Investigating the development of cognitive symbolic representation and gestural communication

A thesis submitted to The University of Manchester for the degree of Doctor of Philosophy in the Faculty of Medical and Human Sciences

2011

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Word count: 70,901

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Abstract

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In this thesis, I explore the ongoing development of symbol use in three domains: pretend play, speech and gestures. In chapter 1, the specific behavioural manifestations of symbol use in these domains are identified and previous literature that has explored the cognitive underpinnings of these abilities is discussed, with a particular focus on children's social cognition. In chapter 2, I review previous research that has sought pairwise relations between these abilities and the theoretical perspectives that have been utilised to explain these relations. In chapter 3, I introduce the four pertinent research questions that emerged from the previous review of the current literature, and provide an overview as to the methods adopted to address these issues.

Chapters 4 to 6 constitute three papers designed to explore and evaluate children's symbol production in a sample of preschool children in pretend play speech and gestures. For the first paper, 38-40 month old children were given a battery of standardised measures to assess their symbolic capacities while controlling for non-verbal abilities. These data were analysed for concurrent relations between symbolic capacities. The second paper extends these concurrent relations longitudinally, by giving the children the same battery of measures six and twelve months after initial testing. Correlational and multiple regression analyses were used to assess the potential predictive relations between these measures, and whether there is a changing relation between these symbolic domains over developmental time. The third paper investigates children's iconic gesture production in further detail, by evaluating whether children aged 44-46 months incorporate the iconic gestures they observe an adult perform into their own descriptions of a novel object.

Taken together, the results indicate a changing relation between the three symbolic measures of interest during the preschool years. The present findings suggest that both pretend play and gesture production are mediated by speech, but in different ways. It was also found that children appear to incorporate the gestures they observe into their own descriptions of objects but this uptake is dependent on the properties of the gesture itself.

In the final chapter, these findings are discussed in relation to previous theoretical notions that place pretend play, speech and gestures as manifestations of an underlying symbolic system. I also discuss the enduring relation between these three abilities and how the pattern of predictive relations found in the present thesis can be explained. Furthermore, I discuss the ontogenesis of symbolic gesture production in children, specifically how children may use the gestures of others as a guide to their own gesture production. Finally I outline some limitations of the present research, and indicate potential avenues for future study.

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Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright statement

Acknowledgements

First of all, I would like to thank my supervisory team of Anna Theakston and Simone Pika for their support, advice and encouragement throughout the three years that have culminated in this thesis. I consider myself most fortunate to have worked with you both so closely. You have steered me expertly through the inevitable highs and lows that only a PhD can bring with the knowledge, honesty and good humour that I will always hold in the highest esteem. I would also like to thank Andrew Stewart, my academic advisor, for providing me with perspective when I needed it most.

Sincerest thanks go the parents and the children who participated in the studies. It is a statement of fact that my work, and the work of many a developmental psychologist, would be stranded from the outset if you were not so kind to offer your time so freely. Watching you and your children taking part in the ‘games’ so enthusiastically was truly a highlight of my time as a PhD student. I will always be grateful to your contribution to my research.

Next I would like to thank Rebecca Crawford, my ‘potential life partner’, for being the emotional scaffold that allowed this thesis to grow. Your patience, understanding and all round support have allowed me to make the very most out of every day. I am also grateful to the support of my family, who set the foundation for my intellectual curiosity before I was even aware of it.

I would like to thank the people that provided me with interesting debates and comments, or just showed enthusiasm for my work, no matter how fleeting. This includes, but is not limited to, the following people: Anna Coates, Doran Cohen, Clara Cotroneo, Judith Holler, Sue Leekam, Lauren Myers, Elena Nicoladis, Claire Noble, Seyda Ozcaliskan, Samantha Rowbotham, Ludovica Serratrice, Zoe Tsivos, Mark Tutton, Jeff Wood and Maria Zammit. Finally, special mention goes to my office mate of two years Rebecca McPhillips, who has broken up my long days of coding expertly with her anecdotes and wit.

I am indebted to you all!

Chapter 1: Symbolic Development in Children

"To become fully functional members of any society, children must gain competence with the symbols and symbol systems through which knowledge is acquired. Fortunately, the first few years of life are characterised by impressive progress toward becoming symbol-minded" (DeLoache, 2004, p. 66).

