., 2014; Kulke et al., 2018). Pairwise comparisons were included to examine participants' underlying reasons for their performance.

Table 8

Four Conditions in the Belief Understanding Task

Conditions	Participant's belief	Jessica's belief
True belief	 *	 *
Matching shape false belief	 *	
Nonmatching shape false belief	 *	
Non-informed belief		

Note. The asterisk indicates information access.

The first aim was to explore whether participants are differentiating when the character has a false belief compared to when the character possesses a true belief. In the a) *true belief* condition, both the participant and the character looked inside the Smarties tube and found pennies – therefore, they both had a true belief about the contents of the tube. In the b) *matching shape false belief* condition, only the participant looked inside the Smarties tube and found pennies, so the character had a false belief. The only difference in these two conditions was the character's belief (true vs. false). Therefore, the difference in participant's responses (Smarties vs. pennies) when labelling the character's drawing reflects on participant's ability to differentiate between character's true and false belief. However, if participant's responses in these two conditions do not differ, that would indicate participants' egocentric reasoning. That is, participants would be answering based on their knowledge of what is inside the Smarties tube.

The next aim was to explore how participants' form of knowledge influences the understanding of character's belief. To examine that, I added the c) *nonmatching*

shape false belief condition, where only the participant looked inside the Smarties tube and found nothing, so the character also had a false belief. I wanted to compare the c) *nonmatching shape false belief* condition to the b) *matching shape false belief* condition, since the only difference between these two condition was participant's knowledge of what is in the tube. A fully developed understanding of false belief would not result in differences in participant's responses in these conditions, since the character's belief is false in both (she thinks there are Smarties inside). However, research claims (Wellman et al., 2001) that children are more likely to correctly reason about a false belief if their knowledge about the contents is not present (the Smarties tube is empty). That is, it is possible that participants would answer differently, because the difference between reality (participant's knowledge) and mental-state content (character's false belief) is more salient in the c) *nonmatching shape false belief* condition.

Finally, to add a condition that would measure participant's baseline expectations of what is in the Smarties tube, I added the d) *noninformed belief* condition, where neither the participant nor the character looked inside the Smarties tube. Therefore, both the participant and the character had the matching belief of the expected contents in the tube.

To examine further whether participants' reasoning is egocentric or sensitive to character's belief, I compared participant's responses in the d) *noninformed belief* condition and c) *nonmatching shape false belief* condition. The only difference between these two conditions was participant's knowledge state – the participant had the knowledge there was nothing inside in the c) *nonmatching shape false belief* condition, but did not have perceptual access (was ignorant) in the d) *noninformed belief* condition. Therefore, if participants can take into account the character's belief, their responses in

the two conditions should match. If however, participants' responses are egocentric, participants should be more likely to answer correctly (Smarties) when they have no perceptual access to the Smarties tube and their belief matches character's belief.

I expected the *matching shape false belief* condition to be the most difficult task, since the false belief of the character ("Smarties inside") and true belief of the participant ("pennies inside") match in shape. Therefore, participants could label the drawing according to both their true belief and the character's false belief.

4.1.2.4. Expectations of adult control group

An adult sample was included to confirm that understanding beliefs of others is a direction towards which children are presumably heading. Since the usual studies evaluating understanding of false belief (unexpected contents, change of location) show that adults perform at ceiling (Coburn et al., 2015), I was also expecting adults to show understanding of Jessica's belief when answering a typical question ("What does Jessica think is inside the tube?"). However, I had no specific predictions how adults will label Jessica's drawings. Although adults have been shown to take into account artist's intent and knowledge when labelling her drawing (Browne & Woolley, 2001), no study to date explored whether adults can reason about artist's other mental states, such as beliefs, when labelling their drawing. Moreover, different conditions in the Belief understanding task enabled me to evaluate adult's belief understanding with more sensitivity, seeking for potential difficulties in understanding of Jessica's belief.

4.2. Method

4.2.1. Participants

One hundred and thirty-three children were individually tested (M_{AGE}= 4 years 6 months, SD_{AGE}=10 months, see more information in Table 9). There were 64 girls and 69 boys. The children were tested in local schools and nurseries near Canterbury and in the Kent Child Development Unit.

Table 9

Demographical Information About Participants

	M_{AGE} (months)	SD_{AGE} (months)	N_{BOYS}	N_{GIRLS}	N_{TOTAL}
3-year olds	42.33	3.43	26	16	42
4-year olds	54.06	3.46	25	25	50
5-year olds	66.29	3.71	18	23	41

As a control group, 53 undergraduates at the University of Kent participated (M_{age} = 18.96 years, SD_{AGE}=0.99). There were 47 women (88.68%) and six men included. The adults were tested in the Kent Child Development Unit at University of Kent in exchange for course credits.

4.2.2. Materials

There were two main tasks used in the study: the Knowledge understanding task and the Belief understanding task. A small plastic figurine named 'Jessica' was used as the main character in both tasks (see Figure 11).

4.2.2.1. Knowledge understanding task

A small model of town was made from cardboard and foam paper. The model included three houses and two roads each with a zebra crossing (see Figure 10). One of

the houses had a removable roof so the figurine of Jessica could be put inside to illustrate when she was in a grocery shop. Two toy cars, red and blue, were also used in the story. A laminated pencil drawing was used to represent either the blue or the red car (see Figure 14).

Figure 10. The Model of Jessica's Town.

Note. This photo is taken from participant's point of view of the town while the story was being told. The building on the far right-hand side was used as the grocery shop.

4.2.2.2. Belief understanding task

For the belief understanding task, a small brown desk was made from carton, to create the school environment. A small book (1 x 1 cm) was made out of hard paper to symbolize a notebook for Jessica's homework. A Smarties box (a box which usually contains chocolate candy) was used in the story (see Figure 11). The Smarties box contained pennies or was empty, depending on the condition. A laminated pencil drawing of circles was used depicting pennies or Smarties.

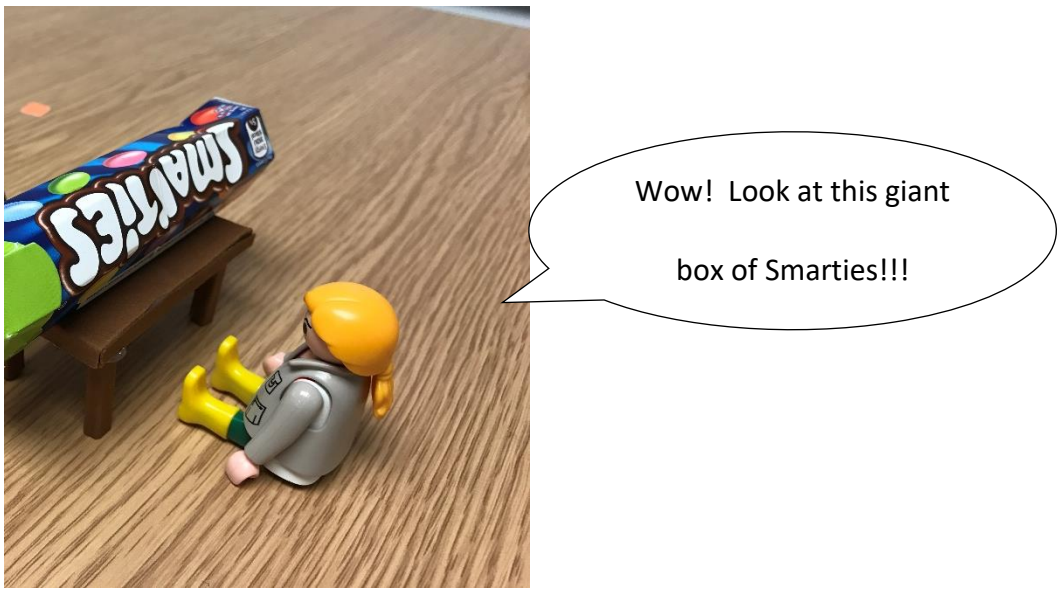


Figure 11. Figurine Jessica Behind the Cardboard Desk with Smarties Tube.

4.2.3. Procedure

The participant and the experimenter were seated facing each other. The experimenter told the participant two stories about a character named Jessica, while moving the character through the scene. All participants heard both the Knowledge Understanding task and the Belief task, in counterbalanced order. The whole session lasted approximately five minutes.

4.2.3.1. Knowledge understanding task

Participants were presented with the small model of a town, and a story in which Jessica went shopping. While she was waiting at the zebra crossing, Jessica saw one car (the red or blue car, counterbalanced across participants). The experimenter moved the car through the model of the town (see Figure 12) as she told the story. From this point in the story, Jessica's experience differed according to condition.

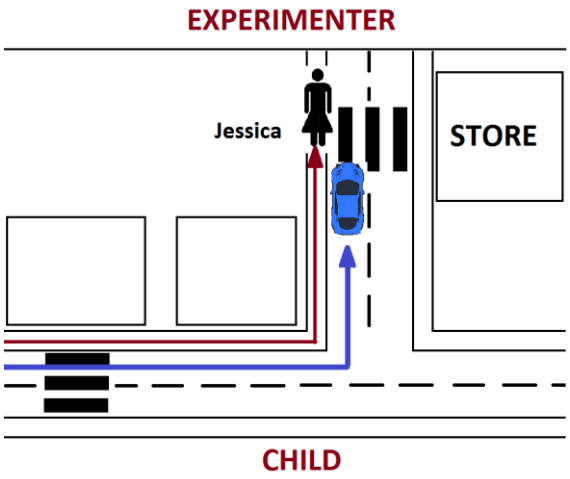


Figure 12. Character Jessica Always Sees One Car Before Visiting the Store.

a) If Jessica was **knowledgeable**, she went into the store. After she was finished shopping, she left the store and saw the second car (e.g., red car) passing through the city (see Figure 13).

b) If Jessica was **ignorant**, she went into the store to do shopping. While she was shopping, the second car passed through the city and was seen by the participant only. Jessica did not see the second car (see Figure 13).

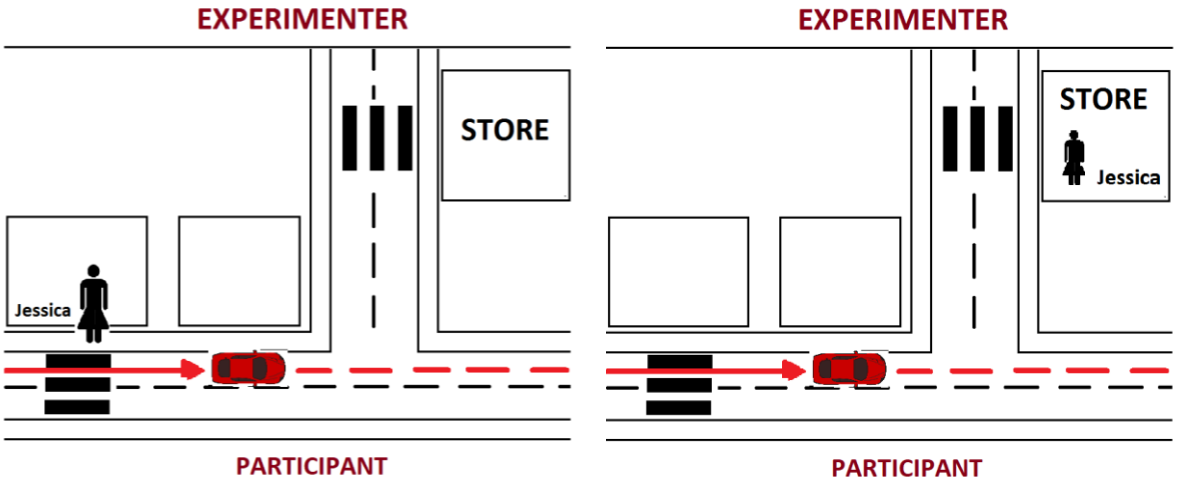


Figure 13. Character Jessica is Knowledgeable (sees the second car) on the Left and Jessica is Ignorant (does not see the second car) on the Right.

In both conditions, the story continued with, Jessica going home and making a drawing of the car she had seen. The experimenter moved the figurine of Jessica out of the child's visual field and took a few seconds as if Jessica was drawing the car. The experimenter showed the participant the drawing (see Figure 14) and asked two questions.

To evaluate participant's understanding of Jessica's drawing: ***Drawing question:*** "Here is Jessica's drawing. Which car did Jessica **draw**?"

To evaluate participant's understanding of Jessica's knowledge state***: Perceptual access question***: "And which car did Jessica **see** today?"

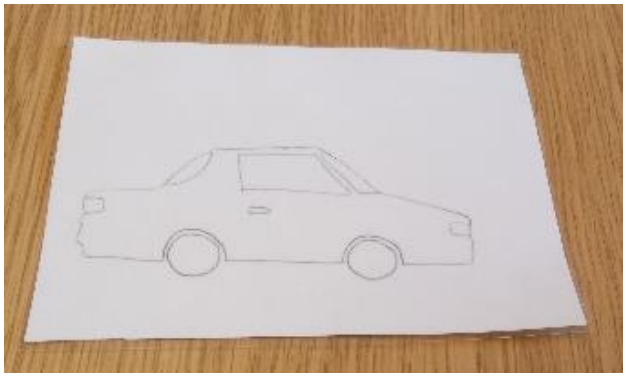


Figure 14. Laminated Black and White Drawing of a Car.

4.2.3.2. Belief understanding task

Experimenter put the model of the town to the side and told a story about when Jessica was at school. In this story, while Jessica was sitting at the desk, she noticed a Smarties tube (see Figure 11). Depending on the condition, the narrative continued:

Table 10

Descriptions with Scripts for Four Different Conditions in the Belief Understanding Task

Script	Storyline	Condition
"Jessica doesn't look inside, but she wants to see. She wants you to help her look inside the Smarties tube." The experimenter takes the Smarties tube and passes it on to the participant. The participant and Jessica look inside the tube and notice **there are pennies inside**. "Look, there are pennies inside!"	Jessica and the participant look inside the tube and find **pennies**.	*True belief*
"Jessica doesn't look inside. Instead, she starts doing her homework. Do you want to see what is inside the box while she is busy doing her homework?" The experimenter takes the Smarties tube and passes it on to the participant. The participant looks inside the tube and notices **there are pennies inside**. "Ok, let's put the box back to Jessica. She is still busy doing her homework."	Only the participant looks inside the tube and finds **pennies**.	*Matching shape false belief*
"Jessica doesn't look inside. Instead, she starts doing her homework. Do you want to see what is inside the box while she is busy doing her homework?" The experimenter takes the Smarties tube and passes it on to the participant. The participant looks inside the tube and notices **there is nothing inside**. "Ok, let's put the box back to Jessica. She is still busy doing her homework."	Only the participant looks inside the tube and finds **nothing**.	*Nonmatching shape false belief*

"Jessica doesn't look inside."	**Nobody looks** inside the tube.	*Noninformed belief*

In all conditions, the story continued with Jessica's drawing "what is inside the Smarties tube". The Experimenter moved the figurine of Jessica out of child's visual field and took a few seconds as she would be drawing the contents of the Smarties box. The experimenter showed the child the laminated drawing (see Figure 15) and asked three questions.

To evaluate participant's understanding of artist's drawing: ***Drawing question***: "Here is Jessica's drawing, what has she **drawn**?"

To evaluate participant's understanding of Jessica's belief: ***Belief question***: "What does Jessica **think** is inside the Smarties tube?"

To control whether participants had the correct memory of the current Smarties tube contents: ***Control question***: "What is actually inside the Smarties tube?"

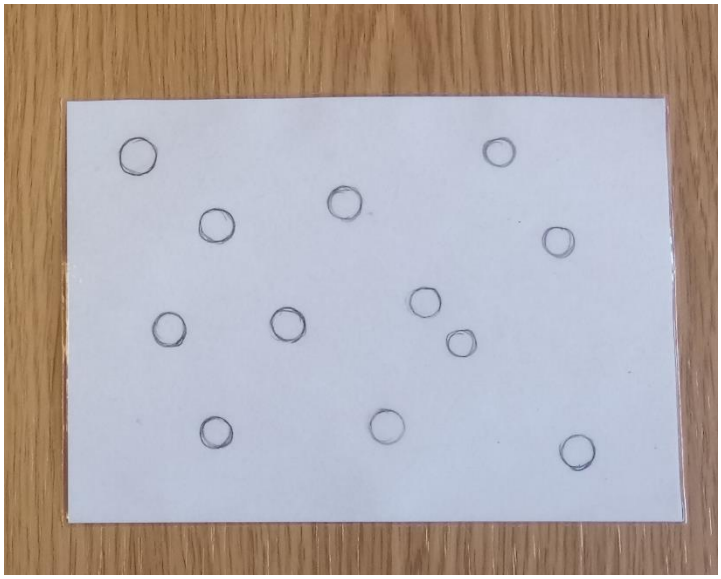


Figure 15. Laminated Black and White Drawing of Pennies/Smarties.

4.3. Results

4.3.1. Knowledge understanding task

To analyse participants' answers in the Knowledge understanding task, participants were given a score of one for each correct answer (see Table 11 below). Participants could receive one point for the drawing question, and a further point for the perceptual access question.

Table 11

Coding Participants' Answers in the Knowledge Understanding Task

Condition	Questions	CORRECT
Jessica saw two cars (Knowledgeable)	Which car did Jessica draw? (*Drawing question*)	Red/Blue
	Which car did Jessica see? (*Perceptual access question*)	Red/Blue/Both
Jessica saw one car (Ignorant)	Which car did Jessica draw?	Red/Blue (depending on the condition)
	Which car did Jessica see?	Red/Blue (depending on the condition)

4.3.1.1. Participants' sensitivity to artist's knowledge

When Jessica was knowledgeable, only one child labelled the car on the drawing as "green" and only one adult answered the drawing question incorrectly (Did not know how to label the car on the drawing.) (see Table 12).

Table 12

Participant's Answers as the Proportion of Trials within Conditions (Jessica Knowledgeable and Jessica Ignorant)

		Children			Adults	
	Jessica's knowledge state	Correct	Incorrect	Missing	Correct	Incorrect
Drawing question	Knowledgeable (%)	92.5	1.3	6.3	96.9	3.1
	Ignorant (%)	67.9	26.4	5.7	95.2	4.8
Perceptual access question	Knowledgeable (%)	93.8	1.3	5	100	
	Ignorant (%)	66	28.3	5.7	90.5	9.5

Results for the Perceptual access question were similar. Only one child answered the Perceptual access question incorrectly (Said Jessica saw a "white" car), but all adults answered the *Perceptual access question* correctly when Jessica was knowledgeable. Since there were only individuals who answered some questions incorrectly in the case when Jessica was knowledgeable, I only perform binomial tests in the condition when Jessica was ignorant.

The binomial test confirmed that children were significantly better than chance at labelling the drawing correctly (p=.003) and at answering the Perceptual access question correctly (p=.007). Similarly, the binomial test confirmed that adults were significantly better than chance at labelling Jessica's drawing correctly (p<.001) and at answering the *Perceptual access question* correctly (p<.001). Collectively, the findings demonstrate that all age groups were capable of reasoning about the artist's ignorance.

In both stories, the character Jessica always saw the first car, regardless of whether she was knowledgeable or ignorant of the second one. If participants are basing

their labels on Jessica's knowledge, then they should label the drawing as the colour of the first car more often when this was the only car she saw (*Ignorant condition*), than when she saw both cars (*Knowledgeable*). The children reported the colour of the drawn car as corresponding to the first car significantly more often when Jessica was ignorant (70.00%) than when she was knowledgeable (40.54%, $\chi 2$ (1, N = 124) = 10.383, p<.001)[2]. Therefore, children were basing their labels on Jessica's knowledge. Similarly, adults reported the colour of the drawn car as corresponding to the first car significantly more often when Jessica was ignorant (95.24%) than when she was knowledgeable (58.06%, $\chi 2$ (1, N = 52) = 8.793, p<.001)[3].

4.3.1.2. Did participants answer differently when naming the drawing and answering the question about what did Jessica see?

As previously, only the results of the Ignorant condition were used in the next analysis. When comparing children's responses on the *Drawing questio*n and *Perceptual access question*, McNemar's test showed that neither children (N=50, p=1.000) nor adults (N=21, p=1.000) answered differently, suggesting that labelling of the drawing reflected their understanding of Jessica's knowledge state.

4.3.1.3. Were there any differences in children's answers by age?

To investigate whether children could reason about Jessica's ignorance equally well in all age groups, responses were divided by age and their performance compared. Since the condition when Jessica was knowledgeable was intended as a control

[2] When children's responses were examined for each colour car separately, the same pattern was found for both the blue car (χ^2 (1, N = 69) = 3.795, p = .051) and the red car (χ^2 (1, N = 64) = 6.557, p = .010).

[3] When adult's responses were examined for each colour car separately, the same pattern was found for both the blue car (χ^2 (1, N = 25) = 4.738, p = .030) and the red car (χ^2 (1, N = 27) = 4.538, p = .033).

condition, the comparison by age was only done for the ignorant condition. When children were labelling a drawing, there were no differences between three-, four- and five-year-olds (χ^2 (2, N = 50) = 1.554, p = .460). Moreover, there were no significant differences in children's responses to the Perceptual access question when comparing three-, four- and five-year olds (χ^2 (2, N = 50) = .680, p = .712).

4.3.2. Belief understanding task

4.3.2.1. Reality control question

To confirm that participants followed the story and recalled the true contents of the Smarties tube, answers to the control question were analysed. The control question was posed in all conditions except in the *Noninformed belief condition.* The majority of children (79.25%) answered the control question correctly. Only 7.55% (*N*=8) children answered incorrectly and 13.21% (*N*=14) children did not answer that question. The majority of missing answers came from three-year-olds (*N*=9). Following previous research (e.g., Callejas et al., 2011; Sabbagh et al., 2006), children with missing and incorrect answers (*n* = 22) were excluded from further analysis reducing the sample to 111 children. All the further analysis was conducted with the reduced sample of children, who had the accurate memory of what was inside the Smarties tube or participated in the *Noninformed belief condition*. All adults, however, answered the control question correctly, and were therefore included in all further analyses.

4.3.2.2. Analysing two critical questions

To analyse participants' answers in the Belief understanding task, participants were given a score of one for every time they answered "Smarties" and a zero for any other answer (e.g., "I don't know", "Pennies", "Bubbles", "Circles"). Participants could receive one point for the Drawing question and a further point for the Belief question.

The answer “Smarties” was the correct answer in all conditions except for the *True belief* condition (when the correct answer was “pennies”).

Firstly, binomial tests for each condition were used to evaluate whether participants were more likely to say “Smarties” than any other answer. Next, pairwise comparisons, as discussed in the introduction of this chapter were conducted to examine children’s understanding of belief more gradually. The analysis looking at children’s responses by age was not performed because of too small numbers of children in each of the conditions.

4.3.2.3. Binomial tests

To determine whether children and adults labelled the drawing more likely as “Smarties” than used any other label, binomial tests were conducted separately for each condition. Since the answer “Smarties” was correct in all conditions expect for the *True belief condition*, binomial tests were not performed for that particular condition (see Table 13 on the next page).

Table 13

Binomial Tests Exploring Whether Participants Used Answer "Smarties" More Often Than any Other Answer

	Drawing question		Belief question	
	Answer "Smarties" (%)	Binomial test	Answer "Smarties" (%)	Binomial test
	Children			
Matching shape false belief condition	45	0.832	45	0.832
Non-matching shape false belief condition	79	**0.019**	63	0.359
Non-informed belief condition	61	0.405	67	0.152
	Adults			
Matching shape false belief condition	64	0.549	100	**.001**
Non-matching shape false belief condition	80	0.109	100	**.001**
Non-informed belief condition	91	**.012**	100	**.001**

The only condition when children showed understanding of Jessica's belief was when they labelled her drawing in the *Non-matching shape false belief condition* (see Table 13). That is, when children knew there was nothing inside the Smarties tube, but Jessica thought there were Smarties inside. On the contrary, adults correctly labelled Jessica's drawing only in the *Non-informed condition* – when neither Jessica nor themselves looked inside (see Table 13).

Children did not answer the belief question correctly in any of the conditions (Table 13), but adults correctly reasoned about Jessica's belief when answering the Belief questions in all three conditions (see Figure 17).

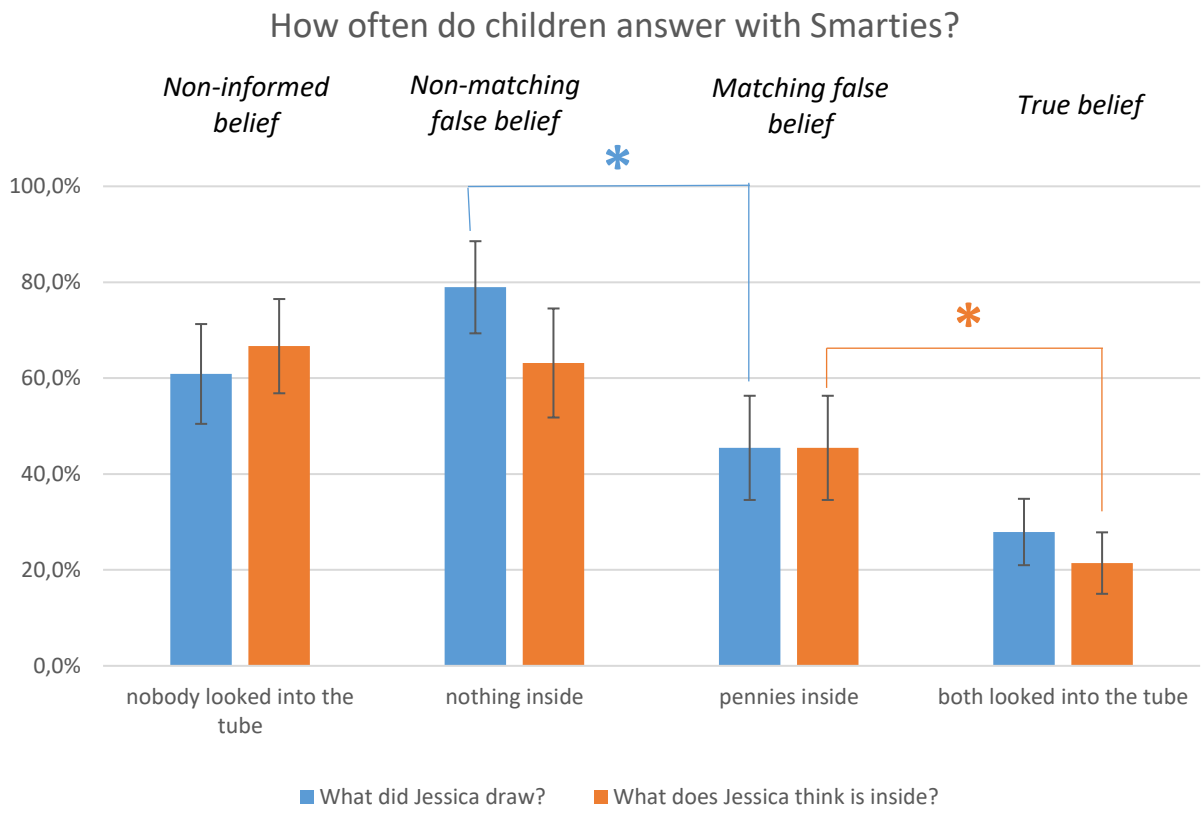


Figure 16. Proportion of Children Answering "Smarties" for All Four Conditions.

4.3.2.4. Comparing True belief and Matching shape belief conditions (A)

To explore whether participants are differentiating when the character has a false belief compared to when the character has a true belief, *True belief* and *Matching Shape false belief* conditions were compared (see A in Table 14). Children labelled the drawing as "Smarties" equally likely in both conditions (χ^2 (1, N = 65) = 2.001, p = .157, see Figure 16), however, their responses on the Belief question differed between conditions (χ^2 (1, N = 64) = 3.993**,** p = .046). That means children did not show sensitivity to Jessica's (false) belief when labelling a drawing, but only when answering the belief question. Adults, on the other hand, differentiated between two conditions when labelling Jessica's drawing (χ^2 (1, N = 32) = 13.345, p <.001) and when answering the Belief question (χ^2 (1, N = 32) = 16.762, p <.001). Together, the results showed that adults can differentiate between Jessica's true and false belief when labelling her drawing and

when answering the Belief question however, children only showed sensitivity to Jessica's belief when answering the Belief question.

Table 14

Scheme of Pairwise Comparisons of Conditions In the Belief Understanding Task

Condition	*Non-informed belief*	*Non-matching shape false belief*	*Matching shape false belief*	*True belief*
Jessica	Thinks 	C Thinks 	B Thinks 	A Sees 
Participant	Thinks 	Sees 	Sees 	Sees 

4.3.2.5. Comparing Non-matching and Matching shape false belief conditions (B)

To test whether participants took into account Jessica's false belief regardless of their own knowledge state, performance in the *Matching shape false belief condition* was compared with performance in the *Non-matching shape false belief condition* (see B in Table 14). Children took into account Jessica's false belief more often when they saw that the Smarties box was empty compared to when it contained pennies, χ^2 (1, *N* = 41) = 4.806, ***p* = .028**. However, when children answered the Belief question, they were equally likely to answer that Jessica thinks that "Smarties" are inside the tube in both conditions, χ^2 (1, *N* = 41) = 1.285, *p* = .257. On the contrary, adults labelled the drawing as "Smarties" equally often in both conditions, χ^2 (1, *N* = 21) = .687, *p* = .407, and answered the Belief question equally often as "Smarties" in both conditions, χ^2 (1, *N* = 21) = .048, *p* = .827. That means adults took into account Jessica's false belief into account regardless of what their knowledge was.

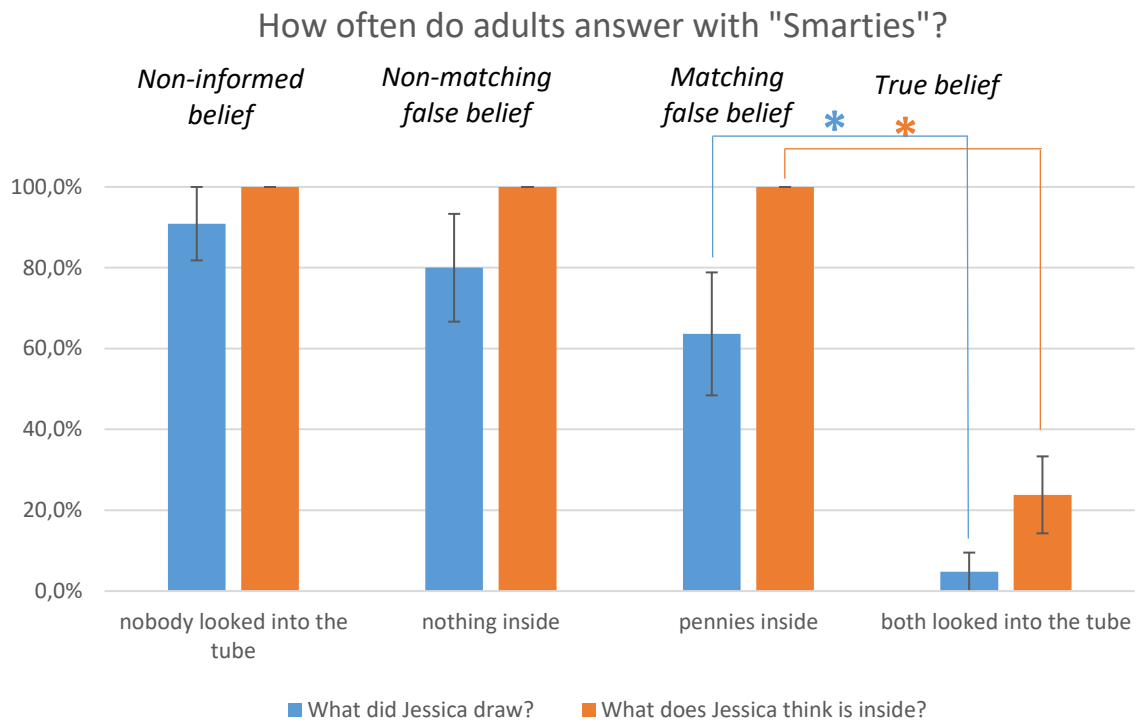


Figure 17. Proportion of Adults Answering "Smarties" for Each of the Four Conditions.

4.3.2.6. Comparing Non-informed belief and Matching shape belief conditions (C)

To test whether participants took into account Jessica's false belief regardless of their knowledge or ignorance about the contents of the Smarties tube, performance in the Non-m*atching shape false belief condition* was compared with performance in the *Non-informed belief condition* (see C in Table 14). Children labelled the drawing as "Smarties" and answered the Belief question with "Smarties" equally likely in both conditions (Drawing question: χ^2 (1, N = 42) = 1.591, p = .207, Belief question: χ^2 (1, N = 43) = 0.057, p = .811). Likewise, adults responses did not differ between conditions (Drawing question: χ^2 (1, N = 21) = .509, p = .476, Belief question: χ^2 (1, N = 21) = .048, p = .827). This means that both children and adults were not egocentric and were sensitive to Jessica's belief, regardless of whether they themselves were ignorant or knowledgeable about the contents of the tube.

4.3.2.7. Are there any differences in responses on the Drawing question and the Belief question?

To test whether participants' labels of Jessica's drawing reflected participant's understanding of Jessica's belief, I compared their answers on the Drawing question and the Belief question. A McNemar test showed that the children responded "Smarties" equally often in both questions, $p = .596$ (2 sided). Children's answers matched in both questions in 42% trials (N=106) – children answered both with "Smarties". These results demonstrate that for children labelling a drawing was an equally good measure of understanding Jessica's belief as it was asking children about Jessica's belief (see Figure 16). On the contrary, adults answered "Smarties" more times to the Belief question than to the Drawing question, $p < .001$ (2 sided) (see Figure 17).

4.4. Discussion

4.4.1. Knowledge understanding task

Three, four and five-year-old children all correctly labelled the ambiguous drawing according to Jessica's knowledge state. That means children were successful at applying their skills of reasoning about other's knowledge when interpreting Jessica's drawing. This contrasts with previous findings which concluded that children do not correctly label the character's drawing based on her knowledge before the age of seven or eight (Armitage & Allen, 2015; Browne & Woolley, 2001; Richert & Lillard, 2002). This study showed that children can reason about the artist's knowledge sooner. In fact, the results from the current study overlap with the results of studies that show that perceptual access leads to knowledge around children's third or fourth birthday (Bradmetz & Bonnefoy-Claudet, 2003; Harris et al., 2017; Hogrefe et al., 1986; H. Wimmer et al., 1988).

There are several reasons why the results of the current knowledge understanding task show children's understanding of artist's knowledge earlier than the previous studies (Armitage & Allen, 2015; Browne & Woolley, 2001; Richert & Lillard, 2002). As I have already outlined in Chapter 1, the previous studies did not use perceptual access as a source of artist's knowledge in the tasks, but described unconventional situations where the artist was ignorant. The artist did not know about conventional objects (e.g., "Chuck doesn't really know what bears are.") therefore, children were just informed about the artist's ignorance. On the contrary, the current knowledge understanding task presented Jessica's ignorance as a result of course of events in the story. Since Jessica did not see one of the cars, children had to infer she was ignorant about the second car. To make sure children noticed that Jessica could not

see the car, the experimenter clearly described the event at the time it happened "Jessica did not see it (the car)." The clarity of Jessica's ignorance could have contributed to children's successful labelling of her drawing. Moreover, the storyline in the current task was something that three to five-year-olds encounter every day. Seeing cars that pass by while walking around the town is a relatable story, which also might have contributed to children's better performance.

The adults in the current knowledge understanding task also successfully labelled Jessica's drawing according to her knowledge state and correctly answered the perceptual access question. This indicates that they understood that Jessica could only draw the car she had seen. Since previous research shows that adults are more likely to label drawings according to artist's intent (Gelman & Bloom, 2000; Gelman & Ebeling, 1998) and take into account the artist's knowledge more likely than younger children (Browne & Woolley, 2001), the adult's results were not surprising and added to the validity of the task.

Children's labelling of Jessica's drawing matched children's answer to the perceptual access question which suggests that labelling the drawing was reflecting children's understanding of other's knowledge state. To substantiate, the usual perceptual access tasks only used the question similar to "Which car did Jessica see today?", which is a more direct measure of children's understanding of Jessica's knowledge. The results of this study however indicate that children are also able to reason about artist's knowledge state when interpreting her drawing.

4.4.2. Belief understanding task

In the usual false belief tasks, children are considered to pass when they perform above chance (Wellman et al., 2001), but infant's performance and newer studies measure performance by comparing test and control conditions to reason about children's understanding of the protagonists' belief (Białecka-Pikul et al., 2019; Buttelmann et al., 2014). Therefore, I decided to use both analyses, such as Rubio-Fernandez (2019), to allow for a more thorough examination of children's and adult's performance.

4.4.2.1. Ambiguous drawing aided children in reasoning about Jessica's belief

When comparing children's performance to chance in each condition, children only answered the *Drawing question* correctly in the *Non-matching shape false belief condition* (see Table 13). That means that children labelled Jessica's drawing according to her false belief (as "Smarties") only in the condition when they saw there was actually nothing inside the tube. This suggests that children had least difficulties when Jessica's false belief contrasted their own true belief (Jessica believed there were Smarties inside the tube but the child knew there was nothing inside – see Table 15). This corroborates the results of previous research that suggest that in cases where the box is left empty, children are more successful reasoning about false belief than in the usual false belief task (Lalonde & Chandler, 1995; Wellman et al., 2001). The pairwise comparison between *Non-matching* and *Matching shape false belief* conditions further confirmed that children labelled Jessica's drawing according to her false belief more likely when children saw there was nothing inside the tube in comparison when they saw there were pennies inside the tube. Although Jessica holds a false belief in both of these conditions,

it clearly shows that children's knowledge of the real contents of the tube could interfere with reasoning about Jessica's belief.

Table 15

How Appearance of the Drawing Could Have Reminded Children About Jessica's False Belief

Non-matching shape false belief condition	Jessica's drawing
Jessica Thinks 	
Child sees 	

Nonetheless, it is important to note that in the *Non-matching shape false belief condition*, the drawing of circles clearly contrasts children's knowledge that there is nothing inside the tube (see Table 15). Jessica's drawing of Smarties could have just reminded the children that Jessica has a false belief about the contents of the tube. The assumption that Jessica's drawing acted as a reminder to Jessica's false belief was reflected in answers on the *Belief question*. Children's answers on the *Belief question* did not differ regardless if children knew there was nothing inside the tube, or if they knew there were pennies inside the tube. That means that the Belief question did not match previous findings (Lalonde & Chandler, 1995; Wellman et al., 2001) that children find it easier when the box is left empty to reason about false belief. This study only confirmed the previous findings when children were labelling Jessica's drawing, but this could be due to the appearance of the drawing reminding children about Jessica's false belief.

To substantiate this assumption, adults were also equally likely to reason about Jessica's false belief in both *Non-matching* and *Matching shape false belief* conditions.

This showed that adults' underlying knowledge (there is nothing in the tube vs. there are pennies in the tube) did not interfere with reasoning about Jessica's false belief. Likewise, both children and adults showed sensitivity to Jessica's belief, regardless of whether they themselves were ignorant or knowledgeable about the contents of the tube (see comparisons of *Non-informed belief* and *Matching shape belief conditions* (C)). This further implies that children's successful reasoning about Jessica's belief in the *Non-matching* belief condition might be due to the drawing as a reminder of Jessica's false belief.

4.4.2.2. Mixed results from binomial tests and pairwise comparisons

No other binomial tests with children showed that children were successful reasoning about Jessica's true or false belief. Based on the usual criteria for passing belief tasks (Wellman et al., 2001), I could assume that children did not show understanding of Jessica's true or false belief. However, pairwise comparisons show that children did differentiate between certain conditions. Firstly, to reason whether children can differentiate between Jessica's true and false belief, I compared *True belief* and *Matching shape belief condition* (see A in Table 14). Children only differentiated between Jessica's false and true belief when answering the Belief question. However, children did not show the same ability when labelling the character's drawing. Although some studies with drawings suggested that offering a physical representation of Jessica's false belief should facilitate children's false belief reasoning (H. Wimmer & Perner, 1983), this study did not confirm these assumptions.

On the contrary, it is possible that Jessica's ambiguous drawing as a physical representation of her false belief interfered with children's reasoning about her belief in the *Matching shape belief condition*. Since the ambiguous drawing could represent

both Jessica's false belief (Smarties) and child's true belief (pennies – see Table 14), the drawing of circles could validate children's egocentric bias of their own true belief. That means the shape of the ambiguous drawing could guide their labelling of the drawing, suggesting that Jessica drew what children think is inside the Smarties box. Considering that only 64% of adults labelled Jessica's drawing in the *Matching shape belief condition* correctly, this particular condition might have been particularly demanding for adults as well.

However, when comparing adult's performance in true and false belief conditions (see A in Table 14), the results show they differentiated between Jessica's false belief and true belief (she did not know there are pennies inside vs. she saw pennies inside the tube). Adults showed this understanding when both labelling Jessica's drawing and answering the Belief question. This expands the previous findings with young adults (Henry et al., 2013) showing that adults can also reason about artist's false belief from a drawing, not just by answering the Belief question. Adult's differentiation between Jessica's true and false belief speaks to the validity of the task.

4.4.2.3. Did participant's labelling of Jessica's drawing reflect their understanding of Jessica's belief?

Overall, the results suggest that children did not perform differently when labelling the drawing or answering the *Belief question*. This suggests that children's labelling of Jessica's drawing as a measure of her false belief understanding seems to validly express children's usual answers to the false belief question (e.g., "What would mummy think is inside the tube?"). However, it is important to note that the Drawing question always preceded the Belief question. It is possible that labelling Jessica's drawing influenced children's answers on the Belief question. However, since the focus

of this task was to evaluate children's ability to label Jessica's drawing based on her false belief, this was the only logical order that enabled me to focus on the research aim.

Contrastingly, adults were more successful answering the Belief question than labelling Jessica's drawing. Many adults seemed confused to be asked about what Jessica drew, especially because the drawing was very ambiguous. Adult's confusion was also observed in a study by Armitage and Allen (2015), were adults seemed to be focusing on the drawing alone and ignoring the picture-referent relationship. It could have happened that Jessica's ambiguous drawing in the current experiment made adults focus more on the appearance of the pencil-drawn circles than the connection between Jessica's belief and her produced drawing. It is possible that adults have solid expectations that the drawings will strongly resemble their referents (Armitage & Allen, 2015; Browne & Woolley, 2001), and that an adult experimenter would create a very clear drawing, so they are confused when their expectations are not met. On the contrary, adults showed no difficulties when answering the *Belief questions* and they showed understanding of Jessica's belief in all conditions (see Table 13).

4.4.2.4. Children's unconventional responses

Many children's first responses were "circles" or "bubbles". That is not surprising considering that children are usually not required to label the drawings beyond their appearance, since appearance is a sufficient cue to recognise the meaning of drawings. When they read picture books with adults, the adults ask them "What is on the picture?", or when children are exploring toys, they are asked "Which animal is this?" (Gelman et al., 2005). Children's labelling of pictures is usually not connected with recognising artist's intent. Some research shows that children are hesitant to spontaneously take into account the artist's intent when interpreting her drawing

(Gardner et al., 1975) if not prompted to do so. However, studies have shown that children can take intent into account when it is explicitly stated (Bloom & Markson, 1998; Browne & Woolley, 2001; Preissler & Bloom, 2008). Consequently, the experimenter in the current design explicitly stated that "Jessica is going to draw what is inside the Smarties tube". Although the intent was explicitly declared, some children apparently still first thought about naming the shape of the drawing.

4.4.2.5. Why did children not pass the false belief task?

4.4.2.5.1. Momentary disappearance of Jessica could influence children's reasoning about her belief

It is possible that a particular feature of the story about Jessica disrupted children's process of perspective taking. According to Rubio-Fernandez and Geurts (2013) momentary disappearance of the main character can have a significant effect on children's performance. In other words, since the false belief stories involve following the perspective of a character, disappearance of the character during the story prevents the children to successfully follow their perspective throughout the task.