Humans have been identified as the symbolic species (Deacon, 1997). To function effectively, humans need to readily interpret and produce symbols successfully to and from members of their society or culture. Although some attempts have been made to teach non-human primates language (Gardner & Gardner, 1969; Rumbaugh, 1977), no other species apart from humans appear to use symbols competently during their everyday activities (DeLoache, 2002a, 2004).

However, the term 'symbol' has been used in a number of different ways and in different contexts. For example, Newell (1990) referred to symbols as part of internal representations, which allow access to knowledge structures. In this view, perceptions are converted into a cognitive symbolic representation which is related to larger representational structures such as schemata. In turn, these symbolic structures constitute a full system reflected in, for example, speech (Barsalou, 1999). In contrast, Vygotsky (1978) regarded symbols as a tool for thought. For example, children may use symbols to modify their own mental states (Holland & Valsiner, 1988), for example in their use of private speech (Al-Namlah, Fernyhough, & Meins, 2006; Duncan & Cheyne, 2002; Flavell, 1966; Kohlberg, Yaeger, & Hjertholm, 1968) or gestures (Goldin-Meadow, 1999, 2003). In other words, using symbols "represents a developmental waystation" (Fernyhough & Fradley, 2005, p.117) between children's outward expressions of knowledge and their subsequent internal cognitions.

Most definitions of the term symbol, however, centre on the idea that symbols serve a referential function, are arbitrary in terms of what they represent, and are decontextualised (i.e., used in contexts beyond their initial learning, Deacon, 1997; Namy & Waxman, 2005; Piaget, 1962; Werner & Kaplan, 1963). The following two sections outline current definitions of what is classed as a symbol, and the symbolic representational abilities that are of interest in the present thesis.

1.1. What constitutes a symbol?

Peirce (1955) distinguished between three levels of sign (icon, index and symbol), which formed a representational hierarchy, based on the arbitrariness of the sign to what it represents. An *icon* is mediated by its physical similarity to what it refers to. Examples of an icon in Peirce's sense would be a scaled down model or a picture to represent an animal or an object. An *index* is defined as a sign that denotes the signifier by having some relation to it, without conveying any information about the signified itself (in contrast to an icon). In other words the signifier is a 'trace' of the signified (Nokony, 1978). An example of an index would be a bicycle to signify a cyclist or the neighing of a horse to signify a horse. These examples of indexes signify the existence of a referent to somebody who has some knowledge of the referent (i.e., they know that horses neigh). The third level of Peirce's representational hierarchy is a *symbol*, which he argued is determined by a formal or conventional link between the signifier and the signified, irrespective of the physical characteristics of the signifier itself. Deacon (1997) agreed with this view, arguing that when we say something is a symbol "we mean there is some social convention, tacit agreement or explicit code which establishes the relationship that links one thing to another" (p.71). This definition of a *symbol* places it at the end of a continuum. At first glance this continuum seems based on the degree to which the signifier has an arbitrary relation to what it represents (Bruner, 1966; Wood, 2010). This arbitrariness distinction between the three levels of sign has been criticised by authors who suggested that reserving the term *symbol* for purely arbitrary entities excludes a number of everyday instances where children and adults make symbolic references, for example when using a map (DeLoache, 2005; Huttenlocher & Higgins, 1978; McNeill, 1985) or pictures (Ganea, Allen, Butler, Carey, & DeLoache, 2009; Preissler & Carey, 2004). Instead DeLoache, in a body of work (DeLoache, 2000, 2002a, 2002b, 2004, 2005a, 2005b; DeLoache & Burns, 1994) defines a symbol not on the basis of its physical resemblance to what it signifies but on the *intention* that a person individually (or a community as a whole) applies to a signifier to represent something else. Thus, a symbol is defined as "something that someone intends to stand for or to represent something other than itself" (DeLoache, 2002b, p. 73). On this definition, as long as one person attaches symbolic significance to an object purposefully then it is a valid symbol. For example, when someone encounters a knot in a handkerchief that they did not make themselves, it is unlikely to have any symbolic meaning. However, for the person who tied the knot, that object will serve a referential function, as they formed the knot with the specific intention of representing something else (possibly as a reminder for an action they intend to carry out later that day). Namy and Waxman (2005) identify intention understanding as one of the 'contemporary themes' of symbol definitions. They argue that understanding the recipient's ability to understand the signaller's symbolic intention is influenced by a variety of social factors including the shared experience of the recipient and signaller, the social context, and the cultural conventions previously established.