The current belief understanding task included a short disappearance of Jessica. In particular, Jessica was removed from the participant's visual field when she was drawing "what is inside the Smarties tube". This was included because Jessica's ambiguous drawing was pre-drawn, so that every participant saw the same drawing. Since the intentional act of drawing has previously been reported that it's important for children to believe that the drawing was intentionally made (Preissler & Bloom, 2008), I as the experimenter had to pretend Jessica really drew. Moreover, I emphasized her intention by saying "Jessica is going to draw what is inside the Smarties tube". The easiest way to perform the drawing action with the pre-drawn drawing was to hide her

behind the desk and pretend to be drawing. Therefore, a short disappearance of Jessica was included in all conditions.

When children's performance was compared to chance, they did not correctly reason about Jessica's belief in any of the conditions, except in the *non-matching false belief condition* (when Jessica drew Smarties, but children saw there is nothing inside the tube). That means it is not just false belief reasoning that seemed to be affected by Jessica's disappearance. These results showed that children's following of Jessica's perspective might have been hindered by her short disappearance.

This assumption is supported by results from adults. Since studies indicate that adult's performance is not influenced by the disappearance of the main character (Rubio-Fernández, 2013), adult participants in the current study should be successful when reasoning about Jessica's belief despite her disappearance. This has been partially confirmed, since adults responded correctly to all the *Belief questions*, showing they could follow Jessica's belief. However, adults were not as successful when labelling Jessica's drawing. However, I discussed reasons for that in the previous section.

4.4.3. General discussion

4.4.3.1. Do children understand knowledge state before belief?

The results reported in this chapter suggest that children can understand knowledge states before understanding beliefs. Children had no difficulties reasoning about Jessica's ignorance at the age of three, but the whole sample of three to five year olds still showed some difficulties with reasoning about Jessica's belief. This is in line with previous studies that discuss how understanding knowledge states precedes understanding beliefs (Hogrefe et al., 1986; Wellman & Liu, 2004). However, it is important to point out that as in many other studies, this chapter measured Jessica's

knowledge state and belief in two different narratives, so any solid conclusions should be further explored. Nevertheless, this study is first to explore these parallels between the usual knowledge and belief tasks with reasoning about drawings.

4.4.3.2. The impact of Jessica's disappearance in both knowledge and belief understanding task

If the disappearance of Jessica in the belief understanding task really disrupts children's reasoning about Jessica's belief (Rubio-Fernández, 2019), how come children were successful reasoning about Jessica's ignorance in the knowledge understanding task? Jessica also disappeared from the scene when she was drawing the car she had seen today. But both children and adults labelled the drawing according to Jessica's ignorance.

It is possible that Jessica's disappearance did not influence both tasks in the same manner because reasoning about Jessica's ignorance was based on different processes than understanding of Jessica's belief. In order to show understanding of the knowledge task, children had to understand that seeing the car leads to knowing about the car, and also that Jessica could have only drawn the car she had seen. Therefore, the knowledge understanding task was measuring perceptual access reasoning. However, understanding perceptual access reasoning does not equal understanding beliefs, which require understanding representations (Keenan et al., 1994). Beliefs are not necessarily facts, but reflect representations, or ideas (S. A. Miller, 2000). In the belief understanding task, Jessica had a false belief about the contents of the tube. She drew what she thought was inside, and that was not seen by the participant nor by Jessica. She drew a representation she had in her mind. Therefore, when Jessica drew based on her ignorance, children had seen the referent she drew, they had the perceptual access

to that referent. On the contrary, Jessica's drawing of her false belief represented Smarties that were not seen by children. It was just a representation of the usual contents of the tube.

It is possible that Jessica's disappearance in the knowledge understanding task did not disrupt children's reasoning about Jessica's knowledge, since that knowledge was shared (e.g., when Jessica was ignorant, both Jessica and the child saw the red car). Following Jessica's perspective when she had the false belief might have been more difficult, because it was not strengthened by a real referent. They were not able to make any associations with Jessica and Smarties, because they have not seen the Smarties. Moreover, following Jessica's false belief was also more demanding than following her knowledge, since Jessica's false belief was not in line with the reality. Therefore, children had to hold Jessica's false representation in mind in order to label the drawing correctly. This might have been interrupted by Jessica's disappearance while she was drawing.

4.4.3.3. Suggestions for improvements

4.4.3.3.1. Mentioning the usual contents of the tube

In the Belief understanding task, the familiarity of children with Smarties tube was not tested. It is possible that some of the children did not know what does the Smarties tube usually contains. Moreover, it has been shown before that mentioning what is usually inside the Smarties tube helped three year olds in the unexpected contents task (Rubio-Fernández, 2019). The experimenter in the current Belief understanding task did not mention what is usually inside ("Jessica finds a Smarties tube"). Therefore, it is possible that that children might have been ignorant about the usual contents of the tube. The study design could be improved by just mentioning what the usual contents is ("There are usually chocolate Smarties inside the Smarties tube.").

4.4.3.3.2. Could undergraduates know about the unexpected contents task?

Since majority of adult participants were undergraduate students of Psychology, there is a possibility they were familiar with the usual unexpected contents task (Perner et al., 1987), used for evaluating false belief. Therefore, their results could be confounded by their knowledge about the aim of the task and reflect their expectancy of what a correct answer is. Although this is a possible limitation that could influence adults' performance, it is important to mention that the belief understanding task in this chapter differs from the usual unexpected contents task in many ways. Firstly, half of the adults first experienced the knowledge task, where Jessica saw some cars and drew them, which continued with the narrative about Jessica's day at school where she sees a Smarties box. This narrative about Jessica made the task very different from the usual procedure of the unexpected content's task (Rubio-Fernández, 2019). Secondly, Jessica was always drawing what is inside the Smarties tube before adults were asked any usual belief questions (e.g., What does Jessica think is inside the tube?). Labelling the character's drawing as a reflection of her mental state is a novel and indirect way of evaluating participant's understanding of Jessica's belief. And thirdly, the different conditions included in the current Belief understanding task are also a more complex and comprehensive way of evaluating Jessica's belief. Since in some conditions, Jessica's and the participant's belief aligned, the usual knowledge about the unexpected content's task could even be suggesting a wrong response (thinking that Jessica probably holds a different, false belief about the contents of the tube).

To summarise, it is possible that undergraduates' responses were influenced by their familiarity with the usual false belief tasks, but the complexity and the novel way of accessing belief understanding in the current task should have reduced student's

familiarity bias. If possible, it would be better to perform the study with students of other subjects, who are not familiar with the false belief tasks.

4.4.4. Conclusion

Three to five year old children and adults both showed that they can take into account Jessica's knowledge when labelling her drawing. That extended the findings of previous studies, which claimed that children are not successful reasoning about artist's knowledge before the age of seven (Browne & Woolley, 2001; Richert & Lillard, 2002). However, the belief understanding task showed some mixed results. The children's labelling of the drawing reflected their understanding of Jessica's false belief only when Jessica's belief clearly did not resemble reality. Children did not label Jessica's drawing according to her belief in any other conditions. Overall, children did not reason successfully about Jessica's belief according to the usual standards of passing false belief tasks (Wellman et al., 2001). Nevertheless, comparing different conditions of belief tasks revealed that children did differentiate between certain conditions, which shows that children are still developing their understanding of belief representation, and are perhaps hindered in reasoning about belief if they are unable to focus on the main character of the story.

CHAPTER 5: EXPLORING CHILDREN'S AND ADULT'S INTERPRETATION OF DRAWINGS (PRE-REGISTERED STUDY): GENERALISATION OF MEANING OF DRAWINGS

The previous chapter explored how children and adults take artist's knowledge state and belief into account when interpreting her drawing. The results provided evidence that even three-year-old children could take into account artist's knowledge, but labelling a drawing according to artist's belief turned out to be more complex. Research using verbal language with children has shown some similar conclusions. Children took into account speaker's knowledge state in verbal communication, but reasoning about speaker's belief showed mixed findings (Robinson & Mitchell, 1992, 1994; Wilkes-Gibbs & Clark, 1992). To further test what characteristics do drawings as communicative symbols share with verbal language, this chapter explored how children and adults generalise meaning of drawings in communication.

Research with drawings to date has focused on factors that influence children's and adults' labelling of drawings or photographs (Armitage & Allen, 2015; Gelman & Ebeling, 1998; Hartley & Allen, 2015; Malt & Sloman, 2007; Preissler & Bloom, 2008), but has not addressed exactly what these labels or drawings refer to. Unlike words which are arbitrary and their meaning is conventional, drawings' labels are not arbitrary but are most commonly led by artist's gaze, drawings' resemblance to real world referents, and artist's intent (e.g., Armitage & Allen, 2015; Hartley & Allen, 2014; Preissler & Bloom, 2008). Therefore, the generalisation of meaning of a drawing might be influenced by artist's mental states – particularly, artist's intent. Since preschool children do take into account not only artist's intent (Bloom & Markson, 1998), but also knowledge (see Chapter 4) and belief to some extent (see Chapter 4) when labelling a drawing, children could generalise the meaning of drawings by considering artist's mental states. This

chapter aims to explore how children and adults interpret and extend the meaning of an ambiguous drawing in communication – do they interpret a drawing according to referents' identity, category, shape or theme?

5.1. Introduction

5.1.1. Generalising meaning of words

Since drawings are usually labelled with verbal labels, it is possible that the generalisation of meaning of these labels, and thus generalisation of drawings, might be led by verbal labels themselves. Consequently, some parallels can be derived from research exploring how children generalise the meaning of words in communication. This line of research explores which referents share the same referential expression. Two factors seem to lead children's extensions of meaning of nouns. One is the referent's shape (Saalbach & Schalk, 2011; Samuelson & Horst, 2007) and another is the referent's category (Markman, 1994). That means that children usually extend the word for a target referent (e.g., saying "dog" when referring to a puddle) to either a referent of the same shape (e.g., cow), or another referent in the same taxonomic category[4] (e.g., Dalmatian). Some findings support a developmental change in generalization of nouns, such that younger children extend the meaning of the nouns based on referent's shape, but as children mature, they develop an understanding of extending the meaning to a noun's category (Imai et al., 1994; Snape & Krott, 2018). This developmental shift apparently happens between three- and five- years of age (Imai et al., 1994; Snape & Krott, 2018). Contrastingly, others demonstrate that even five-year-old children extend

[4] Extending the meaning of a word to referent's category is referred to with many different terms. Ellen Markman (1994) introduces the *taxonomic assumption* which states that a referential expression refers to exemplars of the same kind (e.g., expression "chair" refers to a wooden chair, rocking chair, or a desk chair). Therefore, referent's category (Saalbach & Schalk, 2011; Yoshida & Smith, 2003) or taxonomically similar object (Imai et al., 1994; Markman, 1994) are two terms that are used interchangeably. This thesis will use the term *referent's category*.

the noun names based on shape (Baldwin, 1992; Saalbach & Schalk, 2011). In conclusion, there is no consensus in research with language as to when do children adopt a certain factor for noun extension, but both the **referent's shape and referent's category seem to play a role in generalizations of nouns** (Cimpian & Markman, 2005; Diesendruck & Bloom, 2003; Saalbach & Schalk, 2011; Samuelson et al., 2007; Yoshida & Smith, 2003).

5.1.2. Categorisation strategies

When exploring the generalisation of meaning of drawings, further parallels can be drawn from studies of categorisation. Category knowledge shows the reasoning why certain referents form a category and can therefore also lead the choice of verbal referential expressions (Namy & Gentner, 1999; Waxman & Gelman, 2009). In categorisation studies, children are usually asked either to match a target object with one of three objects (a perceptual matching object, a taxonomically matching object and a thematically matching object), or sort multiple objects by forming categories (Ionescu, 2007). Similar to word generalisation studies, some results of categorisation studies also describe a developmental change showing that younger children first take into account perceptual features of objects in categorisation (sorting objects with same perceptual features together), but older children appreciate a more adult-like categorisation based on conceptual properties (Gelman & Markman, 1986; Kingo, 2008). Therefore, categorisation behaviours rely on both perceptual and conceptual information as word generalisation does (Samuelson & Bloom, 2008).

5.1.3. The role of speaker's intent in generalisation and categorisation

Some research has also highlighted the role of speakers' intent in studies of noun generalisation and categorisation (Bloom, 1996; Diesendruck et al., 2003; Samuelson et al., 2007). Diesendruck, Markson and Bloom (2003) showed that three-year-old children

are not just led by shape similarity when generalising meaning of referential expressions, but referents' intentional characteristics are integral for extending novel referential expressions (Diesendruck et al., 2003). When the experimenter explicitly stated the referent's function (e.g., "it was made for holding coins"), children extended the novel referential expression to a differently shaped item with the same function more often than when the intended function was not clearly expressed. The role of speakers' referential intent in choosing words for referents was corroborated by other studies (Jaswal, 2004, 2006; Keates & Graham, 2008). This is particularly interesting for examining children's generalization of drawings, since artist's intent plays an important role when interpreting her drawing. Ambiguous drawings should be particularly influenced by artist intent (e.g., Allen & Armitage, 2017; Browne & Woolley, 2001; Myers & Liben, 2012), since they resemble more potential referents than iconic drawings do.

5.2. The current study

To sum up, both studies of generalisation of nouns and categorization of objects have identified two most important factors that lead three to six-year-old children's interpretation: the **referent's shape** and the **referent's category** (Cimpian & Markman, 2005; Diesendruck & Bloom, 2003; Gelman & Markman, 1986; Kingo, 2008; Saalbach & Schalk, 2011; Samuelson et al., 2007; Yoshida & Smith, 2003). Moreover, studies have also shown that the **speaker's intent** contributes to children's generalisations of novel labels (Diesendruck et al., 2003; Jaswal, 2004, 2006; Keates & Graham, 2008).

Some studies of generalisation of words and categorisation also compared children's and adult's performance. The study on generalisation of nouns comparing performance of adults and four to five-year-old children showed no significant differences (Emberson et al., 2019). Both adults and children generalised a novel label

for a typical exemplar (e.g., saying “fep” to refer to a fish) to same category of objects (e.g., “feps” to refer to different fish). However, the results of studies with categorisation of objects showed a difference in performance between adults and children (Hammer & Diesendruck, 2005). Unlike adults, four to six-year-old children paid more attention to the object’s appearance than functionality when categorising objects. On the contrary, previous research with drawings has shown that adults and children label ambiguous drawings similarly (Armitage & Allen, 2015; Browne & Woolley, 2001; Gelman & Ebeling, 1998). Both seem to take into account artist’s intent. For this reason, the current experiment included both children and adults to explore whether there are any differences in generalisation of meaning of drawings.

5.2.1. The communicative sorting task

The present study tested four and five-year-old children and adults to explore the factors which drive children’s and adult’s generalisation of drawings in communication. The participants had to sort the offered objects into two bags based on an ambiguous drawing. The sorting task was set up as a tidy-up task, where participants helped the experimenter. The experimenter placed the drawing on one of the two bags, saying “I will show you what goes here …”, and pointed to the other box saying “… and everything else goes here.”

Reasoning from research with generalisation of words (e.g., Imai et al., 1994; Markman, 1994; Samuelson & Horst, 2007) and categorisation (Ionescu, 2007; Namy & Gentner, 1999; Waxman & Gelman, 2009), the current study design offered participants several possibilities of generalisation of meaning of the drawing. Participants could

generalise on the basis of the drawn referent's category[5] (Cimpian & Markman, 2005; Diesendruck & Bloom, 2003), shape (e.g., Hartley & Allen, 2014a; Saalbach & Schalk, 2011), and theme (Markman & Hutchinson, 1984) or constrain the meaning of the drawing to the same identity of the drawn referent. Participant's generalisation of the meaning of the drawing was demonstrated by their sorting strategy –the objects they chose to put into the bag with the drawing.

Parallel to word generalisation studies, it was hypothesised that children and adults might generalise the meaning of a drawing based on referent's shape or category. Since an artist's intent has been recognised as particularly important when labelling ambiguous drawings (Allen & Armitage, 2017), generalisation of the meaning of the ambiguous drawing might result in an interplay of the influence of artist's intent and referent's shape and category. Consequently, the study design also offered two options of generalising based on the referent's theme and identity of the drawn referent.

[5] The term "category" in the present experiment is also referred to as "basic-level taxonomic choice" (Cimpian & Markman, 2005) or "basic level category" (Namy & Gentner, 1999). This term refers to highly perceptually similar referents that are from the same basic level category as the target referent (e.g., Siamese cat and Bengal cat are from the same basic level category).

5.3. Method

5.3.1. Participants

Thirty-two 4-year-olds (M_{age} = 4 years 7 months, 17 girls) and thirty-two 5-year-olds (M_{age} = 5 years 4 months, 17 girls) and 30 adults (M_{age} = 21.17 years, 23 women) were individually tested. There were 34 girls (53.1%) and 30 boys. Some of the children were tested in local schools near Canterbury and some in the Kent Child development unit. All adults were tested in the Kent Child Development Unit at University of Kent in exchange for course credits.

5.3.2. Materials

5.3.2.1. Pictorial stimuli

Pictorial stimuli comprised of three drawings and one picture of the LEGO logo (see Table 16). Two drawings were drawn with a black pen. They were ambiguous and used for the test trials (see Figure 18). The ambiguous drawings depicted a toothbrush/comb and a pencil/straw. The third drawing was a scribble made with a yellow colouring pencil. All the drawings were hand-drawn on a white 10 x 10 cm paper and reused with all participants. The picture of the LEGO logo was also printed on a white 10 x 10 cm paper.

5.3.2.2. Norming of drawings

To confirm that the two ambiguous drawings were equally likely represent any of the two offered referents (toothbrush/comb and pencil/straw), 69 adults who did not participate in the main study participated in an online questionnaire. Participants were presented with an ambiguous drawing (e.g., line drawing) accompanied with text: “Someone made this quick drawing. You are trying to figure out what they drew.” Subsequently, the participants saw a drawing next to one of the target items on the

screen (e.g., a straw). They had to answer a question "On a scale of 0 to 100, what is the likelihood that this is what they were trying to draw?" Analysis of adult's responses confirmed they were equally likely to claim that the drawing of a line could be straw or a pencil ($t(55)= .517$, $p = .607$). It was also confirmed that adults were equally likely to claim that the drawing of a comb/toothbrush could be a comb or a toothbrush ($t(62)= .926$, $p = .358$).

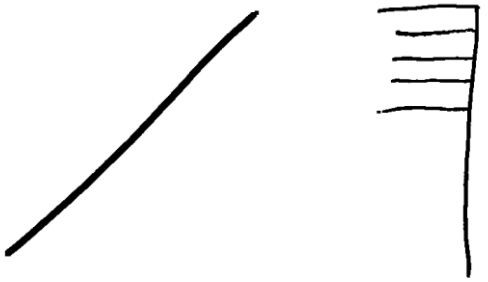


Figure 18. Two Ambiguous Drawings of Pencil/Straw and Toothbrush/Comb.

5.3.2.3. Objects

There were five sets of objects used in this study (see Table 16). Two sets of objects were carefully selected for the two test trials and associated with two ambiguous drawings. In each test trial, there were seven toys. One of the toys was the target referent, which the experimenter drew - e.g., toothbrush or a comb, counterbalanced between participants. Each set was constructed so that it could be sorted on the basis of four different organizations:

(1) Identity: in each set, there was only one target object that the experimenter was looking at while drawing (e.g., pink comb);

(2) Category: in each set, there was another exemplar of the target object, only a different colour (e.g., pink comb and a yellow comb);

(3) Shape: each set contained two objects that were of the same shape as the ambiguous drawing (e.g., blue toothbrush and a purple toothbrush);

(4) Theme: in each set, there was one object that was thematically related to the target object (e.g., hairband); and

(5) Other: in each set, there was an object that was thematically related to the other shape-related object (e.g., toothpaste) and an unrelated filler object (e.g., duct tape).

The two warm-up sets and a filler set of objects are listed in Table 16.

Table 16

Pictorial Stimuli with the Corresponding Five Sets of Objects

Trial	**Pictorial stimuli**	**Target object**	**Category match**	**Shape matches**		**Thematic match**	**Other thematic match**	**Filler**
Test		**Blue toothbrush**	Purple toothbrush	Pink comb*	Green comb	Toothpaste	Hairband	Duct tape
Test		**Red straw**	Yellow straw	Brown pencil*	White pencil	Cup	Rubber	Hoop
Warm up		Blue creature	Yellow creature	Purple mosquito	Blue ball	Blue trumpet		
Warm up		Long lego block	Lego wheel	Short lego piece	Christmas star	Spikey ball		
Filler		Red plate	Yellow plate	Yellow egg	Spoon	Yellow mini fence		

Note. The asterisk (*) marks the other possible target object in two test trials.

Ten same sized, brown paper bags were used for the experimental game. For each trial, two bags were used to sort the presented toys.

5.3.3. Procedure

Participants began with two warm-up trials (see Table 16) intended to make them feel comfortable and to familiarize them with the tidy-up game. The participants had to help the experimenter tidy objects into bags.

In trial one, the experimenter showed the participant five objects and after the participant had explored them, the experimenter put two empty bags in front of the participant. The experimenter instructed the participant: “I want you to help me tidy up the toys into these two bags. Can you help me tidy them up?" After the participant put the toys into bags so each box had at least one toy, the experimenter continued. In trial two, the experimenter repeated the procedure, but when she put the bags in front of the participant, the experimenter also put a picture of the LEGO logo on one of the bags while saying: “I will show you what goes here (pointing to the picture), and everything else goes here (pointing to the other bag).” This warm-up trial was designed to familiarize the participant with sorting with the help of pictorial stimuli.

Trial three was the test trial. The experimenter put only one object in front of the participant and asked: “What is that?” After the participant had correctly named the object, the experimenter announced that she would draw it. She showed the participant her drawing and asked: “What is that?” The participants were expected to correctly label the drawing according to what the experimenter drew. The experimenter then showed six other objects (see Table 16 above) and repeated the procedure from the warm-up trials. When she put the bags in front of the participant, the experimenter also put the drawing on one of the bags while saying: “I will show you what goes here (pointing to the picture), and everything else goes here (pointing to the other bag).”

The fourth trial was a filler trial, when the experimenter made a yellow scribble without looking at any object. After the drawing was made, she presented the participant five objects and repeated the sorting procedure as in the previous trials.

The last trial was another test trial where the experimenter repeated the procedure from the third trial, but using the last set of objects. The whole procedure lasted from five to eight minutes.

5.4. Results

5.4.1. Coding participant's answers

To analyse how participants extend the meaning of drawing in the communicative game, participant's sorting strategies were assigned into five categories based on what they put in the bag with a drawing:

- *identity* (they only put the drawn referent in the bag – e.g., pink comb),
- *category* (they put both referents from the same category in the bag – e.g., both combs)
- *shape* (they put all referents that corresponded with the shape of the drawing in the bag – e.g., both combs and both toothbrushes)
- *theme* (they put the referents from the same category and the thematically connected referent in the bag – e.g., both combs and a hairband)
- *other* (they put any other unmentioned combination of referents in the bag).

When describing the results, the term "sorting strategy" will be used to describe what the participants put into the bag with the ambiguous drawing, which represents participant's generalisation of meaning of the ambiguous drawing.

5.4.2. Order effects of the drawings

All participants saw two ambiguous drawings, but the order of the two drawings was counterbalanced between participants such that half saw the pencil/straw drawing first and half saw the toothbrush/comb drawing first. To test whether participants extended the meaning of drawings differently depending on the order of the presented drawings, two chi-square tests were conducted separately for each ambiguous drawing.

Results indicated that children did not extend the meaning of the drawing pencil/straw differently depending on the presented order (χ^2 (2, N = 63) = 2.699, p = .259). Children also did not extend the meaning of the drawing

toothbrush/comb differently depending on the presented order (χ^2 (4, *N* = 63) = 4.379, *p* = .357). Therefore, data was collapsed across both order conditions for further analysis.

Adults also did not extend the meaning of the drawing pencil/straw (χ^2 (2, *N* = 30) = 1.487, *p* = .475) or toothbrush/comb (χ^2 (2, *N* = 30) = 3.500, *p* = .174) differently depending on the presented order, so data was also collapsed across order conditions.

5.4.3. Sorting strategies depending on the drawn referent

To assess whether participants' sorting strategies differed depending on the original referent that the experimenter drew (e.g., toothbrush vs. comb), chi-square tests were performed for each of the two ambiguous drawings.

Children's sorting strategies for the ambiguous drawing of pencil/straw were not significantly different (χ^2 (2, *N* = 63) = 3.785, *p* = .151). However, children extended the meaning of the ambiguous drawing differently depending on whether the drawn referent was a toothbrush or a comb (χ^2 (4, *N* = 63) = 15.692, *p* = .003). To analyse which sorting strategy significantly differed for the two drawn referents, post-hoc test were run. Standardized residual method was used (Beasley & Schumacher, 1995). Residuals were calculated with a Bonferroni adjustment to avoid Type I error (Beasley & Schumacher, 1995; Sharpe, 2015). The post-hoc tests showed that children extended the meaning of the drawing more often to the toothbrush theme (two toothbrushes and a toothpaste) than to the comb theme (two combs and a hairband), p= .003 – with Bonferroni adjustment.

Adults' sorting strategies for the ambiguous drawing of pencil/straw (χ^2 (2, N = 30) = 1.487, p = .475) and toothbrush/comb (χ^2 (2, N = 30) = 4.000, p = .135) were not significantly different.

Although children showed a difference in the extension of the meaning of toothbrush/comb drawing, the drawn referent was counterbalanced between participants (half the participants saw a comb being drawn and half participants saw a toothbrush being drawn). Therefore, I collapsed the results for each drawing regardless of which target referent was drawn for both children and adults.

5.4.4. Consistency of children's and adult's sorting strategies

To test whether participants' sorting strategy was consistent or different for the two ambiguous drawings in the two trials a dummy variable was created for each participant. Participants were assigned a score of one if sorting strategies for both drawings matched (e.g., the participant sorted the objects according to category for both pencil/straw drawing and toothbrush/comb drawing) or a score of zero if sorting strategies for each drawing differed (e.g., the participant sorted the objects according to category for pencil/straw drawing, but according to shape for toothbrush/comb drawing).

More than half the children extended the meaning of a drawing consistently regardless of the drawing they were presented (binomial test, p = .005). Similarly, a binomial test indicated that the majority of adult participants' sorting strategies **matched** for both drawings ($p < .001$).

5.4.5. Analysis of children's and adult's choices

Since there were no significant differences within participants in sorting strategies for the two drawings (they mostly extended the meaning consistently), data was collapsed across participant's sorting strategies for both drawings to determine which sorting strategy were participants most likely to follow.

Chi-square tests conducted on sorting strategy results (see Table 17) showed that both children (χ^2 (4, *N* = 126) = 130.349, *p* < .001) and adults most often extended the meaning of a drawing on the basis of the **referent's category** (χ^2 (2, *N* = 60) = 67.600, *p* < .001.)

Table 17

Children's and Adult's Sorting Strategies

	f	
Organisation	Children	Adults
Identity	1	0
Category	73	50
Shape	15	6
Theme	8	4
Other	29	0
Total	126	60

5.4.6. Analysis of differences according to age

Four and five-year-olds sorting strategies did not differ, χ^2 (4, *N* = 126) = 6.334, *p* = .176, *w* = .224 (see Table 18 on the next page).

Table 18

Children's Extensions of Drawings by Age

Organisation	*f* 4-year-olds (*N* of trials)	5-year-olds (*N* of trials)
Identity	0	1
Category	38	35
Shape	9	6
Theme	5	3
Other	22	7
Total	74	52

5.5. Discussion

This chapter investigated how four and five-year-old children and adults generalise the meaning of ambiguous drawings in communication. Four and five-year-old children almost always extended the meaning of the ambiguous drawing to objects of the same category as the drawn item. That means that they interpreted the same ambiguous drawing in communication as referring to objects that are of the same taxonomic category as the drawn referent (e.g., both combs). The adult sample in this study matched children's performance, showing the generalisation of meaning of drawings to the same category the drawn object.

The findings of the current study converge with studies about how children generalise the meaning of words in communication. Children generalised meaning to the referent of the same category and shape (e.g., pink comb and a yellow comb) which corresponds with findings showing that three to five-year-old children generalise nouns based on the both referent's shape and category (Cimpian & Markman, 2005; Diesendruck & Bloom, 2003; Saalbach & Schalk, 2011; Samuelson et al., 2007; Yoshida & Smith, 2003). This also aligns with findings from studies of categorisation, showing that children sort objects from the same category together (Gelman & Markman, 1986; Kingo, 2008).

Moreover, adult's performance was similar to children's – adults also generalised the meaning of drawings based on the referent's category. Firstly, this suggests that four and five-year-old children already show adult-like generalisation of ambiguous drawings in communication. Secondly, this confirmed some findings from other word generalisation studies that showed that both children and adults generalise nouns similarly (Emberson et al., 2019). In particular, adults and four to five-year-old children

generalised nouns to the same category of objects, therefore the current study extends these findings to communication with ambiguous drawings.

5.5.1. Why did participants generalise based on the category of the drawn referent?

5.5.1.1. The influence of using ambiguous drawings

It is possible that the mere choice of ambiguous colourless drawings accentuated participant's interpretation as categories. Some research suggests that grayscale images are more abstract and thus allow for more generic interpretations than more detailed coloured drawings (Armitage & Allen, 2015; Gelman et al., 2005). Moreover, the research with generalisation of nouns has shown similar findings, indicating that less prototypical exemplars of categories (e.g., poodle) are generalised more narrowly (e.g., to poodles only) compared with more prototypical exemplars (e.g., Labrador), which are generalised to categories (e.g., dogs). That means that using more detailed and colour drawings in the current study could elicit interpretations of more specific referents (Armitage & Allen, 2015). To test whether that assumption is true, I would have to add a condition where the experimenter would not draw ambiguous drawings, but coloured or more detailed drawings.

5.5.1.2. Participants might have been led by the artist's intent

The results also suggest that children and adults might had been led by artist's intent in their generalisation of drawings. The participants first correctly labelled the experimenter's ambiguous drawings (question: "What is that?") according to the experimenter's intent, which confirms the previous findings when labelling drawings (Armitage & Allen, 2015; Browne & Woolley, 2001; Gelman & Ebeling, 1998). However, when these drawings were used in communication, participants generalised meaning of

drawings to the same category the drawn object. This shows that participants were also led by the artist's intent. If they had been ignorant to the artist's intent, they could just generalise the meaning of the drawing based on shape (all straws and pencils together). However, it appears that participants tried to persevere with the experimenter's intent by interpreting the drawing in communication as the category of the drawn referent. This finding is not surprising since the artist's intent has been identified as the defining characteristic of drawings (Bloom, 1996), which leads the connection between the appearance and the meaning of the drawing.

5.5.2. Did the results show a shape bias in generalisation of drawings?

Both noun generalisation studies and findings from children's categorisation studies show that children have a stronger focus on perceptual features of the referent in generalisation when they are younger, but shift towards conceptual properties approaching the age of five (Gelman & Markman, 1986; Imai et al., 1994; Kingo, 2008). This strong shape bias means that children tend to generalise based on the referent's shape (Samuelson & Bloom, 2008; Tek et al., 2012). The results from the current chapter however did not confirm this assumption. If children really followed their strong shape bias, they should generalise the meaning of the drawing to all referents that corresponded with the shape of the drawing (e.g., in case of a line, they would put red and yellow straws, and brown and white pencils together). However, children did not generalise the meaning of drawings on the shape alone, since children only chose the objects that were from the same category as the drawn referent.

This is not that surprising considering that the sample of children in this study consisted of four- and five-year-olds. Since the research suggests that especially younger children have a stronger shape bias (Diesendruck & Bloom, 2003), it would be

particularly informative to test three year olds with the same study design. My first aim for this study was to include children aged from three to five, so that their age range would coincide with the age range of children that are included in word generalisation studies (Imai et al., 1994; Snape & Krott, 2018). However, since the age when children in the UK start school is four, and this study was done in UK schools only, I could not include three-year-olds. It would be informative to perform the same experiment with three-year-olds, as word generalisation and categorisation studies also observe differences between three year olds and older children.

5.5.3. Testing the limits of influence of the drawing's shape on generalisation

The current study offered the possibility to generalise based on the referents category by offering two items from the same category (e.g., two straws or two combs). However, these items were not only from the same category, but also matched in shape (e.g., two combs were exactly the same shape, but of a different colour). Future research may consider expanding the variety of offered items from the same category. It should be noted that shape is not necessarily a representing feature when defining object categories (Yoshida & Smith, 2003). For example, a rocking chair and a desk chair belong to the same category of chairs, but are shaped differently. To really test whether children and adult's generalisation is led by the object's category, future investigations could also offer an object from the same category, but of a different shape (e.g., two line straws and one swirly straw – see Figure 19).

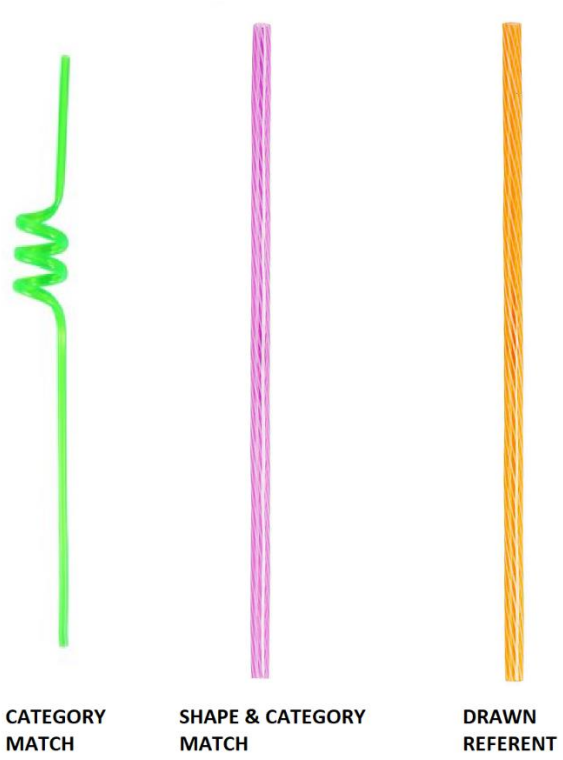


Figure 19. Offering Three Objects from the Same Category as the Drawn Referent.

Actually, word generalisation studies tested the generalisation of nouns in the same manner, by offering two objects from the same category, but of a different shape (Cimpian & Markman, 2005; Gelman et al., 1998). They found that children still generalise based on category. Considering that drawings are symbols that are defined and recognised by their shape, it is plausible that children's generalisation to the referent from the same category, but of a different shape would not be the same as with nouns. Therefore, an important future question relates to whether children and adults would generalise the meaning of an ambiguous drawing based on the referent's category even if the items were differently shaped as the drawn item.

5.5.5. Conclusion

This study shows that four- and five-year-old children and adults generalise ambiguous drawings in communication as categories. This suggests that children generalise ambiguous drawings in communication in a similar manner as they understand nouns. This study forms some basic parallels between verbal language and drawings, showing that both symbols are understood as concepts in communication. Although drawings are created with a specific intent, their meaning can be generalised and used in communication.

CHAPTER 6: DO ADULTS AND CHILDREN SHOW SENSITIVITY TO PARTNER-SPECIFIC MEANING OF AMBIGUOUS DRAWINGS: EXTENDING CONCEPTUAL PACTS OUTSIDE OF VERBAL LANGUAGE

Previous chapters have shown that children understand some underpinnings of communication with drawings that explain some underlying factors why people form conceptual pacts. The results from Chapter 4 showed that children can reason about artist's mental states when interpreting a drawing, which is a skill that one stream of theories consider important for forming conceptual pacts (Brennan & Clark, 1996; Metzing & Brennan, 2003). Moreover, Chapter 5 showed that as in verbal language, four- and five-year-old children generalize the drawing's meaning to the category of the drawn referent. This corresponds with the definition of conceptual pacts which claims that pacts are conceptualizations, which means they refer to concepts (Brennan & Clark, 1996). Considering these parallels between theoretical underpinnings of conceptual pacts in verbal language and interpretation of ambiguous drawings, I wanted to test whether children and adults can form conceptual pacts with drawings. Consequently, the study reported in this chapter was designed to test whether children and adults form conceptual pacts in communication with drawings.

6.1. Introduction

6.1.1. Sensitivity to partner's mental states in communicative principles

Although verbal referential expressions have arbitrary meanings, communication is often ambiguous and requires cooperation between interlocutors to resolve communicative meaning. For example, if Tom says to Lisa: "Look at the tall one!", Lisa has to resolve what object is Tom referring to. Interlocutors can resolve these ambiguities with taking into account each other's perspectives and knowledge (Garrod

& Anderson, 1987). Lisa figures out that Tom is talking about the tallest plant on the shelf, because they just previously discussed how to nurture indoor plants. Coordination of interlocutor's perspectives and their knowledge ensures that communicational meanings are understood (Garrod & Anderson, 1987). Since preschool children are still developing their skills to make inferences about other's mental states (Wellman et al., 2001), exploring the role of children's sensitivity to interlocutor's perspectives in communication can contribute to the understanding of underpinning processes in communication.

One communication principle that could help determine the underlying processes in communication are conceptual pacts (Brennan & Clark, 1996). Conceptual pacts are tacit agreements between interlocutors about how to conceptualize a referent. They are observed as particular referential expressions that interlocutors reuse and expect from the same speaker in a given conversation (for a more detailed description, see Chapters 2 and 3). However, interlocutors have no such expectations from new speakers. Researchers measure these expectations by measuring reaction time. If a speaker unexpectedly changes the referential expression she used previously to refer to an object (e.g., an object formerly called a shiny cylinder is later referred to as a silver pipe), adults and children are slower to understand what she means than if the speaker uses the same referential expression she used previously (Kronmüller & Barr, 2015; Matthews et al., 2010; Metzing & Brennan, 2003). Importantly, this slowing is only observed when interacting with the same interlocutor. With a new interlocutor, there is no conceptual pact and therefore no difference if the new speaker uses the same or a new expression (Metzing & Brennan, 2003). This reflects partner sensitivity. Although adults show sensitivity to conceptual pacts (Kronmüller & Barr, 2015),

preschool children do not show consistent expectations of referential expressions from specific interlocutors (Graham et al., 2014; Lindsay et al., 2019; Ostashchenko, Deliens, et al., 2019b).

6.1.2. Communicative principles with drawings

The majority of research with communicative principles such as conceptual pacts was focused on verbal language (Barr & Keysar, 2002; Graham et al., 2014; Köymen et al., 2014; Matthews et al., 2010). However, there seem to be striking similarities between different communicative systems, such as gesture, sign language, or drawing (Garrod et al., 2007; Healey et al., 2007; Hilliard & Cook, 2015; Lederberg et al., 2012). Experimental semiotics in particular has been investigating communication with drawings parallel to research in verbal referential communication (Galantucci et al., 2012).

Analogous to studies with verbal language (Brown-Schmidt, 2009), experimental semiotics showed that interactivity in communicative contexts with drawings is important for successful transfer of meaning (Fay, Walker, Swoboda, & Garrod, 2018). Moreover, when adults were communicating by drawing, the studies found evidence that the drawings simplified with the increased number of turns (Fay, Walker, Swoboda, Umata, et al., 2018; Healey, Garrod, et al., 2002). This parallels research with verbal language which shows that recurrent referential expressions are shortened with the increased number of repetitive references to the same object (Clark & Wilkes-Gibbs, 1986). Similarly, research in experimental semiotics showed that adults have a tendency to match interlocutor's drawing style in graphical communicative games, which is analogous to interlocutor's tendency to match each other in choice of referential expressions in verbal language (Garrod & Anderson, 1987; Healey, Garrod, et al., 2002).

In conclusion, the studies from experimental semiotics have already shown that adults can use drawings to communicate in a similar manner as they communicate with verbal language.

However, studies from experimental semiotics all used pairs of adult participants. There are a small number of studies with children (Callaghan, 1999; Light & McEwen, 1987), but they only assessed children's ability to understand and produce graphical symbols for communicative purposes, without evaluating their sensitivity to communicative principles. Moreover, the role of the artist's perspective in communication was overlooked. This chapter therefore evaluates whether children follow communicative principles with drawing, including if they take into account mental states of artists. In particular, this study focused on children's comprehension of conceptual pacts with drawings. Since research suggests that children recognise other's communicative intentions in drawings before they develop the skills to intentionally communicate through their own drawing (Callaghan, 1999, 2000, 2005), the first step to evaluating whether children follow communicative principles with drawing, is to focus on comprehension only.

6.1.3. Measuring comprehension in conceptual pacts

Research to date on comprehension of conceptual pacts in verbal language tested their existence by changing the specific expression (e.g., flying mammal vs black bat) and by exploring the degree to which changing the partner changes interlocutor's expectations (talking to a same interlocutor or talking to naïve interlocutor). To change specific referential expressions, synonyms were used (e.g., shiny cylinder vs silver pipe, or bunny vs. rabbit). If I wanted to create a parallel design with drawings, I would have to find two drawings that equally felicitously represent the intended referent as

synonyms do. However, that is quite difficult because drawings are iconic. Research shows that more a drawing resembles its intended referent, the easier is for the viewer to understand the meaning of the drawing (Garrod et al., 2007). Creating a parallel study design to verbal language, using drawings, thus might not be feasible.

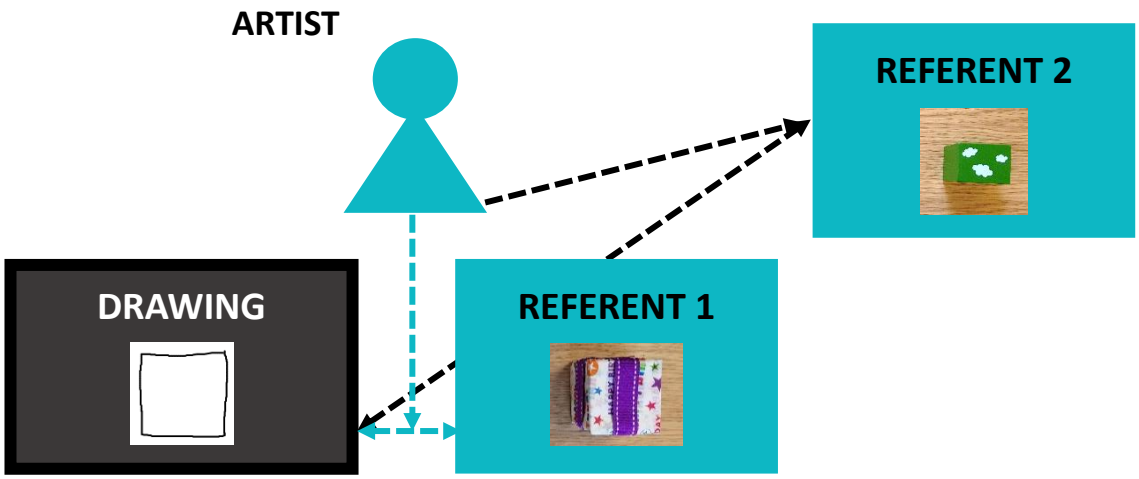


Figure 20. How to Manipulate Referents of Ambiguous Drawings within the Conceptual Triad.

However, given that the conceptual pact represents a conceptual triad (see Figure 20 and Chapter 2), this chapter tested if conceptual pacts could also be tested by changing the referent instead of changing the expression. Following the design and the idea of Chapter 3, this study was investigating whether children are sensitive to change in meaning of the artists' drawing (e.g., using a square to refer to a present, but then suddenly to refer to a cube), and sensitive to change of the partner (artist's using his drawing to refer to the present or a naïve interlocutor using the artist's drawing to refer to the present).

6.2. The current study

The current study tested whether children show sensitivity to conceptual pacts with drawings. After establishing the meaning of a drawing with its artist (establishing the relationship between the three elements of the conceptual triad), children's expectations in communication with the drawing were tested. To test whether the conceptual triad holds, the drawing was kept constant, but the meaning of the drawing and the interlocutor were manipulated (see Figure 20 to see how meaning was manipulated).