From this overview, I define a symbol in the present thesis as something that intentionally represents something else. However, it is *not* a prerequisite that the form that the signifier takes (in terms of its shape, movement, the object used etc.) bears no physical resemblance to what it signifies. The following section utilises this working definition to elaborate further on the production of the symbols in children that are of interest in the present thesis.

1.2. Three symbolic domains

1.2.1. Speech

Perhaps the most obvious examples of intentional symbols are words. Indeed, theorists have long been interested in the apparently unique capacity for humans to use symbols in this domain in contrast to non-human primates (Deacon, 1997; Gardner & Gardner, 1969; Herrmann, Call, Hernandez- Lloreda, Hare, & Tomasello, 2007; Tomasello, 1999). When one uses the word “dog”, the physical characteristics of the word (its sound and form) have no inherent resemblance to what it represents (i.e., a furry animal with a tail). The meaning of this verbal (or written symbol) is derived from an understanding of the convention, and thus the intention of the person who used that symbol to represent something. The early work of Saussure (1969) was one of the first attempts to determine the signifier-signified relation between a word and what it represents. He reasoned that a word (i.e., the signifier) was closely related to the idea, object or event that it signified, so much so that if either one of these two “planes” was not considered in conjunction with the other then the symbol itself would lose all meaning. This view of a symbol is a relatively simple one, which refers to the associative signifier-signified relation between the symbol and what it represents. However, there are two criticisms of this symbolic definition as outlined by Deacon (1997). First, Saussure argued that meaning is acquired via an understanding of this signifier- signified relation. Deacon (1997) suggested that this is not sufficient as it is only an associative relation and cannot explain the rich interrelated semantic networks underpinning human language and other symbolic reference that humans have over other animals. The rote learning of words by dogs for example would be classed as symbol learning in this definition, but this does not seem to capture the essence of human language. Deacon (1997) added the caveat that for the meaning of the word to be truly understood as a symbol, it has to be used outside of the context in which it was originally learned, thus going beyond the associative understanding of words seen in lower animals. Second, Saussure’s signifier-signified distinction does not account for the differing levels of arbitrariness that the signifier may have in relation to the signified. For example onomatopoeic speech bears a closer relation to the referent (i.e., it is more iconic in nature) compared to truly arbitrary symbols.

1.2.2. Gestures

1.2.2.1. Defining gestures

Before discussing the potential symbolic nature of gestures in any detail, it is first necessary to outline what is meant by the term ‘gesture’. Different scholars have their own conceptions of what forms a gesture can take (Armstrong, Stockoe, & Wilcox, 1995). The first issue one faces when attempting to define gestures is separating them from the continuous movements that take place during everyday interactions (Tellier, 2009). Kendon (2004) argued that gestures are a name for “visible action when it is used as an utterance or as part of an utterance” (p. 7)[1]. Kendon identifies the main characteristic of gestures as “deliberate expressiveness” (p. 15). This notion helps separate actions that form part of the speaker’s communicative intention from actions that were designed to assist with a practical aim (e.g., walking or movement of objects). However, while the notion of deliberate expressiveness is useful in separating communicative from non-communicative actions, it does not take into account actions that may be involuntarily communicative, for example displays of affect or self adaptors, such as touching hair or rubbing hands (Ekman & Friesen, 1969)[2].

In addition to the differentiation of gestures from other forms of locomotory action, there is the significant task of categorising these gestures on the basis of their communicative properties. Ekman and Friesen (1969), in an early attempt to establish a

[1] By ‘utterance’, Kendon refers to an instance of activity by the communicator that is regarded as communicative.