To keep the drawing constant, but change its meaning, I needed to use drawings that refer to two referents. Ambiguous drawings suit these requirements; since they equally resemble two different referents (e.g., a drawing of a circle resembles a plate or a ball). Consequently, I used four ambiguous drawings to establish four conceptual pacts. To measure whether pacts were established, half of the trials adhered to the pact, keeping the established meaning (e.g., a circle represented a plate), and half of the trials broke the pact (e.g., a circle represented a ball), changing the established meaning.

Moreover, to manipulate the interlocutor, half of the participants interacted with the artist throughout the experimental game, and half of the participants interacted first with the artist, to establish the conceptual pact, and then with a new interlocutor, to test the existence of pacts. Since conceptual pacts are partner-specific (Kronmüller & Barr, 2015), I wanted to test whether children are sensitive to partner's specific interpretation of the ambiguous drawing – in other words, if children expect the artist to use the same drawing to refer to the same referent. This would show conceptual pact sensitivity. Considering that ambiguous drawing's appearance is insufficient to determine its depicted referent, the research findings show that children take into

account the artist's intent to correctly interpret the drawing (Armitage & Allen, 2015; Browne & Woolley, 2001; Gelman & Ebeling, 1998; Preissler & Bloom, 2008). This suggests that children might prefer the intended referent when the artist is communicating with the drawing. On the other hand, children would probably not have any particular expectations of what the drawing depicts with a naïve interlocutor, who does not know which referent was drawn by the artist.

6.2.1. Measures of behaviour

Since the child's task in each trial was to correctly identify the target referent after the experimenter requested it with the drawing, I examined children's choices of referents. The array of offered objects allowed me to explore children's interpretation of ambiguous drawings. Participants could choose from four possible referents:

c) *the target referent,* which was described by the ambiguous expression (e.g., plate),

d) c) *two thematically related referents* (each related to one of the interpretations of the ambiguous drawing – e.g., spoon related to a plate and football shoe related to the ball) or

e) an unrelated referent (see Materials section for a detailed description).

If participants did not choose the target referent, their choice would still be informative of their reasoning process. I wanted to offer the participants the possibility to adhere to the perspective of the current interlocutor, even if that meant choosing another referent. With participants' choices of referent, I could explore the underlying reasoning for their interpretation of ambiguous drawings.

Moreover, I also measured participant's reaction times, following the designs of previous studies with conceptual pacts (Barr & Keysar, 2002; Matthews et al., 2010; Metzing & Brennan, 2003). I expected children would be fastest when choosing the drawn referent upon seeing the ambiguous drawing with the artist, but slower, if the artist requested a new referent with the same drawing. However, I was not expecting any differences in reaction time when a new interlocutor used the ambiguous drawing, regardless of the referent the interlocutor was requesting.

6.3. Experiment 1

6.3.1. Method

6.3.1.1. Participants

Fifty-one children participated in the Kent Child Development Unit at University of Kent. There were 19 three-year-old children (M_{AGE}= 3 years 6 months, SD_{AGE}= 3.9 months), 16 four-year-old children (M_{AGE}= 4 years 5 months, SD_{AGE}= 3.8 months), and 16 five-year-olds (M_{AGE}= 5 years 4 months, SD_{AGE}= 3.7 months). There were 27 boys (52.9%) and 24 girls (47.1%). The information about children's language was retrieved from our database. There were 78.5% monolingual children whose native language was English and 21.6% children were bilingual. Children were divided into two between-participants conditions such that in one condition participants communicated with only one experimenter throughout the experiment (N=26), and in the other condition participants communicated with two experimenters; a new experimenter replaced the first experimenter in the second phase of the experiment (N=25).

6.3.1.2. Design

The experiment used a mixed design, with change of referents (established meaning vs. new meaning) as within subjects variable and change of experimenters (same experimenter/artist[6] vs. new experimenter) as between-subjects variable.

Pairs of people, a participant and an experimental confederate, played the communication game together. The communication game had three phases: 1) the Entrainment phase, 2) the Interruption phase, and 3) the Test phase (see Figure 21). The participant's task was to find target objects requested by the experimenter with an

[6] The artist will be addressed as *experimenter 1* or *the same experimenter* from this point on in this chapter, to follow the expressions used in conceptual pact research with verbal language.

ambiguous drawing. There were four ambiguous drawings to refer to each of four target objects (see Table 19). In the Entrainment phase the participant and the experimental confederate first had to establish conceptual pacts, using these four ambiguous drawings. Experimenter clearly expressed a perspective of each referent by drawing it. To establish conceptual pacts, the experimental confederate asked the participant to label the drawing. This procedure was repeated with all four drawings until all four target referents were drawn. The Interruption phase followed to allow for change of experimenters. Half of the participants continued to the Test phase with the same experimenter, and half of the participants continued with a new experimenter.

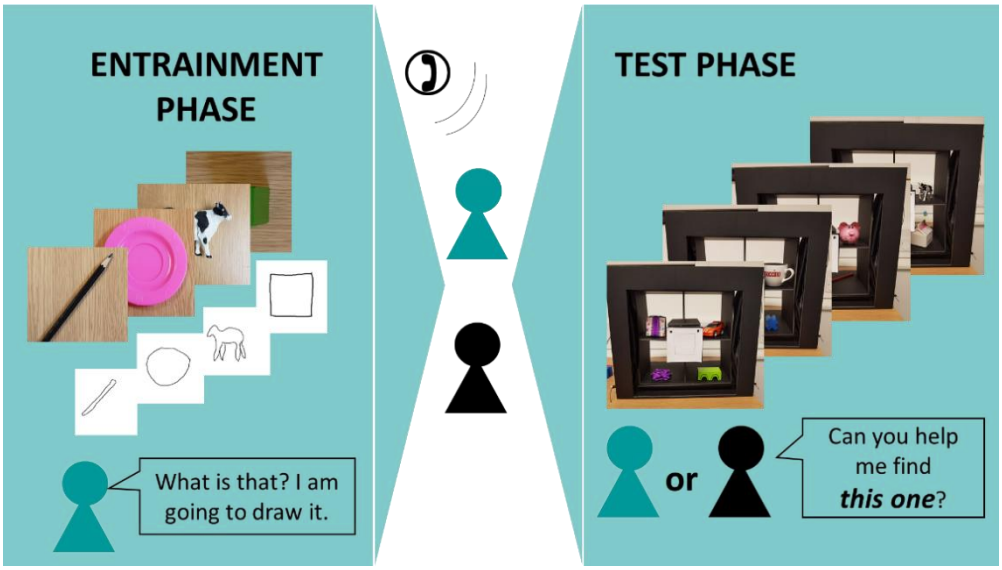


Figure 21. Schematic View of Two Phases of the Experiment.

The participant's task in the Test phase was to find the drawn referent in the grid among four offered toys. First, there was a warm up trial to make sure participant understood the task. There was one trial for each of the four ambiguous drawings, adding up to four trials. In two trials the grid with toys contained an object of the same category as drawn in the Entrainment phase (A – same meaning), and in two of the trials the grid contained a new category of an object (B – new meaning) – order ABAB. If

participants established conceptual pacts, they should be slower when the experimenter uses an ambiguous drawing to refer to a new category of an object compared to when it refers to the same category of an object (e.g., drawing of a circle to refer to a plate or to refer to a ball). Furthermore, if these pacts are partner-specific, this delay should be smaller with a new experimenter compared to the same experimenter.

6.3.1.3. Materials

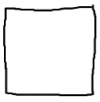
Four ambiguous drawings were hand-drawn and photocopied. Each of the ambiguous drawings depicted two referents equally felicitously: block/present, pencil/straw, cow/dog and plate/ball (see Table 19). In the Entrainment phase, four target objects were used. Each of the four target objects represented one meaning of the ambiguous drawing (e.g., circle represented the plate). The target objects in the Entrainment phase were a wooden block, a pencil, a cow and a plate. These exemplars were only used for the Entrainment phase.

Twenty unfamiliar objects were used in the Test phase (see Table 19). In each trial in the Test phase, the participant saw an array of four unfamiliar objects in each trial. For the warm up trial, the participant could choose between the zebra and three wooden letters. Following the warm up trial, there were four trials paired with four ambiguous drawings. In each trial, there was one target object and three other objects. **The target object** was manipulated to investigate the effects of changing the referent. In two of the four trials, the target object represented the established meaning of the ambiguous drawing (e.g., *circle* for a yellow plate). These trials allowed participants to keep the pacts. In other two trials, the target object represented a new meaning of the ambiguous drawing (e.g., *circle* for a ball). These trials represented cases where the pact

was broken. Other three objects that were in the array in a given trial are described in Table 19 (see b), c), d)). Four experiment scripts were prepared, where the order of four ambiguous drawings paired with four different trials was in a Latin Square design.

Table 19

*Objects and Drawings Used in the Entrainment and Test Phase of the Experimen*t

The Entrainment Phase		**The Test Phase** Keep Pact		Break Pact		
Target Object	**Ambiguous Drawings**	**Target:** Established meaning	b) Related to established meaning	**Target:** New meaning	c) Related to new meaning	d) Filler object
Green Block		Orange Block	Double bridge	Present	Bow	Car
Black Pencil		Brown Pencil	Rubber	Straw	Cup	Pig clock
Big Cow		Small Cow	Milk	Dog	Bone	Rubik cube
Pink Plate		Yellow Plate	Mug	Ball	Soccer shoe	Blue cross

Note. Each row within the Test Phase represents an array of objects. The order of presented arrays was paired with the counterbalanced order of four ambiguous drawings.

In the Entrainment phase, there were four objects in a box, whereas in the Test phase, a handmade theatre was placed between the experimenter and the child. The theatre was made out of black foam board. It consisted out of a frame (33 x 33 cm) with black curtains and an insertable grid. The grid was arranged in 2 X 2 pattern with an additional square in the middle of the grid. The curtains, which were attached to the

frame of the theatre, could be opened with a pull of strings on the left and right-hand-side of the theatre (see Figure 22). Apart from the middle square of the grid, other squares were uncovered, so it was possible to see through each square to the other side. The middle square of the grid offered a central position for the ambiguous drawing presented at each Test trial.

For each ambiguous drawing, there was pre-assigned positioning of the objects in the grid. The positioning of the objects ensured that the target objects were at four different quadrants for four different trials. This balanced participants' possible preferences for specific sides or quadrants.

Figure 22. Participant's View of the Theatre. The target toy in this case represents the wooden block which is referred to with an ambiguous drawing of a square.

6.3.1.4. Procedure

The child and their caregiver were invited to the Kent child development Unit where the caregiver read and signed informed consent forms. Both experimenter 1 (E1) and experimenter 2 (E2) were present to answer any questions and briefly describe the study. This was planned to ensure that the child had met and established contact with both experimenters. After signing the consent form, the child was seated behind a table.

There were two cameras used to record participant's reaction time (camera 1 from participant's left hand side) and to capture participant's choice of objects (camera 2 from participant's back).

In the Entrainment phase, E1 explained to the participant they will first have to pick a toy and the Experimenter will try to draw it. There was an open box on the table that contained (four) objects: a pencil, a pink plastic plate, a plastic cow and a green wooden block. Once the participant randomly picked one of the four objects from the box, E1 asked the participant to name that object. The experimenter seemingly drew the picked object, ostensibly looking at the object (the drawings were pre-prepared). E1 lifted her drawing and asked the participant: "What is this?" The participant had to label the drawing analogously to how they named the object before the drawing was made. In other words, participant had to understand the E1 made the drawing of the object they picked out of the box. The order of retrieved objects from the box was random. The Entrainment phase lasted until all four objects were retrieved out of the box and drawn by the E1.

Following the Entrainment phase, E1 coughed, making clear to E2 to interrupt the experiment. E2 came inside the test room with a phone call for E1.

In the same experimenter condition, E1 postponed taking the phone call and continued communication game with the participant.

In the new experimenter condition, E1 would have taken the call and told E2 that they are about to play the theatre game.

The Test phase of the experiment followed, where the participant and the experimenter played the *"theatre game*". The experimenter explained to the participant

that the goal of the game was to find the objects she (E1) will refer to. The experimenter put a pillow with a board attached to participant's lap. The board ensured that participant's hands were always in the same position before they picked an object out of the theatre.

The warm-up trial followed to practice the procedure of the game and make sure that the participants reached the objects. The experimenter put the theatre on the table. The participant was asked to *find the zebra*. As for all the subsequent trials, the experimenter counted to three and opened the curtains of the theatre to reveal the objects. If the participant did not try to reach object, they were prompted to touch the zebra.

After the warm-up trial, there were four test trials. First, the experimenter placed the objects according to the prechosen condition while the curtains were closed. Then, the experimenter placed the ambiguous drawing on the middle square of the theatre (see Figure 22) and said: "On three, when I open the curtains, I want you to *find THIS one* (pointing on the ambiguous drawing)." Before the experimenter opened the curtains, the participant could only see the ambiguous drawing in the centre of the theatre. The experimenter repeated the request and opened the curtains. After the participant had reached for one of the four objects, the experimented reacted with: "Good!/Well done!". If the participant did not pick any object, they were prompted with " Can you find *THIS one* for me?". If the participant still did not pick anything, the experimenter proceeded with the next trial. The experimenter presented the participant with four trials with four ambiguous drawings. The whole procedure lasted for about seven minutes.

6.3.2. Results

6.3.2.1. Choice of objects

To find out whether participants understood the task, I checked whether children chose the target objects in the Test phase more than any other alternative objects. Children's choices of objects were coded using videos that captured participant's behaviour from their point of view. The choices of toys are displayed in Table 20.

Table 20

Children's Choices of Objects in Percentages of Trials

Choice	Percent (%)
Target object	76.0
Object related to established meaning	11.8
Object related to new meaning	2.0
Filler object	7.8
No choice	2.5

Since children did not pick the target object in 26.0% cases, I performed chi-square test to examine whether there were any differences in children's error rates (did not choose the target object) between conditions. When comparing error rates in the same experimenter and new experimenter condition, there were no differences (χ^2 (2, N = 44) = .426, p = .808). I found marginally significant differences in error rates when comparing children's choices in the condition when they could choose the established meaning (keeping the pact) to the condition when they had to choose a new meaning (breaking the pact) (χ^2 (2, N = 44) = 5.851, p = .054).

In 70.83% of erroneous choices when the pact was broken, the children chose the toy related to the established meaning. In the case when the pact was kept, children chose the filler object in 50% of their erroneous choices.

6.3.2.2. Age differences in children's choice of objects

Table 21

Number (and Percentage) of Trials According to what Children of Different Ages Picked

Choice	Years		
	3	4	5
	N trials (% trials)	*N* trials (% trials)	*N* trials (% trials)
Target object	57 (75)	42 (66)	56 (87)
Object related to established meaning	8 (11)	10 (16)	6 (9)
Object related to new meaning	2 (3)	1 (2)	1 (2)
Filler object	8 (11)	7 (11)	1 (2)
No choice	1 (1)	4 (6)	0 (0)

When comparing whether children of different ages chose different objects across trials, chi-square analysis showed there were no significant differences (χ^2 (8, N = 204) =13.964, p = .083, see also Table 21). I also found that three-year-olds (χ^2 (4, N = 76) =3.518, p = .475), four-year-olds (χ^2 (4, N = 64) =8.267, p = .082), and five-year-olds (χ^2 (3, N = 64) =2.738, p = .434) did not choose differently when reaching for the established meaning vs. the new meaning of the drawing. Moreover, children did not choose differently in the same or the new experimenter condition (three-year-olds: χ^2 (4, N = 76) =5.964, p = .202; four-year-olds: χ^2 (4, N = 64) =2.932, p = .569; five-year-olds: χ^2 (3, N = 64) =1.983, p = .576).

6.3.2.3. Children's comments/protests

Children's comments were transcribed after they have retrieved the object from the theatre. I decided to perform this additional analysis after running the experiments since many children protested or made comments that could be relevant for the interpretation of the results.

Children commented on their choices after retrieving an object in 22 trials (10.8%). Their comments most often expressed confusion or protest, since they could not find the originally drawn object in the array of offered objects.

Examples:

- "This is a cup, but there is no plate."
- "Can't see it anywhere."
- "Ehm, there is nothing really in there. I can't find it. I can't pick because I can't find it."
- "It is not a pen but a straw."
- "It is supposed to be a plate but I can't see it."
- "But it wasn't actually a pencil."

In fact, there were more comments made after the children had to choose a new meaning for the ambiguous drawing, then when they could choose the established meaning (McNemar test: N=102, p=.012). Children made more comments in the new experimenter condition than in the same experimenter condition, but this just failed to reach significance (χ^2 (1, N = 204) = 3.623, p = .057). Out of all comments there were 27% three-year-olds, 41% four-year-olds, and 32% five-year-olds.

6.3.2.4. Reaction time

The reaction times were coded as a measure of comprehension of the ambiguous expressions. They represent the length of time it took the participant to

retrieve the toy in the trial. The reaction times were only coded in the for the Test phase of the experiment.

The videos of participants retrieving toys from the theatre were coded using the annotation tool ELAN (Wittenburg et al., 2006). Using videos capturing each participant's hand movement from the left side, the reaction times were obtained. The onset of reaction time was the time point when the theatre curtains completely opened and the end of reaction time was marked as the participant's reach into the theatre box, measured as the time point when participant's knuckles crossed the vertical line of the theatre. The first author of this paper, Rater 1, and three research assistant who were blind to experimental questions and conditions coded reaction times. All raters coded 25.00% of all the trials to establish inter-rater reliability (all coded 52 out of 204 trials). Inter-rater reliability for reaction time was very high ($ICC_{average}$ =.999, p<.001). The high reliability suggest there was a minimal amount of coding error by independent coders. In all subsequent analysis, I only included reaction times for trials when participants chose the target toy (for 70.833% trials), coded by Rater 1.

6.3.2.5. Analyses

Table 22 reports the mean raw reaction times for correct choices only. Since the time in which participants should pick the toy was not limited, I winsorized the reaction time outliers. I replaced the outliers with reaction times equal to two standard deviations from the mean (Ratcliff, 1993). I winsorized reaction time separately for four conditions: Keeping the pact-Same experimenter, Breaking the pact-Same experimenter, Keeping the pact-New experimenter, Breaking the pact-New experimenter. Moreover, as the reaction times were not normally distributed, I did further analyses with logistic transformations of reaction times (Baayen & Milin, 2010).

Table 22

Mean Raw Reaction Times (in Seconds) to Retrieve Target Objects

	Keeping the pact		Breaking the pact	
	M	*SD*	*M*	*SD*
Same experimenter	3.683	4.210	4.452	4.100
New experimenter	2.976	2.626	4.661	4.023

In order to examine possible significant predictors of participant's reaction time, I used linear mixed effects model lme4 package of R (Bates et al., 2014). The outcome measure of the model was log-transformed reaction time. The model fitting was performed with by-item and by-subject intercepts in the random structure. Pair of trials (First two trials vs. second two trials), experimenter (same vs. new partner), referent (same meaning vs. new meaning) and interaction between experimenter and referent were included as fixed factors within the model. This model was the result of backward selection removing predictors one at a time until the point when removing did not improve the model fit anymore (Baayen et al., 2008). Descriptive statistics for this model are provided in Table 23.

Table 23

Summary of the Converged Final Model Specifying Fixed Effects of a Mixed Liner Model Predicting Reaction Times of Children

Fixed Effects	Estimate	Standard Error	*df*	*t* value	Pr(>|*t*|)
(Intercept)	8.888	0.440	55.241	20.207	**0.001**
Pair of trials	-0.075	0.089	99.500	-0.842	0.402
Age	-0.011	0.007	40.495	-1.613	0.115
Experimenter	-0.117	0.171	77.685	-0.687	0.494
Referent	-0.409	0.211	8.192	-1.940	**0.088**
Experimenter*Referent	0.226	0.180	102.457	1.253	0.213

6.3.3. Discussion

The results suggest that children were not sensitive to partner's specific interpretation of the ambiguous drawing. In other words, children's choices of objects and reaction times for reaching the target object did not significantly differ when communicating with the same or a new experimenter. However, results suggest that children might have a preference for the established meaning of the ambiguous drawing in comparison to the new meaning of the ambiguous drawing.

Children picked the target object in majority of cases (76.0%) which shows that they understood the experimenter's communicative intent expressed with the drawing. Children picked the target object more often when the pact was kept (participants saw the same category of the object) compared to when the meaning changed and the pact was broken. Moreover, when children could not adhere to the pact they most often picked object related to the established meaning. This implies that children wanted to keep the pact and choose the established meaning. However, since that was

unavailable, they chose the thematically related object to the established pact. This result is surprising considering that the object related to the established meaning did not correspond to the shape of the drawing, but more with the artist's intent (e.g., when children could not pick a pencil, drawn with a line, they picked an eraser, which is also a stationery item). Previous research has found that if the artist's intent conflicted with the shape of the drawing, children and adults relied on shape when making inferences about the drawing's meaning (Browne & Woolley, 2001; Richert & Lillard, 2002). On the contrary, some children in the current experiment relied on the artist's intent, even if that contradicted the shape of the drawing. This suggests that perhaps establishing a conceptual pact, solidifying the meaning of the ambiguous drawing, created a stronger expectation to adhere to the original artist's intent.

Children's comments also suggest that the artist's original intent was perceived as binding. Transcriptions of comments show children were thinking about the original intent when presented with the new meaning of the ambiguous drawing (when the pact was broken). Similar findings were found in related studies, where children also protested to demonstrate violation of expectations about conceptual pacts (Matthews et al., 2010) or experiencing contrast between drawing's appearance and artist's intention (Armitage & Allen, 2015). As suggested by previous studies (Armitage & Allen, 2015), these comments show that children's understanding of drawings is becoming multifaceted – that is, they are becoming aware that multiple cues have to be taken into account to correctly interpret a drawing.

Although children's choices indicate that they showed sensitivity to the change of meaning of the ambiguous drawing, reaction time analysis did not confirm the same finding. With regards to partner-specific interpretations, neither children's choices nor

the reaction time analysis showed sensitivity to change of partners. Children's choice of objects and their reaction times were similar regardless of whether they interacted with the same partner throughout the experiment or if the partners changed. This corresponds to the most recent studies with verbal language (Lindsay et al., 2019; Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019) which showed that three to five year old children are egocentric in their interpretation of communication.

Children's choices and the linear mixed effects model of reaction times did not show any differences between children of different ages. Although differences between younger and older children were predicted when observing partner-specific interpretations of ambiguous drawings, since those might emerge with theory of mind skills, the results did not confirm this hypothesis.

Since research with verbal language suggests there might be some differences in how adults and children take into account interlocutors when understanding communication (Kronmüller & Barr, 2015; Lindsay et al., 2019; Metzing & Brennan, 2003; Ostashchenko, Deliens, et al., 2019b), it would be informative to see whether these differences might be observed with communication with drawings. Experiment 2 addresses this issue by replicating Experiment 1 with adult participants.

6.4. Experiment 2

Since children from three to five years of age are still developing their theory of mind skills (Wellman et al., 2001), it is possible that they did not employ their perspective taking skills in communication with drawings. Some research with children about conceptual pacts with verbal expressions have shown that children in that age range are egocentric (Lindsay et al., 2019; Ostashchenko, Deliens, et al., 2019b), but research with adults consistently shows that they are sensitive to partner-specific conceptual pacts (Kronmüller & Barr, 2015). Experiment 2 investigated whether, using the current experimental design, adults would replicate children's understanding of communication with drawings, or would they show a more partner-specific interpretation of drawings.

6.4.1. Method

6.4.1.1. Participants

Twenty-five undergraduates (M_{AGE}= 19.00 years) at the University of Kent participated in return for partial course credit. Three students (12.00%) were male. Twenty students were native English speakers (80.00%) and the others were non-native speakers of English. There were 17 first-year students (68.00%), seven second-year students (28.00%) and one fifth-year student. Participants were divided into two between-participants conditions such that in one condition participants communicated with only one experimenter throughout the experiment (N=12), and in the other condition participants communicated with two experimenters; a new experimenter replaced the first experimenter in the second phase of the experiment (N=13).

6.4.1.2. Design, materials and procedure

The experimental stimuli, design and procedure was the same as in the Experiment 1. The only difference in the design for adults was implemented in the Test phase. An additional black box was put below the theatre so that the theatre was risen to the participant's eye level.

6.4.2. Results

6.4.2.1. Choice of Objects

Adult participants chose the target object in 91.90% of the trials, object related to established meaning 8.10% of the trials and did not choose any object in 1.00% of the trials. Since adult participants did not pick the target object only in 8.10% of the trials (10 trials), the number was too small to perform chi-square test with these choices. Therefore, I describe adults choices.

Objects related to the established meaning (wooden bridge and a mug) were chosen only in the condition when the pact was broken. However, choosing any other than target object was equally frequent with the same partner (4 trials) and new partner (4 trials).

6.4.2.2. Reaction time

The reaction times were coded in the same manner as they were for Experiment 1. The first author of this paper, Rater 1, and a research assistant who was blind to experimental questions and conditions, Rater 2, coded reaction times. Both raters coded 66.00% of all the trials to establish inter-rater reliability (both coded 66 out of 100 trials). Inter-rater reliability for reaction time was high (Pearsons r = .968, p=.000/ ICC =.984, p=.000). The high reliability suggest there was a minimal amount of coding error by

independent coders. In all subsequent analysis, I only included reaction times for trials when participants chose the target toy (for 91.90% trials), coded by Rater 1.

6.4.2.3. Analyses

Table 24 reports the mean raw reaction times for adult's correct choices only. Following the data preparation as in Experiment 1, I winsorized the reaction time outliers, and did further analyses with logistic transformations of reaction times (Baayen & Milin, 2010).

Table 24

Mean Raw Reaction Times (in Seconds) for Adults to Retrieve Target Objects

	Keeping the pact		Breaking the pact	
	M	*SD*	*M*	*SD*
Same experimenter	1.384	0.843	4.388	4.258
New experimenter	1.278	1.105	2.926	2.772

The linear mixed-effects model fitting was performed with by-item and by-subject intercepts in the random structure. Descriptive statistics for this model are provided in Table 25, showing that only manipulation of the referent significantly contributed to differences in adult's reaction times.

Table 25

Summary of the Converged Final Model Specifying Fixed Effects of a Mixed Liner Model Predicting Reaction Times of Adults

Fixed Effects	Estimate	Standard Error	*df*	*t* value	Pr(>|*t*|)
(Intercept)	7. 874	0.251	49.292	31.408	**0.000**
Pair of trials	-0.126	0.114	57.751	-1.106	0.273
Experimenter	0.368	0.218	44.396	1.691	0.098
Referent	-0.844	0.213	9.997	-3.958	**0.003**
Experimenter*Referent	-0.124	0.230	57.439	-0.541	0.591

6.4.3. Discussion

Adults did not show partner-specific interpretations of ambiguous drawings, which means that adult's choices of objects and adult's reaction times did not significantly differ when communicating with the same or with a new experimenter. However, adults did show some differences in behaviour when choosing the established meaning or a new meaning of the ambiguous drawing. Although adult's choices of objects did not indicate these differences, the reaction time analysis revealed that adults needed more time to choose the new meaning than the established meaning of the ambiguous drawing.

Adult's choices of objects did not show any differences between different experimental conditions. Adults picked the target object in 91.9% trials, which shows they understood the experimenter's communicative intent in test trials. The adults picked the target object in most trials regardless if they picked the established meaning or a new meaning of the ambiguous drawing. This demonstrates adult's

representational flexibility when interpreting the ambiguous drawing. Similarly, Allen, Nurmsoo and Freeman (2016) also found that around 93% adults accepted two labels for the same ambiguous drawing. These results together suggest that ambiguous drawings are flexible symbols that allow for a flexible interpretation regardless of the original intent.

Although adults showed no significant differences in their choices of objects between picking the established meaning or the new meaning, the reaction time analysis revealed that they were quicker at picking the established meaning. This demonstrates that adults did take the artist's intent into account and reacted faster when the drawing was used accordingly. This sensitivity to intentionality has usually been measured with adult's labelling the drawing (Allen et al., 2016; Browne & Woolley, 2001), but not with implicit measures as reaction time. Therefore, this study is the first to detect adult's sensitivity to artist's intent with implicit measures.

The analysis of reaction times indicated that adults expected the same ambiguous drawing will refer to the same referent. However, this expectation was not only observed with the same experimenter (E1), but also with a new experimenter (E2). This suggests that adults did not show partner-specificity in communication with drawings (see Effect of the Experimenter in Table 25). If adults considered mental states of the experimenters, then adults should be faster when retrieving the established meaning in comparison to the new meaning only with E1. That was expected because only the artist of the drawing (E1) knew what she intended the drawing to represent (e.g., she drew a circle to represent a plate). On the contrary, E2 was not aware of the artist's intentions therefore, there was no expectation of difference in reaction times between the established and the new meaning with E2. However, the results did not

confirm these predictions. This did not corroborate the findings from studies with verbal communication that indicated that adults utilize a mature understanding of other's mental states when interpreting communication (Brown-Schmidt, 2009; Kronmüller & Barr, 2015; Metzing & Brennan, 2003).

To summarise, adults performed similarly to children, showing only sensitivity to change in meaning of the ambiguous drawing. Although the expectation was that adults would show sensitivity to change of experimenters, even if children did not, the results did not confirm this expectation.

6.5. General discussion

Both children and adults showed sensitivity to change in meaning of ambiguous drawing. Children showed preference for the established meaning of the ambiguous drawing in their choices of referents. Adults indicated their preference for the established meaning of the ambiguous drawing with reaction time; they were faster at picking the established meaning than a new meaning. However, neither adults nor children showed differences in behaviour when communicating with the same or a new experimenter. There was no indication of partner-specific interpretation in communication with drawings.

6.5.1. Taking into account the mental state of the interlocutor might not be an automatic process

Conceptual pacts are defined as mutually accepted agreements between specific interlocutors (Brennan & Clark, 1996). They create expectations of how will the particular interlocutor refer to a referent, but create no specific expectations of how will any new, naïve interlocutors refer to referents. Therefore, the agreement relies on the identity of the speaker. One stream of explanations for these partner-specific expectations is that a listener automatically takes into account the knowledge that interlocutors share when resolving reference (Brown-Schmidt, 2009; H. H. Clark & Carlson, 1981; H. H. Clark & Marshall, 1981). That means that a listener expects that the particular interlocutor will reuse the conceptual pact. Listeners' use of information about what their interlocutor already knows was shown to facilitate understanding of the intended meaning (Arnold, 2008; Brennan & Clark, 1996; Shintel & Keysar, 2007).

The results with children and adults from the current experiment with drawings suggest that their expectations for the established meaning did not rely on the identity

of the speaker. It is possible that taking into account the experimenter's knowledge was not necessary to successfully perform the task. Since there was only one object that corresponded with the shape of the drawing, children and adults perhaps did not have to employ their reasoning about experimenter's knowledge about what was the original referent of the drawing.

In fact, another stream of explanation for partner-specific interpretation in communication suggests that taking into account the mental state of the experimenter in communication might be a non-automatic process (Barr et al., 2014; Pickering & Garrod, 2004), that is only used in later stages of processing meaning (Kronmüller & Barr, 2007). That stream suggests that both children and adults are egocentric by default when processing communication, but adults become better at correcting their egocentric perspective to accommodate any differences between their own and their interlocutor's perspective (Epley et al., 2004a). Therefore, considering another's mental state according to this stream of explanations is only activated if necessary. Since the current experiments offered only one referent in each array that corresponded to the shape of the drawing, it is possible that both children and adults did not have to employ their mental state reasoning.

To address the assumption of effortful mental state processing in communication, I could adapt the experiment. Instead of offering only one object that corresponded to the shape of the drawing in the array, I could offer two. The participants could choose between the established meaning (e.g., referring to a plate with the drawing of a circle), the new meaning (e.g., referring to the ball with the drawing of a circle), or two unrelated meanings. If participants were more likely to choose the established meaning when interacting with the same experimenter, but were equally

likely to choose the established or a new meaning with a new experimenter, then their choices would confirm the partner-specific interpretation in communication with drawings.

6.5.2. Choices of objects could just reflect symbolic understanding

It is also possible that children's and adult's choices of objects in the theatre did not reflect adherence to conceptual pacts or lexical entrainment, but could just reflect their understanding of symbolic nature of drawings. Since only one object in the array corresponded with the appearance of the ambiguous drawing, interpretation of the drawing's shape could lead participants' correct choice of the target object, without taking into account the referential history of using that ambiguous drawing. Choosing the objects that correspond to the shape of the drawing reflects participant's understanding of picture-referent relations (Ganea et al., 2008; Preissler & Carey, 2004). Furthermore, research shows that drawing's appearance plays a big part when interpreting it's meaning (Browne & Woolley, 2001; Hopkins, 1998; Richert & Lillard, 2002). It could also be the case that the drawing's appearance led inferences about the creator's intent (Bloom & Markson, 1998). Participants could have used the drawing's shape as a cue to infer the interlocutor's intention to her question: "Can you help me find this one?". This would also explain why children and adults did not have to employ their reasoning about experimenter's knowledge about what was the original referent of the drawing.

Because of the aforementioned features of the design of the test phase (offering only one object that corresponded with the shape of the drawing), I could not exclude these alternative explanations for participant's choices of target objects. However, that is why I included the measure of participant's reaction time. Although the majority of

children and adults chose the target item, I could reason about their underlying processes of comprehension by comparing reaction times in different conditions. As seen from some conceptual pact research with children (Graham et al., 2014), explicit measures of behaviour did not correspond with the implicit measures, such as reaction time. It is possible that participants' choices would not reflect the same differences as their reaction times. That occurred with adults, who only showed sensitivity to change in ambiguous drawing's meaning in reaction time analysis. However, neither of the measured groups used in the current experiment indicated partner-specific effects. Moreover, even with measuring participants' reaction time, I could not test whether conceptual pacts were established in the first place. Or in other words, whether the referential history with a drawing had any influence on the subsequent interpretation of the drawing.

To offer the possibility of measuring whether pacts were established, I could have added a baseline condition (Kronmüller & Barr, 2015). This proposed baseline condition would have a different entrainment phase. Instead of entraining on the four ambiguous drawings, participants could just label some randomly made drawings by experimenter (e.g., the experimenter would draw a butterfly). After, they would participate in the same test phase as designed in the current experiment (e.g., seeing a picture of a circle to refer to a ball). If the results in the baseline condition would differ from the experimental condition, then I could assume that the differences between these two conditions were led by established conceptual pacts when choosing the target object. However, if participants showed the same behaviour in the test phase even if they did not form pacts with the ambiguous drawings, then I could assume that pacts were not established.

6.5.3. Preferences for established meanings show that ambiguous line drawings can refer to categories

To eliminate the effects of familiarity and memory, the objects in the entrainment phase and in the test phase always differed. If the experimenter drew a pink plate in the entrainment phase, the participants could not see the pink, but a yellow plate in the test phase. This was not the case in the previous studies of conceptual pacts with verbal expressions (Graham et al., 2017; Metzing & Brennan, 2003; Ostashchenko, Deliens, et al., 2019b). However, since conceptual pacts are by definition agreements about concepts, not particular exemplars of referents, I wanted to examine if that holds when establishing conceptual pacts with drawings.

It has been suggested that understanding of drawings as symbols develops by using them as labels for particular exemplars of referents, and later develops to understanding drawings as reflecting categories or concepts (Myers & Liben, 2012). Ambiguous line drawings in particular have been shown to have more potential to be interpreted as categories than coloured drawings (Armitage & Allen, 2015). The results from the previous chapter further confirmed that four and five year old children and adults all interpret ambiguous drawings in communication as categories. Therefore, the foundation for establishing conceptual pacts with drawings as categories has been demonstrated.

Children and adults in current experiments showed a clear preference for the established meaning compared to the new meaning of the ambiguous drawing. Consequently, this supports the assumption that ambiguous drawings are interpreted in communication as categories. Moreover, it also suggests that children and adults could establish an agreement in communication that was not restricted to particular

exemplar of a referent, but to the same category of a referent. This was already supported in verbal language with children, who showed lexical entrainment with objects of the same category (Lindsay et al., 2019), but has not yet been showed in communication with drawings.

6.5.4. Further improvements

6.5.4.1. Controlling participant's language

The research shows that bilingual children are more successful in understanding that the same symbol might have more than one interpretation (Bialystok & Shapero, 2005; Falandays & Spivey, 2020). Or in other words, bilingual children show more cognitive flexibility (Adi-Japha et al., 2010; Bialystok & Martin, 2004), which could aid when switching between the condition when the pact was kept (same category of a referent) and when the pact was broken (different category of a referent). Bilinguals' faster switching abilities could contribute to the decrease of the differences between the conditions. That could potentially skew the results of the experiments.

However, I did not control the children's language due to limited resources. Since this study could only be done in the Kent Child Development Unit, our University laboratory, multiple other researchers and I had to accommodate our needs to space and time constraints. The majority of children, who participated in this study were monolingual (78.5%), therefore any comparison of performance between bilingual and monolingual children would not be a valid reflection of any potential differences. Despite that, the results could be clearer if controlling for language of children and adult participants.

6.5.5. Conclusion

Experimental semiotics has been predominately focusing on research with adults (Fay, Walker, Swoboda, Umata, et al., 2018; Galantucci et al., 2012; Healey, Garrod, et al., 2002), thus examining some linguistic principles with drawings with both adults and children was one of contributions to the field. Although the results of the current experiments did not provide enough evidence to conclude whether adults or children established conceptual pacts in communication with drawings, they suggested some other important characteristics of comprehension of ambiguous drawings in communication.

The results showed that the artist's intent does have an effect on the subsequent use of the same drawing in communication. In particular, both children and adults show a preference for the intended meaning of the drawing. This suggests a preference for consistent use of symbols in communication, which corroborates with the phenomenon of lexical entrainment that has been shown in verbal language (Garrod & Anderson, 1987; Lindsay et al., 2019) and also in adult's communication with drawings (Healey, Garrod, et al., 2002).

Moreover, the results suggest that both children and adults are egocentric in comprehension of communication with drawings. However, it is possible that the current study design did not offer the opportunity for participants to utilize their skills of perspective taking in communication, so further research using suggested improvements of the design would give a clearer understanding whether children and adults use their social perspective taking in communication with drawings. Despite that, the results extended the findings from Allen, Nurmsoo, and Freeman (2016), showing

that children and adults are representationally flexible when assigning meaning to an ambiguous drawing in communication.

CHAPTER 7: GENERAL DISCUSSION

This thesis explored how children use their developing theory of mind (ToM) to understand ambiguous referential expressions and ambiguous drawings. In particular, the thesis focused on how understanding of drawings parallels understanding of verbal language, and thus investigated communicative underpinnings with ambiguous drawings. Since children develop ToM skills between three and five (Wellman et al., 2001; Wellman & Liu, 2004), and ToM has been connected with the capacity to communicate effectively (Achim et al., 2015; Maridaki-Kassotaki & Antonopoulou, 2011; Sidera et al., 2013, 2016), this thesis focused on children in this age range.

7.1. The pillars of the conceptual triad do not have the same weight in verbal language

Successful understanding of communication entails resolving meaning and thus intention of the speaker (Keysar et al., 2000). The utility of ToM skills in communication has been particularly important when resolving ambiguous messages (Achim et al., 2015; Keysar et al., 2000; Sidera et al., 2016). One communication principle that explains how to avoid ambiguity are *conceptual pacts* (Brennan & Clark, 1996). Conceptual pacts are consistent expressions that speakers tend to reuse and expect from the same speaker in a given conversation. The systematic review in **Chapter 2** focused on the research with children on *conceptual pacts*. Since one stream of theories explains that the expectations that the same speakers will use the same referential expressions rely on the social perspective taking abilities, research with children is particularly well positioned to determine if ToM abilities are needed for following conceptual pacts. If these expectations are reliant on ToM skills (Brennan & Clark, 1996), children should show developmental change of conceptual pact sensitivity between the ages of three

and six. However, Chapter 2 found that some studies confirm that children as young as three show adult-like understanding of conceptual pacts (Graham et al., 2014; Matthews et al., 2010), whereas others show that even five year old children do not have partner-specific expectations (Ostashchenko, Deliens, et al., 2019b; Ostashchenko, Geelhand, et al., 2019). To address the inconsistencies, **Chapter 3** tested children's conceptual pact sensitivity with a novel design. Instead of testing whether children are expecting the same speaker to use same referential expressions, Chapter 3 tested whether, given the same speaker and expression, children and adults are expecting the same *referent*. In other words, whether conceptual pacts create not only expectations of specific referential expressions, but also partner-specific meanings. The results in Chapter 3 showed that neither adults nor children showed sensitivity to partner-specific meaning. They did not expect a particular speaker to use an ambiguous expression consistently to refer to the same meaning. Instead, they showed semantic flexibility regardless of which speaker used the ambiguous expression. This might suggest that relationships in the conceptual triad between the person, the symbol, and the meaning, might not have equal weights. Changing the referential expressions has been shown to break the pact, resulting in delay in comprehension (Matthews et al., 2010; Metzing & Brennan, 2003; Yoon & Brown-Schmidt, 2014), but changing the meaning of the expression does not have the same effects.

7.2. Utilizing ToM skills when resolving meaning of ambiguous drawings

Chapter 4 introduced first steps towards the exploration of the same communication principle of conceptual pacts, but with drawings. Since successful interpretation of referential communication is connected to perspective-taking skills (R. J. Roberts & Patterson, 1983), namely determining the speaker's knowledge and belief

(H. H. Clark et al., 1983), the same was tested with ambiguous drawings. Children and adults listened to a narrated story with a character, who produced ambiguous drawings. The participants had to label the character's drawings by taking into account her knowledge and belief. Chapter 4 suggested that even three-year-old children and adults can reason about an artist's knowledge when labelling her drawing. The results provided evidence that children's interpretation of drawings, parallel to understanding verbal expressions (B. P. Ackerman et al., 1990; Diesendruck & Markson, 2001; Resches & Perez Pereira, 2007), entail inferring the artist's knowledge. However, children and adults showed some mixed results when reasoning about artist's belief. Interestingly, correctly inferring speaker's belief from verbal expressions has also shown contrasting findings, where one study suggested that children as young as three can reason about beliefs when interpreting a verbal message (Robinson & Mitchell, 1992), but these results could not be replicated (Robinson & Mitchell, 1994). Together, Chapter 4 provided evidence that children and adults can reason about artist's knowledge when labelling her drawing, but reasoning about artist's belief is more complex, analogous to children's performance in studies with verbal expressions.

7.3. Ambiguous drawings as communicative symbols

Nevertheless, to create additional parallels with verbal language, this thesis also focused on interpretation of drawings in communicative interactions. **Chapter 5** explored how children interpret drawings as symbols in a communicative context. Comparable with generalisation studies with verbal language (Saalbach & Schalk, 2011; Yoshida & Smith, 2003), children and adults in Chapter 5 had to sort objects following a communicative request with an ambiguous drawing. Both adults and children generalised meaning of the ambiguous drawings to the drawn referent's category,

which corresponds with studies of noun generalisation (Cimpian & Markman, 2005; Diesendruck & Bloom, 2003; Saalbach & Schalk, 2011; Samuelson et al., 2007; Yoshida & Smith, 2003). Moreover, children and adult's generalisation in communication also reflected their adherence to the artist's initial intent. Although many objects corresponded with the shape of the drawing, the participants only chose the objects that were from the same category as the drawn referent, persevering with the experimenter's intent.

Chapters 4 and 5 together demonstrated some characteristics of ambiguous drawings that parallel the properties of verbal language. Building further on this evidence, the more recent studies from experimental semiotics (Fay et al., 2013; Fay, Walker, Swoboda, & Garrod, 2018; Galantucci et al., 2012) clearly show that both verbal language and drawings are symbols that have the potential to be used in communication (Rakoczy et al., 2005). Experimental semiotics provided evidence that adults can deploy similar communication principles with drawings as they do with verbal language. Adults simplified the drawings with repeated references and aligned with their partners when producing drawings referring to previous mentioned referents (Fay, Walker, Swoboda, Umata, et al., 2018; Healey, Garrod, et al., 2002). Therefore, adults showed alignment when communicating with drawings, but experimental semiotics has not yet looked at conceptual pact sensitivity with drawings. To extend the findings of adults, and create further comparisons with verbal language, **Chapter 6** investigated children's and adults' understanding of conceptual pacts with drawings.