[2] Whether certain forms of body posture are regarded as gestures has also been a source of deliberation. For example, gestures have been referred to as communicative actions involving either the arms or the head that are mechanically ineffective and intentional, in the sense that they are performed to be observed by a communicative partner (Bretherton & Bates, 1979; Pollick & de Waal, 2006; Tanner & Byrne, 1996). Pika and Zuberbuhler (2008) gave more emphasis to the role of body postures. They argued that gestures can be defined as expressive, intentional movements of the head, limbs or the adoption of body postures which are mechanically ineffective but still emit a response from the individual to whom the gesture is directed.

typology of gesture forms, refer to five broad categories of gesture. The two categories of most interest in the current thesis are *Emblems*, which are gestures that have a direct, culturally defined verbal translation, and *Illustrators*, which are movements which are directly tied to the speech concurrently being performed[3].

While Ekman and Friesen's early work focused on affect displays (Kendon, 2004), more recent research has generally focused on defining specific types of illustrator gestures. McNeill (1985, 1992, 1998, 2000, 2005) has distinguished two main types of illustrative gestures: *imagistic* and *non-imagistic* (see also de Ruiter, 2000; Kendon, 2004; McNeill, 2005). *Imagistic* gestures are those that depict an element of the ongoing speech and can be broken down into two main types, *iconic* and *metaphorical*. Iconic gestures refer closely to the concrete semantic elements of speech (for example speed or motion), while metaphorical gestures depict "imagery, but present an image of an abstract concept such as knowledge" (McNeill, 1992, p. 80). *Non-imagistic* gestures, on the other hand, are those that point to some concrete entity in the environment or mark out segments of discourse. These include *deictic* gestures, which are typically pointing gestures that refer to objects or people, and *beats* which "are movements which do not present a discernible meaning" (McNeill, 1992, p. 80).

The gesture taxonomy outlined by McNeill (1985, 1992) has been used widely in research into gesture production and comprehension (Beattie & Shovelton, 1999b; Capone & McGregor, 2004; de Ruiter, 2000; Gullberg, de Bot, & Volterra, 2008; Holler & Beattie, 2003; Kita, 2009; Mayberry & Nicoladis, 2000; Nicoladis, Mayberry, & Genesee, 1999; Stefanini, Bello, Caselli, Iverson, & Volterra, 2009). However, Poggi (2002) suggested that "a gesture does not belong to a single type but is better characterised against several parameters" (p. 158). Poggi (2002) argued for four dimensions of analysis; (1) the *relationship to other signals* (i.e., whether the gesture was autonomous or synchronous

[3] The three other types of gesture (broadly referred to as 'emotional' gestures (Doherty-Sneddon, 2003)) are *affect displays*, which include facial expressions, *adaptors*, which are related to bodily needs (e.g., scratching a nose) and *regulators*, which act to maintain the participation and roles of two or more interlocutors (e.g., during word search (Streeck, 1993)).

with speech); (2) the gesture's *cognitive construction* (whether the gesture represented one particular lexical item or was 'creative', in the sense that it is not bound by any cultural influence); (3) the *gesture-meaning* relationship (how closely the form of the gesture matches with the meaning attached to the gesture); and (4) *semantic content* (whether the gesture contains information about the world or about the speaker's mind). These four dimensions however match relatively easily to McNeill's taxonomy, meaning they are of little practical use. For example, for the dimension of *cognitive construction*, lexicalised items are similar to emblems (or conventional) gestures (Brookes, 2005; Kendon, 1992), while non-lexicalised items fall into the categories of iconic, metaphorical or deictic gestures.

Kendon (1982, 1988) suggested that gestures can be categorised into four broad types (gesticulation, pantomime, emblems and sign language). Gesticulations consist of imagistic and non-imagistic gestures that are typically produced with speech (iconic, metaphoric, deictic and beat gestures to use McNeill's categories). Emblems have similar properties to a word in the sense that it is a stand-alone symbol, while sign language has properties of language (syntax etc.) which means that it is its own encapsulated communicative method.

1.2.2.2. Gestures as symbols

McNeill (1992) suggested that the broad gesture categories outlined by Kendon form a continuum (termed "Kendon's continuum"), with gesticulation and pantomimes at one extreme, followed by emblems and finally sign language at the other extreme. McNeill (1992, 2000) suggested that a gesture type's location on the continuum is directly associated with the co-presence of speech with the gesture, its linguistic properties, and its degree of conventionalisation (see Table 1.1).

Table 1.1: Characteristics of gesture types according to "Kendon's Continuum" (adapted from McNeill, 2000)

Continuum	Gesture type			
	Gesticulation	Pantomime	Emblem	Sign Language
Relation to speech	Obligatory presence	Optional Presence	No speech	No speech
Relation to linguistic properties	No linguistic properties	No linguistic properties	Some linguistic properties	Linguistic properties
Relation to conventions	Not conventionalised	Not conventionalised	Partly conventionalised	Fully conventionalised

These categories of gestures are useful working instruments to mould research endeavours[4]. McNeill (1992, 2005) for example has focused on 'gesticulation' gestures, which he argues reveal, along with speech, the nature of a speaker's thought. Other researchers have oriented their research to the nature of emblematic gestures cross-culturally (e.g., Kendon, 1992; Pika, Nicoladis, & Marentette, 2009). The question here is which of the gesture types identified as being part of the gesture continuum (iconics, metaphoric, emblems, deictics and beat) can be classed as symbolic?

One of the criterion for the definition of a symbol is that the form of the symbol should be arbitrary to what it represents (Peirce, 1955; Piaget, 1962; Werner & Kaplan, 1963). Under this criterion, only emblems (conventional) gestures would be termed symbolic. For example, the structure of the 'thumb up' gesture in English-speaking cultures bears no physical resemblance to the concept of satisfaction. In this sense, these gestures are analogous to words, and indeed according to "Kendon's continuum" have similar linguistic properties to a word (Table 1.1). Iconic gestures, on the other hand, are

[4] While identification of a gesture typology has proven useful for conceptual understanding and scientific enquiry, its application to everyday gesture production is difficult. Kendon (2004) noted that "given the nature of gesture as a form of human expression, we cannot establish permanent categories that represent essentially different forms of expressive behaviour" (p.107),

representative of the actual event taking place (i.e., they are imagistic of how an event occurred, the properties of an object etc). On initial inspection these gestures, as alluded to in the name of the category itself, are icons in Peirce's sense, as the signified and the signifier share common features.

However, a number of authors have suggested that iconic gestures are symbolic, on the basis that they fulfil Quine's (1960) basic criteria of something standing in for something else (Bavelas & Chovil, 2000; Kendon, 2004; McNeill, 1985, 1992). McNeill (1985) argued that even though iconic gestures are not conventional or arbitrary (two of the traditional criteria for a symbol, Namy & Waxman, 2005) they are symbols in the sense that they form signifier-signified pairs, so that one cannot be understood without the other (Saussure, 1969). For example, if one was attempting to represent the concept of an up and down movement through gesture, for the concept to be communicated the *form* of the symbol (in this case a vertical hand movement) would need to be matched with the *concept* of vertical movement. In isolation, neither the hand movement nor the concept would be sufficient to represent the signified.

Bavelas and Chovil (2000) suggest that iconic gestures are also used *intentionally* by the communicator to transfer information to the addressee. Research in favour of the intentional nature of iconic gestures comes from Alibali, Heath and Myers (2001), who asked participants to provide narrations of cartoon stories in two conditions; one where they could see the interlocutor (face-to-face condition) and one where their view of the interlocutor was blocked by a screen (screen condition). They found that participants in the face-to-face condition produced a significantly higher rate of representational gestures (which included iconic *and* deictic gestures) compared to the screen condition. This effect was also found for iconic gestures, which constituted 75% of the representational gesture category.

On first glance, it is possible to interpret these findings as evidence that speakers gesture with the intention of providing information to their interlocutor. However, this research does not differentiate whether the speaker *intends* to provide information to the speaker, or whether the speaker is merely responding to the added interactive nature of the face-to-face condition (i.e., by being 'rewarded' by head nods and smiles, A. Cohen & Harrison, 1973; Holler & Wilkin, 2011). Studies that have investigated the intention to communicate via gesture have focused on addressee location and the orientation in gesture space (Bavelas, Kenwood, Johnson, & Phillips, 2002; Holler & Beattie, 2005; Holler & Wilkin, 2011; Ozyurek, 2002). These studies taken together suggest that speakers have an intention to be informative through their gestures (see section 1.5.2.2).

1.2.3. Pretend play

The two domains of symbol production outlined in the previous two sections are of interest to researchers concerned with how speakers use their linguistic resources to give and receive messages. In contrast, the symbolic domain of pretend play is developmental in nature, as it shows a developmental progression throughout the preschool years and appears to follow a ‘U’ shaped trajectory (Piaget, 1962).