Using the study design of Chapter 3, Chapter 6 investigated whether children and adults show sensitivity to partner-specific meaning of an ambiguous drawing. One partner established the initial meaning (creating a conceptual pact) by clearly drawing a

target (e.g., a circle as a plate). The same partner or a new partner used the same drawing (e.g., the circle) to request an object from an array including either the original object or a new, similarly shaped object (e.g., a ball). The results showed that both children and adults were sensitive to change in meaning of ambiguous drawing (e.g., using the circle to request a plate vs. requesting a ball). However, children and adults did not show any partner-specific interpretation in communication with drawings, which aligns with findings with ambiguous verbal expressions from Chapter 3. Contrary to the findings of Chapter 3, children and adults showed a preference for the intended meaning of the drawing, which means that the artist's intent did have an effect on the subsequent use of the same drawing in communication. This confirmed the preference for consistent use of symbols in non-verbal communication (Fay, Walker, Swoboda, Umata, et al., 2018; Healey, Garrod, et al., 2002), and corroborated with the phenomenon of lexical entrainment that has been shown in verbal language (Garrod & Anderson, 1987; Lindsay et al., 2019). However, both Chapter 3 and Chapter 6 showed that participants were egocentric when interpreting the ambiguous expressions and drawings, raising questions about the involvement of perspective taking skills in comprehension of conceptual pacts.

7.4. How do results from this thesis inform Freeman's intentional network theory?

Freeman (see Figure 1 in Chapter 1) describes four entities in his intentional network theory, that together contribute to full understanding of pictures. The recent systematic review by Vivaldi and colleagues (2020) which looked at people's understanding of pictures through the lens of the Freeman's intentional network theory (Freeman, 1995, 2008), discovered that artist's intent remains the most researched

mental state. However, in order to understand the link between the artist and the drawing (Freeman, 1995, 2008; Vivaldi et al., 2020), more research investigating the relation between all the artist's attributes (mental states, style, cultural background, age) and the pictorial outcome was requested. Especially the consideration of artist's mental states such as desires, knowledge and belief are scarcely investigated (Vivaldi et al., 2020).

The focus of Chapter 4 was also put on the A–D link, addressing the seldom researched artist's knowledge and belief. Although Vivaldi and colleagues (2020) came to a conclusion that understanding of the artist's knowledge develops in mid-childhood, the data in Chapter 4 showed that even three year olds can take artist's knowledge into consideration. However, understanding artist's belief extended beyond the A-D link. In order for the viewer to understand that the artist is drawing based on their false belief (Jessica thinks there are Smarties inside), the viewer also has to understand that the artist's reality is different than their reality (see Figure 23). The child saw there are pennies inside the tube (Viewer's reality), but in order to interpret Jessica's drawing correctly, the child had to understand that Jessica's reality was different (she believed there are Smarties inside the tube – Artist's reality). And understanding artist's belief, which connects Reality-Artist-Drawing, seems to be more difficult than understanding artist's knowledge. Chapter 4 therefore connected the Artist-Drawing link with Reality and created the first attempt to test people's understanding of artist's beliefs.

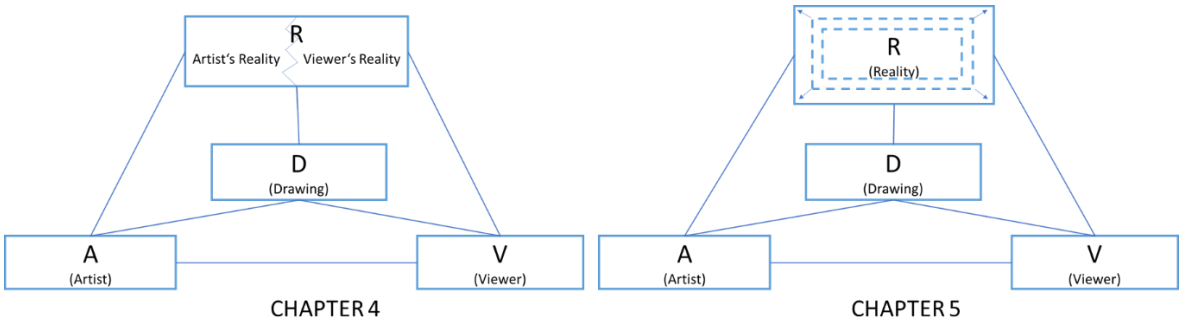


Figure 23. Extending Freeman's intentional network in Chapters 4 and 5.

Chapter 5 focused on the D-R link. It explored how broadly does the drawing represent the world when interpreted by the viewer. Research usually looked at perceptual similarity between the drawing and the drawn referent (Ganea et al., 2008; Preissler & Carey, 2004; Vivaldi et al., 2020), but I explored how is the meaning of the drawing generalised in communication. That is, I used the drawing in communication and tested what Reality does the Drawing refer to (see Figure 23). The results revealed that in communication, people assign a broader content of referents to the picture. More precisely, people can use ambiguous drawings in communication to refer to categories of referents.

Lastly, Chapter 6 explored whether this intentional network between the four factors holds only with the artist of the drawing, or whether the interpretation of the drawing is any different if a naive person is using the picture for communication. The results showed that the viewer interprets the drawing similarly regardless if the artist or a naive person is presenting the drawing. Moreover, the viewer always prioritizes the initial intent when interpreting the drawing compared to any other possible interpretation.

Although Freeman's model (1995, 2008; Freeman & Sanger, 1995) focuses on the pictorial medium, it is analogous to the verbal medium, which was also explored in this thesis. Chapter 3 tested whether the Freeman's intentional network or the Conceptual triad (see Figure 2 in Chapter 2) holds only with the original interlocutor. The results indicated that children and adults were not sensitive to change in interlocutors.

Collectively, this thesis emphasized the interconnectedness of all four entities of the Freeman's intentional network theory (1995, 2008; Freeman & Sanger, 1995), extended the findings concerning A-D link and created parallels between understanding of pictures and understanding verbal language. Most importantly, I designed first attempts to measure understanding of pictures as communicative symbols and discussed their use through Freeman's intentional network theory (1995, 2008; Freeman & Sanger, 1995).

7.5. Is using ToM skills in communicative context an effortful process?

Although the Chapter 4 provided evidence that even three-year-old children can reason about the artist's knowledge when labelling their drawing, it is not clear why children in Chapter 6 did not show any differences when they interacted with the same or a new experimenter. Since the same experimenter knew what the drawing originally referred to, she was knowledgeable about the original referential intent, whereas the new experimenter was ignorant about the original referential intent. Chapter 4 showed that children can distinguish between a knowledgeable and an ignorant artist, but Chapter 6 did not confirm these findings. Similar discrepancies between children's understanding of mental states and the inability to use them in communication were also shown by research in verbal language. The latest studies looking into referential pact sensitivity showed that three to five-year-old children are egocentric (Lindsay et al.,

2019; Ostashchenko, Deliens, et al., 2019a; Ostashchenko, Geelhand, et al., 2019). Although children in this age range do show some understanding of knowledge and beliefs of others (Wellman et al., 2001; Wellman & Liu, 2004), they do not always demonstrate this understanding in verbal communication.

Westra (2016) has attemped to explain this discrepancy with the *pragmatic development account*. His proposal claims that young children are capable of representing mental states of others, but they have to learn through experience to use this ability in communication. This could explain children's egocentric performance in chapters 3 and 6, since they might not be able to correctly attribute speaker's knowledge in communication, although they already have some understanding of mental states of others. This is perhaps why neither chapter 3 or 6 found partner-specific effects of conceptual pacts with children. However, if the *pragmatic development account* (Westra, 2016) holds, then adult participants in chapters 3 and 6 should show sensitivity to partner-specific meaning. However, neither of these chapters confirmed partner specific sensitivity of conceptual pacts with adults.

Nevertheless, adult's egocentric interpretation of ambiguous referential expressions and ambiguous drawings also has a possible explanation. A small number of studies have shown that partner-specific effects in comprehension of conceptual pacts emerge after the initial processing of the referential expressions takes place (Barr & Keysar, 2002; Keysar et al., 1998; Kronmüller & Barr, 2007). This means that participants first interpret communication by revisiting the stored associations between the referential expressions and their meanings (e.g., "the round one" for the plate), and process information about specific speakers with a delay. In other words, these studies claim that initial understanding of communication is egocentric, and is later corrected

by taking into account the perspective and knowledge of the speaker only if necessary. Moreover, some argue that both children and adults first process communication egocentrically, but adults are better able to correct the egocentric interpretation and take into the account the speaker's perspective (Epley et al., 2004b). All these studies detecting the delay in partner-specific interpretations used eye-tracking measures (Barr & Keysar, 2002; Epley et al., 2004b; Keysar et al., 1998; Kronmüller & Barr, 2007). Since I did not use eye-tracking measure in chapters 3 and 6, I cannot confirm nor reject this interpretation of dual-processing account of understanding communicative references. However, it is possible that taking into account the knowledge and perspective of the speaker/artist in communication is an effortful process, which is learned and only used if necessary.

7.6. The influence of context in interpretation of ambiguous symbols

Symbols are ambiguous when they have more than one meaning. A circle can represent a plate, a peach, a coin or a ball and so on. There are several explanations for how the correct meaning of ambiguous symbols is resolved. In this thesis, the focus was on the utility of mental states of the speaker to resolve the correct meaning of the ambiguous symbol. Research with drawings has repeatedly shown that especially when drawings are ambiguous, children take into account the artist's mental state to correctly interpret the drawing (Barquero et al., 2003; Browne & Woolley, 2001; Hartley & Allen, 2015; Vivaldi & Salsa, 2014). Similar analogies can be drawn with verbal language as children were shown to use the knowledge shared by the speaker and the listener to interpret ambiguous sentences or referential expressions (B. P. Ackerman et al., 1990; Nadig & Sedivy, 2002; Nilsen & Graham, 2009). Therefore, utilising ToM skills to resolve ambiguities in communication has been repeatedly demonstrated. This thesis also

provided some supporting evidence. The children in Chapter 4 took into account Jessica's knowledge to correctly interpret the colour of the car she had drawn. Moreover, participants in Chapter 5 generalised the meaning of a drawing to the category of the artist's referential intent (e.g., when the artist drew a pencil, the participants generalised the meaning of that drawing to the category of pencils). However, chapters 3 and 6 did not demonstrate corresponding results, but instead showed children and adult's egocentric interpretation of ambiguous symbols. That implies that participants did not take into account the speaker's/artist's mental state when interpreting their ambiguous symbols.

The participant's performance in chapters 3 and 6 could be explained with another assumption that claims that the context also influences the interpretation of ambiguous symbols (Heruti et al., 2019; Mazzocco, 1997; Mazzocco et al., 2003; Misyak et al., 2016). The context can be a sentence in which the ambiguous referential expression is uttered ("Can you push on *the round one*?" vs. " Can you pass me *the round one*?"), an array of objects (a black car in a parking lot full or cars or a car on a deserted road), or a drawing's label (a drawing of a circle labelled as an "orange" or as a "plate"). Consequently, the meaning of ambiguous symbols can be distinguished by the communicative context (Doherty, 2004; Misyak et al., 2016). In particular, when the context creates only one suitable meaning of the ambiguous symbol, but the alternative meanings are not offered, then the context has an important role for reference resolution of that ambiguous symbol (Snedeker & Trueswell, 2003). For example, if one is talking about *the bat* while seeing multiple referents on the computer screen, including the flying mammal and the wooden baseball club, the referential context does not have an essential role in reference resolution. If however, one is talking about *the*

bat during a cave visit, the context clearly indicates that the word is referring to the flying mammal. The former example is analogous to the case in chapters 3 and 6, where the context in the test phase clearly limited the interpretation of the ambiguous symbol. To explain, the array of objects in the theatre did not display multiple meanings of the ambiguous symbol, but endorsed only one (see Figure 24).

Figure 24. Example of Two Trials, where the Available Objects Create a Context, which Endorses a Specific Interpretation of the Ambiguous Symbol. The context, which facilitates the established meaning, is on the left (cow) and the context, which facilitates the new meaning, is on the right (dog).

Therefore, the array of objects created a context in which the target object was the only object that corresponded with the ambiguous symbol. Despite participants' established conceptual pact in the entrainment phase (e.g., the shape of an animal representing a cow), the context of the objects in the test phase might have had a stronger impact on their interpretation of the communicative request (e.g., choosing the dog for the drawing of in the shape of an animal – see the picture on the right, Figure 24). Participants showed representational/semantic flexibility, choosing the appropriate

meaning in the communicative context, regardless of the established pact. Therefore, the chapters 3 and 6 showed evidence that the context indeed might have had a significant impact in interpretation of ambiguous symbols (Heruti et al., 2019; Mazzocco, 1997; Mazzocco et al., 2003; Misyak et al., 2016).

This provides additional evidence to support recent findings with conceptual pacts, showing that participants adapt to the communicative context, even if that means they will break an existing conceptual pact (Ibarra & Tanenhaus, 2016). It is therefore possible that the communicative context in chapters 3 and 6 influenced the interpretation of ambiguous symbols, and diminished the impact of conceptual pacts. Despite the lack of evidence for partner-specific effects, the results from chapters 3 and 6 demonstrate that the communicative context can also break the conceptual triad.

7.7. Is the research of communication with ambiguous symbols a valid way of evaluating the utility of theory of mind skills?

In order to evaluate the connectedness of ToM skills and referential communication, majority of studies used the standard tasks measuring false belief, knowledge or intent, and correlated them with referential communication tasks (Maridaki-Kassotaki & Antonopoulou, 2011; Resches & Perez Pereira, 2007; Sidera et al., 2013, 2016). Given that ToM skills are used on an everyday basis, it is surprising to see that not many studies have evaluated these skills in everyday tasks. Recent studies encourage more researchers to explore the mutual dependencies of language and ToM *in situ* (Ralph et al., 2019; Rubio-Fernandez, 2020; Rubio-Fernández, 2018), and this was one of the objectives of this thesis. Chapters 3, 4, and 6 in particular aimed to evaluate the role of ToM skills in communication with ambiguous symbols.

There are several reasons why the recent discourse in scientific community encourages investigations of ToM skills with communicative tasks (Ralph et al., 2019; Rubio-Fernandez, 2020). One reason for this is that the standard false belief tasks measure more than just belief reasoning. Situational factors, cognitive, and verbal skills have led to masking ToM skills when making conclusions based on the false belief performance alone (Hutchins et al., 2008; Karmakar & Dogra, 2019). Moreover, standard ToM tasks are disadvantaged by the ceiling effects when performed with older children or adults (Karmakar & Dogra, 2019). But most importantly, the traditional ToM tasks do not rely on real world social interactions, which is surprising given that ToM skills are expressed in social interactions.

Therefore, this thesis sought to introduce more ecologically valid study designs for evaluating ToM skills by understanding communication with ambiguous symbols. Although this was a key aim, one can question whether ambiguous symbols are truly a valid way of evaluating the utility of ToM skills. A critical ability in utilizing theory of mind skills is being able to hold simultaneous representations (Leslie, 1987). For example, when a child is solving a usual false belief task, the child has to simultaneously understand his own true belief, but also reason about the character's false belief (see rightmost Smarties tube in Figure 25). Similarly, ambiguous symbols elicit metarepresentational abilities, since they require understanding that the same symbol can represent multiple meanings (M. C. Wimmer & Doherty, 2011). Moreover, ambiguous drawings in particular have been recognised as an ecologically valid method of assessing artist's mental state (Hartley & Allen, 2014a). Therefore, it seems like ambiguous symbols can represent a valid way of utilising ToM skills.

Seizing this, all the chapters in this thesis required some level of understanding of simultaneous representations (see Figure 25). Chapter 2 discussed conceptual pacts, which are usually tested with synonyms. Synonymy requires understanding that the same referent can be labelled with two distinct words (see Matthews, Lieven & Tomasello, 2010 in Figure 25). Conceptual pacts reveal whether children and adults are sensitive to person-specific labelling of the same referent (e.g., Anna calls it a "pony" but Ben calls it a "horse"). That is, whether children understand that different people might refer to the same referent differently. On the contrary, understanding homonymy requires understanding that the same symbol might represent two distinct referents (Doherty, 2004). This also requires understanding of two simultaneous conflicting perspectives (Garnham et al., 2000). This thesis continued to explore how different people can interpret the same ambiguous symbol differently (See Figure 25).

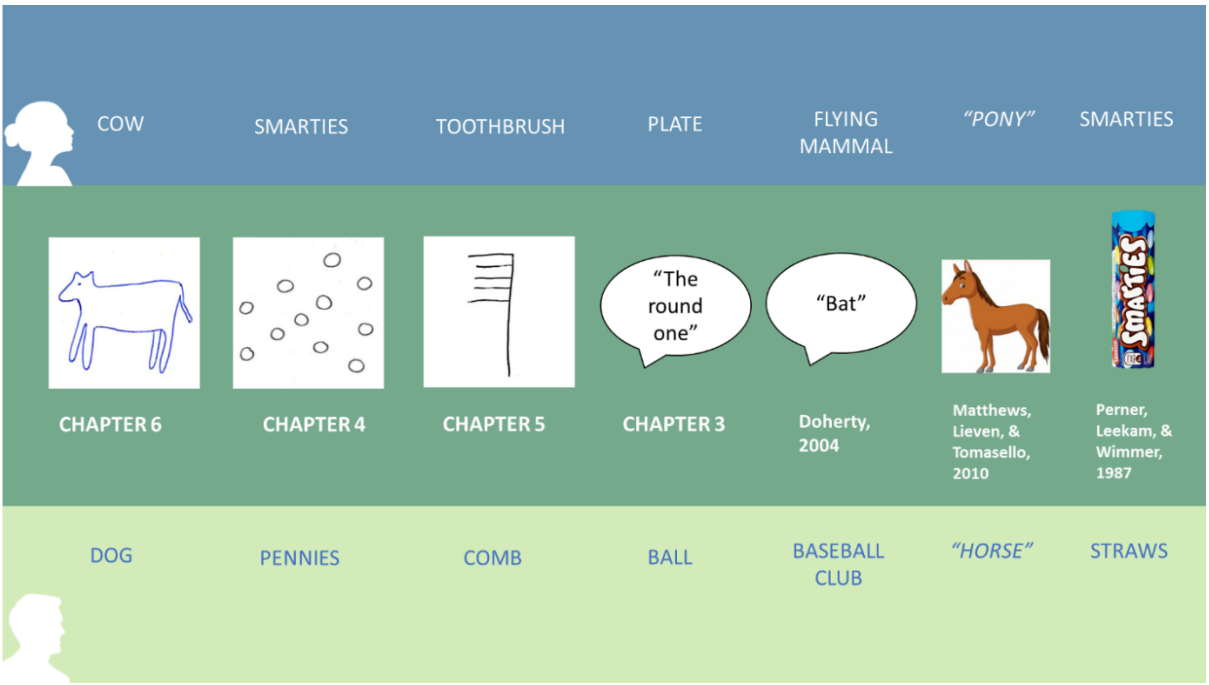


Figure 25. Children's Understanding of Simultaneous Perspectives in Understanding of Ambiguous Drawings, Homonyms, Synonyms, and False Belief.

All the empirical chapters used an ambiguous symbol and tested whether children and adults can assign its meaning with accordance to the artist's/speaker's mental state (see Figure 25). Chapter 4 showed that children consider the artist's knowledge when interpreting that artist's ambiguous drawing. Chapter 5 provided evidence that children and adults generalised the meaning of an ambiguous drawing with accordance to the category of the artist's intended referent. However, chapters 3 and 6 did not demonstrate participant's sensitivity to speaker's/artist's mental states, since children and adults did not interpret ambiguous symbols depending on whom they interacted with. Therefore, both children and adults interpreted ambiguous symbols in communication egocentrically. Despite that, participants showed flexibility, demonstrating that they can assign the ambiguous symbol any available meaning in the current communicative context.

Together, the empirical studies in this thesis used ambiguous symbols to assess utilisation of the artist's mental states in communication. The findings contributed to the understanding of how children and adults resolve the meaning of ambiguous symbols and coordinate simultaneous perspectives. Moreover, they added to the traditional ToM tasks, by showing the richness and complexity of using ToM skills in interaction with others.

7.8. Addressing the limitations

7.8.1. Understanding ambiguous symbols is connected to executive function

Executive function (EF) skills are basic processes that underlie flexible goal-driven behaviour (Walker & Murachver, 2012; Welsh et al., 1991). They encompass several skills including behavioural inhibition of prepotent responses, flexibility or set shifting, and planning abilities (Hughes, 1998). Studies show that EF skills underlie the majority

of aspects of children's cognitive development (D. J. Ackerman & Friedman-Krauss, 2017). Specifically, EF skills have been closely related to theory of mind, verbal abilities, and understanding ambiguous symbols (Graham et al., 2017; Hughes, 1998; Nilsen & Graham, 2009, 2012; Panesi & Morra, 2018; Perner et al., 2002). However, I did not discuss chapters in this thesis in relation to executive function. The focus of this thesis was on communication with ambiguous symbols and children's and adult's abilities to take into account the speaker's knowledge states. Therefore, discussing the empirical chapters with relation to children's executive function skills was outside the scope of this thesis. Nevertheless, it is imperative to mention that the experiments this thesis most likely required children to use their developing executive function skills.

Since all the empirical chapters required some level of understanding of simultaneous representations (see Figure 25), they also sought participants to coordinate these perspectives and resolve the correct meaning, which also requires executive function skills (Nilsen & Graham, 2009, 2012; Tomasello, 2020). Considering that children are developing their EF skills between ages 3 and 5 (Garon et al., 2008), controlling for them in the empirical chapters of this thesis would contribute to explain the complex role of EF in understanding ambiguous symbols in communication. Future studies should aim to add measures of EF and explore the interplay between the influence of context, utility of ToM skills, and EF skills when resolving ambiguous meaning in communication. Nevertheless, chapters 3 and 6 already contributed to this debate, showing that even three-year-olds were semantically and representationally flexible when interpreting ambiguous symbols. This provides further evidence for their cognitive flexibility, which is still shown to be developing at the age of three (Garon et al., 2008). Future research would benefit from examining the relations more closely to

get a more accurate perspective on the involvement of executive function in the role of understanding ambiguous communicative symbols.