Play can be divided into three main forms that develop in a set progression: sensorimotor play, functional play, and pretend play (Fein, 1981). Sensorimotor play occurs from around seven months of age and involves simple object manipulation, including pushing or banging an object around (Fein, 1981). This is then followed at around the end of the first year by functional play, which involves using objects for their appropriate purpose (e.g., looking through a toy telescope, Fein, 1981; Fenson, Kagan, Kearsley, & Zelazo, 1976). Finally, pretend play behaviours emerge during the second year, and increase up until around the sixth year where they gradually decline. Pretend play can be broadly defined as the “projecting of a supposed situation onto an actual one” (Lillard, 1993a, p. 349). This involves the child being able to reason counterfactually, by representing situations (e.g., a cup being full of water) which are not actually the case (P. L. Harris & Kavanaugh, 1993; Kavanaugh & Harris, 1999) and being able to separate pretense representations from reality (e.g., Bourchier & Davis, 2002; Nichols & Stich, 2000). The idea of projecting a supposed situation is an important one, as it separates pretend play from merely imagining an action (Lillard, 2001). According to a number of researchers, pretend play is characterised in three significant ways: through object transformations, the attribution of pretend properties to objects, and referring to objects that are not present (Baron-Cohen, 1987; Leslie, 1987; Lewis, 2003; Lewis, Boucher, Lupton, & Watson, 2000).

Belsky and Most (1981) found that between the ages of seven and 21 months, there was a decrease in the number of sensorimotor behaviours observed during play sessions, while there was an increase in the amount of pretend play behaviour observed. Belsky and Most (1981), in line with a number of other researchers (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Fein, 1981, 1987; Nicolich, 1977; Piaget, 1962), suggest that pretend play becomes 'decontextualised' in the sense that the representations made during the pretense activity are no longer bound by the properties of the object itself. This is in contrast with functional play, where the properties of the objects involved in the play dictate the possibilities of the play activity.

This body of research suggests that for pretend play, children follow a set developmental trajectory; beginning with a 'close' relation between the signifier and the signified *at* emergence, leading to a 'distant' symbolic relation *after* emergence (Flavell, 1970). Leslie and colleagues (Bosco, Friedman, & Leslie, 2006; O. Friedman & Leslie, 2007; O. Friedman, Neary, Burnstein, & Leslie, 2010; Leslie, 1987) call this ability *metarepresentation*; the capacity to understand that someone (e.g., the child or her caregiver) is representing something (e.g., a block) as something else (e.g., a car). In contrast, functional play is not symbolic, because children do not need to understand that one object (e.g., a toy hammer) has two representations (a hammer and what it represents, e.g., a car). Indeed, children have been found to use objects in an appropriate way, before they are able to use the object counterfactually (Tomasello, Striano, & Rochat, 1999).

Tomasello et al. (1999) suggested that using substitute objects is difficult for young children because they are not able to inhibit their sensorimotor schemes that automatically activate when the object enters their perception. Children also need to understand the temporary basis of pretense acts (P. L. Harris & Kavanaugh, 1993; Kavanaugh, 2002). In order to achieve this form of pretense behaviour, Tomasello et al. (1999) suggested that children need to understand that (1) the object in question can be manipulated, (2) the object has a conventional use and (3) on this specific occasion, the conventional object is being used to represent another object[5]. McCune (1995) characterised children's pretend play as a developmental sequence including five levels (see also McCune-Nicolich, 1981; Nicolich, 1977). At the first level, children use sensorimotor actions to express knowledge of the functions of real objects for real actions. At the second level, children begin to use this awareness to act 'playfully'[6] (McCune-Nicolich, 1981). At the third level the child is able to 'decentre', and use dolls to 'fill in' for themselves, while at the fourth level, children are able to combine these play schemes with more than one object. Finally, the fifth level is achieved when children are able to plan their pretense behaviour *before* performance of the pretense act.