7.8.2. Could controlling the language of participants make a difference in results?

There is evidence demonstrating that early bilingualism leads to a developmental advantage in non-linguistic tasks (Adi-Japha et al., 2010; Bialystok & Shapero, 2005; Yow & Markman, 2016). The research with drawings found a difference between monolinguals and bilinguals in production (Adi-Japha et al., 2010; M. C. Wimmer & Marx, 2014) and comprehension of drawings (Bialystok & Shapero, 2005; M. C. Wimmer & Marx, 2014). Bilinguals were demonstrated to outperform monolinguals in understanding and producing ambiguous pictures (Bialystok & Shapero, 2005; M. C. Wimmer & Marx, 2014). Although both monolingual and bilingual three to five-year-old children showed no differences in understanding that an ambiguous picture can represent two referents, bilinguals were more successful when the task required to inhibit one of the two possible interpretations (M. C. Wimmer & Marx, 2014). This suggests that the conceptual understanding of ambiguous drawings is similar in mono- and bilingual children, but bilinguals benefit especially when inhibitory processes are involved. These differences could influence the results of some of the empirical studies involving producing and interpreting ambiguous drawings. It seems surprising then that the majority of studies with ambiguous drawings did not control or report about children's language (e.g., Browne & Woolley, 2001; Callaghan, 1999; Gelman & Ebeling, 1998; Hartley & Allen, 2015; Vivaldi & Salsa, 2014, 2017).

Similarly, none of the empirical studies in this thesis controlled for language of participants. The information about children's language was only reported in chapters 3 and 6, where the number of monolingual participants was always larger than the

number of bilinguals (e.g., Chapter 3, 80% monolingual children, Chapter 6, 79% monolingual children). Thus, the proportion of bilinguals in the sample was too small to compare the results between monolinguals and bilinguals. To control for any possible effects of language on children's performance in my experiments, I would have to limit the studies only to monolingual participants. However, I only obtained information about children's language when they participated in the experiments in the Kent Child Development Unit (chapters 3 and 6). To become included in the database of our Child Development Unit, the parents had to fill in information about their language and language they speak at home with their child. On the contrary, I have not requested information about parental language from children, who participated in local nurseries and schools (chapters 4 and 5). Due to limited numbers of nurseries and schools that were willing to participate, their diverge group of children, and my lack of awareness about the influence of language, I have not obtained information about their language.

Taking into account the reported differences between the monolingual and bilingual children, there are several possibilities of how these differences could influence the results in this thesis. It is possible that the bilingual children could switch between different interpretations of the ambiguous drawing *quicker* than monolinguals (Bialystok & Shapero, 2005), which would skew the results of the Chapter 6 (since reaction times were measured in that chapter). Moreover, the studies to date suggest that bilinguals are better at inhibiting one of the possible interpretations of the ambiguous drawings (M. C. Wimmer & Marx, 2014), which could particularly influence the results of Chapter 4. Since Chapter 4 presented children with opposing beliefs in the same drawing (the circles represent Smarties – false belief, and pennies – true belief), inhibiting the true belief might be easier for bilingual children. In fact, findings from studies suggest that

bilinguals are more successful at inhibiting the real state of affairs and answer according to character's false belief (Diaz & Farrar, 2018; Nguyen & Astington, 2014). With regards to Chapter 5 however, the research comparing monolinguals and bilinguals generalisation of nouns suggests that bilinguals generalise similar to monolinguals if they are tested in the same language (Schonberg et al., 2020). That indicates that the results of Chapter 5 would not significantly change depending on the involvement of monolinguals and bilinguals.

Taken together, some chapters in this thesis would benefit if controlling for the language of participants due to the potential differences between monolinguals' and bilinguals' interpretations of ambiguous drawings.

7.9. Future directions

This thesis provides first evidence that children's communication with drawings parallels some aspects of communication with verbal language, but the inconsistencies in results and lack of studies in this field seek for further research.

To investigate how do children utilise ToM skills in communication with verbal language, I presented an overview of children's understanding of a specific communicative principle – conceptual pacts – in Chapter 2. The review of all studies has shown that children's understanding of conceptual pacts is not clear. While some researchers demonstrate that children can utilize their theory of mind skills in communication by the age of three (Matthews et al., 2010), others show that children are not that successful (Ostashchenko, Deliens, et al., 2019a). Conceptual pacts with children are under-researched, but present a pragmatic and ecological way to assess the utilization of mindreading skills in communication. Therefore, study replications and studies looking closely into communicative patterns where children show early signs of

partner-sensitivity in communication should be encouraged. More research and consensus on children's sensitivity to communicative principles would clarify their behaviour and utilisation of ToM skills in real-time conversation.

Research about communicational principles to date has been focusing more on the choice of specific referential expressions, but put less emphasis in variability of meaning. Chapter 3 demonstrated that children and adults are not as sensitive to change in meaning, as they are sensitive to change in referential expression in verbal communication. This confirms assumptions by Shintel and Keysar (2007), claiming that change of referential expression indicates a change of meaning, whereas change of meaning has no subsequent indications. That could explain the different reactions times in two instances, and also no partner-specific effects. What is more, the inequality of form and meaning have already been mentioned in linguistics. However, whether the form is processed before its meaning is still debated in the literature (Feldman et al., 2009, 2015; Rueckl & Aicher, 2008). Together, Chapter 3, which posits relationship between the speaker, referential expression and its meaning into pragmatic situation, and research from linguistics (Feldman et al., 2009, 2015; Rueckl & Aicher, 2008) seek further investigation of the relationships within the Conceptual triad.

Although the thesis raised a lot of questions about verbal language comprehension and children's' utilization of ToM in communication, next chapters sought to create first parallels between verbal communication and communication with drawings. Chapter 4 looked at children's ability to recognise artist's mental states from a drawing, which represents one of the core abilities of successful communication (Scott-Phillips, 2015; Tomasello et al., 2005). The results demonstrated that children were able to consider artist's knowledge from their drawing at the age of three, even

when the reliance on language was minimized. This contributed to the existing evidence, which mostly focused on another mental state - artist's intent (Vivaldi et al., 2020). Together, results show that children can reason about artist's intent around the age of two (Vivaldi et al., 2020), and artist's knowledge around the age of three (see Chapter 4). To explore and clarify whether understanding of artist's belief develops at a later age, future studies should explore whether children can reason about the artist's belief. Investigating whether understanding of artist's mental states evolves in a similar sequential fashion as experimental tasks looking at children's ToM (intent, then knowledge, then belief) would solidify our understanding of when do children understand other's mental states.

Another well researched aspect of verbal communication, which has never been tested in communication with drawings, is generalisation of meaning of words. Results from Chapter 5 created a clear parallel between children's generalisation in verbal language (Diesendruck & Bloom, 2003; Gelman & Markman, 1986; Saalbach & Schalk, 2011) and with ambiguous drawings. Both four and five-year-old children generalised based on the drawn referent's category. However, since drawings are iconic – have visual similarity to referent they depict – future research should explore generalisation of different types of drawings. Ambiguous drawings are more prone to be interpreted as categories, but more detailed drawings could have different patterns of generalisation. Investigating different types of drawings in communication and their generalisation would help determine what kind of drawings have the potential to be used as communicative symbols, and which are less appropriate.

Finally, Chapter 6 tested the relationship within the Conceptual triad in communication with drawings. Although there was no evidence of partner specific

interpretation of drawings, the original meaning of drawings was clearly preferred to a newly assigned meaning. Unlike flexibility of meaning of verbal expressions, as shown in Chapter 3, children and adults seem to interpret drawings original intention as binding (Allen et al., 2016). If drawings communicative intent is considerably less flexible than in verbal language, potential limitations of use of drawings to communicate could be explored. For example, irony and sarcasm require a listener to infer the opposite of the literal meaning ("You did just great!" – meaning you did badly). Thus, they require flexibility of meaning. Consequently, it would be interesting to see whether drawings as communicative symbols can flexibly transfer sarcastic meaning, or if the originally intended meaning prevails.

The approach adopted in this thesis launched first experiments investigating children's communication with drawings. Furthering this approach would advance understanding of the mechanisms and cognitive processes behind communication with symbols.

7.9.1. General suggestions about experimental designs and potentially influencing factors in investigation of communication with drawings

More research should be aimed at investigating the specific context characteristics that might influence the utilisation of mental states in communication (see *7.5. The influence of context in interpretation of ambiguous symbols*) not only with drawings, but also with language. Future research should consider the executive skills demands when interpreting children's comprehension in communication and also aim to design experiments that mimic everyday activities even more than study designs used in this thesis. Considering that latest research encourages evaluation of children's mental state understanding in everyday activities (Ralph et al., 2019; Rubio-Fernandez,

2020; Rubio-Fernández, 2018), and that the interactivity of designs was identified as an important factor in understanding of communicative intent (see also Chapter 2), future studies could include child dyads when investigating communication with drawings. Exploring communication between peers who are in absence of any social hierarchy and have little differences in in their expressive competence, can provide a more spontaneous and ecologically valid assessment of children's behaviour in communication (Hoff, 2010; Köymen et al., 2014; Oben & Brône, 2016).

To sum up, focusing on more interactive study designs, taking into consideration the influence of context, and executive function skills when explaining children's understanding of communication with drawings would clarify the underpinnings of communication with symbols.

7.9.2. Research with children with autism spectrum disorder

This thesis provided evidence that typically developing children can interpret ambiguous drawings analogously to interpretation of verbal language in communicative context. Future research could explore interpretation of ambiguous drawings in communication with atypical populations of children. Exploring this type of non-verbal communication could be particularly advantageous for children with autism, since approximately 25-30% of children with autism remain minimally verbal at late preschool age (Anderson et al., 2007; Norrelgen et al., 2014).

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder which is defined by limited verbal and non-verbal communication, and by impairment in social and behavioural domains (American Psychiatric Association, 2013; Kanner, 1943). The 25-30% of children with ASD who have minimal verbal abilities are good candidates for augmentative and alternative communication (AAC) which aims to help their

communication skills. So far, the Picture Exchange Communication System (PECS) (Bondy & Frost, 1994) has provided a good substitute for non-verbal communication based on symbolic exchange. The goal of PECS is for children to exchange a communication card depicting a picture for a desired item or activity, which also enables them to initiate communication. However, understanding pictures as communicative symbols requires multiple skills. As mentioned previously, one has to understand the symbolic nature of pictures and also infer the speaker's intent to correctly interpret a communicative request with a picture (Preissler & Bloom, 2007, 2008). Although using PECS has been linked to general improvements in children's behaviour and speech (Anderson et al., 2007; Charlop-Christy et al., 2002; Flores et al., 2012) there has been a lack of systematic research investigating symbol comprehension and understanding of PECS communicative cards. Given that children with ASD were shown to struggle to pair pictures with the represented objects (Ganz et al., 2012; Hartley & Allen, 2013; Marckel et al., 2006), and have difficulties inferring communicative intent (Allen & Carey, 2005; Hartley & Allen, 2015), it would be particularly informative to test their performance with ambiguous drawings in this thesis.

Given that some studies showed that children with ASD have intact performance in non-verbal pictorial false belief tasks (S. R. Leekam & Perner, 1991; Zaitchik, 1990), whereas others showed that children have difficulties with understanding false beliefs in both verbal and non-verbal tasks (Iao & Leekam, 2014; Perner & Leekam, 2008), Chapter 4 could address these inconsistencies. Moreover, the results with children with ASD could provide more evidence in the discussion whether language skills of children with ASD pose significant demands in false belief understanding. The modifications of the standard unexpected contents task in study design of Chapter 4, the variety of

conditions, and usage of ambiguous symbols might provide additional information in understanding of how children with ASD reason about another's beliefs.

Furthermore, Chapter 5 could address an unexplored facet of using PECS, that is; how children with ASD generalise the meaning of PECS communication cards. Children's interpretation of PECS communication cards could be very limited given that PECS communication cards are colour pictures of prototypical items, but evidence suggests that minimally-verbal children with ASD generalize objects based on irrelevant details like colour (Hartley & Allen, 2014b). Testing children with the study design of Chapter 5, which explores the generalisation of ambiguous drawings, could provide more understanding of the constraints of generalising meaning of pictures.

Lastly, testing children's performance with the design of Chapter 6 could explore how do children with ASD follow communicative principles. Although latest research concluded children with ASD were not sensitive to partners' specific choice of referential expressions (Ostashchenko, Geelhand, et al., 2019), but future research could determine whether children show sensitivity to conceptual pacts with drawings. The results could unveil whether following communicative principles is impaired because of receptive language delay, or if the difficulties represent a more general characteristic of ASD diagnosis.

By researching children with autism, and minimally verbal children who use PECS, future research has a wide clinical and educational impact. It could both inform children's understanding of fundamental symbolic processes and provide information about how to best deliver picture based communication aids in the precise group of children who rely upon pictures as their primary mode of communication. Furthermore,

guidelines about how to use PECS could be modified in order to best correspond to the skills and abilities of children with ASD.

7.10. Practical implications of the findings

Nowadays, both children and adults constantly communicate with pictures. Social media has provided us with a way to express and transfer messages not just with using words, but emojis, GIFs, and similar pictures. Data suggests that up to 20% of text messages involve emojis (Lu et al., 2016). Mostly, emojis, GIFs, and similar pictures were recognized as a way to indicate mood and help transfer communicative intent (Hu et al., 2017; Lo, 2008; Wagner et al., 2020), but this thesis highlights the usage of pictorial symbols as means to transfer the whole communicative message.

Although some of pictorial symbols online have conventional meanings (🎵 means music, based on Barbieri et al., 2016), many meanings are assigned to specific pictures within specific conversations (H. Miller et al., 2016; Wiseman & Gould, 2018). I might be using some symbols in conversation with my brother, but the same symbols would mean different things in conversation with my partner. That is, it is possible that we are forming tacit conceptual pacts even when communicating online. This has actually been looked at - adjustment of meaning as described above has been shown to be particularly often between intimate partners and friends (Wiseman & Gould, 2018). These differences in interpretation of meaning of different emojis show that it is important to recognise the communicative intent if we want to understand what the person behind the other device is trying to tell us.

As simple as these pictorial symbols seem, they share a lot of parallels with verbal language. Although verbal communication still holds the most weight in all transfer of ideas between people, we should not overlook all the alternative means of

communication. It seems like gestures, drawings, and emojis also parallel verbal language in many ways. However, we know very little about how communication with pictorial symbols happens. To grasp the full meaning of what people behind other devices are trying to tell us, we have to understand not only verbal language, but other pictorial symbols as well.

7.11. Conclusion

This thesis confirmed that drawings can be used as communicative symbols (Rakoczy et al., 2005). By showing multiple parallels with verbal language, the findings added to the developing field of experimental semiotics and explored the involvement of mindreading skills in communication. Chapter 4 provided evidence that children's interpretation of drawings, parallel to understanding verbal expressions (B. P. Ackerman et al., 1990; Diesendruck & Markson, 2001; Resches & Perez Pereira, 2007), entailed inferring artist's mental states. Moreover, Chapter 5 showed further parallels with verbal language, showing that children generalise the meaning of ambiguous drawing in communication to the category of the drawn referent. Chapters 3 and 6 together demonstrated that children and adults are not sensitive to partner-specific meaning of the ambiguous symbol, indicating their egocentric interpretation of symbols in that particular context. However, both children and adults showed preference for the artist's intended meaning of the ambiguous drawing, but did not show any preferences with ambiguous expressions, indicating a bigger influence of the artist's intent in understanding of drawings compared to understanding verbal expressions.

Taken together, utilizing ToM skills in communication depended on the interplay of communicative context, the benefit of considering others' mental states, and executive function skills. All these should be considered in future research of

communication with ambiguous symbols. More, this thesis should help evaluate existent alternative symbolic systems that help non-verbal individuals communicate and encourage further development of drawings as communicational symbols.

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APPENDIX A

Ethical approval ID's for each empirical study

All the empirical studies in this thesis were approved by the Kent Psychology Ethics committee. The committee follows the guidance set out in the BPS Code of Ethics and Conduct (2018). A table of all ethical approval ID's is displayed below.

Chapters	Ethics ID	Participants
3 and 6	201714873535754347	Adults
3 and 6	201614810726604199	Children
Chapter 4, together with 3 and 6	201815427157075387	Adults
Chapter 4	201614815589034210	Children
Chapter 5	20111881	Children
Chapter 5	202015819464746135	Adults
Chapter 5	201915579358395777	Adults

Before collecting any data, participants and their legal guardians (if participants were underage) were informed about the main aims of the study. The legal guardians or participants received the Research information sheet, Consent forms and after the data collection, verbal or written debrief. The example of all three documents is provided below for the study with the Ethical ID 201614810726604199.

APPENDIX B

Research information sheets for participants' parents (Ethical ID: 201614810726604199)

University of Kent | Department of Psychology

CHILDREN'S UNDERSTANDING OF AMBIGUOUS DRAWINGS and SENTENCES

Who is organising this study?

This research is being conducted as a part of a PhD project at University of Kent. It is organised by a PhD student Nera Bozin under the supervision of Dr. Erika Nurmsoo at the Kent Child Development Unit, within the School of Psychology at the University of Kent.

What are we interested in?

Broadly speaking, this research project aims to explore children's understanding of ambiguity. As adults, we have no problem understanding that one shape can represent many different objects (e.g., a circle could be a ball or a plate). We are interested in learning at what age children develop this same understanding. More, we are interested whether children are sensitive to when other people decide to interpret the same drawing or an ambiguous sentence differently.

What are we going to do?

In this project, children will be shown a series of toys, and will be asked to match ambiguous sentences or drawings to toys. Sometimes the drawings/sentences will represent one toy all the way through the game (e.g., the circle will always be matched to a ball), but other times the pictures will shift (e.g., the circle must be matched to a plate). We are interested in what toys children choose, how long it takes them to match the pairs, and where they look as they make their decision.

In order to measure your child's reaction time in completing this task, the study will be video recorded. The recordings will be stored in a locked room on campus, and will only be viewed by the researchers directly working on this project. The videos will be securely destroyed as soon as we have recorded what we need, and no child's personally identifying information will be stored with the videos – instead, we will give each child a number and their names will not be recorded.

What happens to the information I provide?

Participation in this study guarantees confidentiality of the information you provide. No one apart from the researcher will have any access to the information you provide. Your child's name and any other identifying information will be stored separately from his or her data in a securely locked filing cabinet for as long as is required by the Data Protection Act, and then they will be destroyed by our confidential shredding service. Once the data are analysed, a report of the findings may be submitted for publication. Only broad trends will be reported and it will not be possible to identify any individuals. A summary of the results will be sent to all participating families, once the study is complete.

Contact for further information

If you have any questions or concerns about this research, you can contact the researchers by email at child@kent.ac.uk, or her supervisor at E.Nurmsoo@kent.ac.uk or by phone at 0122 782 4381. If you have any serious concerns about the ethical conduct of this study, please inform the Chair of the Psychology Research Ethics Panel, via the School of Psychology, in writing. The School of Psychology office can be reached on 01227 823699.

APPENDIX C

Research informed consent forms (Ethical ID: 201614810726604199)

School of Psychology
Keynes College
University of Kent
Canterbury, CT2 7NP

RESEARCH INFORMED CONSENT FORM

Title of Project: Children's understanding of ambiguous drawings and sentences

Researcher Email: Nb468@kent.ac.uk

Investigator(s): Nera Bozin, dr. Erika Nurmsoo

I am the parent / legal guardian of: _____
Please, print child's name

Consent to participate (please initial all boxes that apply):

☐ I understand that she / he is free to withdraw from the research at any stage, without giving any reason, and that I can ask for her / his data to be destroyed if I wish.

☐ I confirm that I have read and understand the information sheet for the above study, and have had the opportunity to ask questions.

☐ I consent to my child's participation being video recorded.

☐ I agree to take part in the above study.

Consent for use of videorecording (please initial any box you consent to):
Note: the recordings always will be anonymized, and never linked back to your child.

☐ I consent to the video recording to be used *for the purposes of data collection.* (Initial this box and no others if you would like to limit the video recording to *only* those working on this project, for data coding purposes only. If you select this box only, videos will be securely destroyed as soon as we have recorded what we need).

APPENDIX D

Debrief forms for parents (Ethical ID: 201614810726604199)

University of Kent | Department of Psychology

Children's understanding of ambiguous drawings and sentences

Thank you very much for your participation in this research, we appreciate your time and willingness for participation.

Broadly speaking, this research project aims to explore children's understanding of ambiguity. As adults, we have no problem understanding that one shape can represent many different objects (e.g., a circle could be a ball or a plate). We are interested in learning at what age children develop this same understanding which is called *representational flexibility*.

Furthermore, we are interested whether children are sensitive to when others decide to interpret the same drawing or a sentence differently. Here, the assumption is that when we are naming one's drawing, we are creating a pact about the drawing – what it represents. Similarly, when we hear an ambiguous phrase naming an object, we connect the phrase with that specific object. We are therefore interested how children will react when another person uses the same drawing or a phrase for another object – for another referent.

In order to keep the data confidential, the recordings will be stored in a locked room on campus, and will only be viewed by the researchers directly working on this project. The videos will be securely destroyed as soon as we have recorded what we need, and no personally identifying information will be stored with the videos – instead, we will give each child a number and their names will not be recorded. The consent forms will be stored in a folder in a password-secured locker in the Kent Child Development Unit. It will be separate from both the results file and the file linking your child's number to name.

If you have any queries about this research or would like to ask any further questions, please contact the researcher (Nera Bozin) or research supervisor (dr. Erika Nurmsoo) using the contact details below.

Once again, we would like to thank you for your valuable contribution to this research. Your participation is greatly appreciated.

Yours sincerely,

Nera Bozin
Nb468@kent.ac.uk

Supervisor contact details:
Dr Erika Nurmsoo
E.Nurmsoo@kent.ac.uk