1.2.4. Summary

The preceding sections have discussed the potential behavioural manifestations of children's symbolic understanding in three domains. Speech appears to be a natural candidate for symbolic expression, as words are produced intentionally for the act of communication and the form of the word itself bears little resemblance to what is being represented. A body of research has also established that iconic gestures are produced intentionally by the speaker and are symbolic in the sense that speakers use their hands to represent events and concepts that are not visible. Pretend play involves the intentional

[5] Tomasello et al. (1999) calls this knowledge of 'triune representations'.

[6] By the term 'playfully' McCune (1995) suggests that children are able to add realistic motions and noises to accompany their sensorimotor acts.

transformation of an object or person into another object or role. The intentional nature of pretense activity is perhaps reflected in children's increased use of behavioural checks during pretense behaviour, including increased gaze at a play partner and 'knowing smiles' (Lillard & Witherington, 2004; Rakoczy, Tomasello, & Striano, 2005a; Randell & Nielsen, 2006).

The ontogenetic development of symbolic understanding has interested theorists for many years (Braswell, 2006). The following section outlines three theories of development of historical importance that incorporate the development of symbolic thought in children. The theories that will be addressed in turn are the cognitive developmental theory of Piaget, the sociocultural approach of Vygotsky and the organismic approach of Werner.

1.3. Theories of symbolic development

1.3.1. Piaget's cognitive development theory

The body of work by Piaget (Piaget, 1926, 1954, 1962; Piaget & Inhelder, 1962) has been perhaps one of the most influential in developmental psychology (Crain, 1992). As Siegler and Ellis (1996) noted, no contemporary developmental psychology textbook would be complete without reference to Piaget's research and theoretical viewpoint! The core assumption of Piaget's theory is that children are active thinkers, who endeavour to individually construct a better understanding of the world around them by passing through a number of distinct cognitive stages (Siegler & Ellis, 1996). The transition from one stage of operations to another was argued to result from a child's adaptation to their environment, achieved by the joint operation of *assimilation* and *accommodation* (Piaget, 1954). Assimilation can be broadly defined as the integration of external elements into a previously existing schema (Block, 1982), for example, a child seeing a zebra and calling it a horse. In this case the child has taken their pre-existing concept of a horse and attached it to the new experience of a zebra. On the other hand accommodation is when the child changes their cognitive structures to fit with their environmental experience or input

(Block, 1982; Patterson, 2008). To use the horse example again, when the child understands that the ‘horse with stripes’ is in fact a zebra and names it so, that is evidence of accommodation (i.e., the recognition of a new animal).

For Piaget, symbolic thought occurs near the beginning of the preoperational stage, at around two years of age, through the processes of assimilation and accommodation coordinated by the child’s everyday activities (Nokony, 1978). Up to this age, children are bound by their actions in their immediate environment. They are not capable of representing or referring to any object or person beyond what they see. This idea is best shown by the robust phenomenon of object permanence. Piaget (1954) found, using observations from his own family members, that seven month old children would not search for a hidden object even in cases where the child had observed the object being hidden. Piaget theorised that this was because children at this age had not achieved full object permanence, although this idea has been disputed on the basis of the methodology Piaget adopted (object search) being too conservative (Baillargeon, 1987; Baillargeon & DeVos, 1991). Meltzoff and Moore (1998) noted that while 5 month old children appear to understand that objects still exist when occluded (as shown through a preferential looking paradigm), they are still not able to recover hidden objects until around eight months. They suggest that children from birth are able to represent objects, but do not have the motor abilities required to govern actions based on this knowledge[7]. This is problematic for Piaget’s theory, as he suggests that children’s representational knowledge is reflected in their actions on objects[8].

The understanding that objects can exist outside of their immediate perception is central to Piaget’s idea of cognitive representation. Infants who have attained full object

[7] Munakata, McCelland, Johnson and Siegler (1997) argued that the apparent variety in children’s performance on tasks designed to tap into object knowledge may be due to the relative *strength* of representations. For example ‘weak’ representations may be sufficient for children to make perceptual predictions (and thus affect looking at the occluded object) but may not be strong enough to induce reaching behaviour.

[8] Smith and Thelen (2003) suggest that children make object permanence errors (as shown by the A not B task) on the basis of maintaining their original representation of the target object which leads to a ‘reaching threshold’. If the correct ‘B’ cue is kept relatively strong (e.g., by reducing the time between the cue itself and the child’s selection), then this dominates over the child’s habituation to the incorrect ‘A’ selection.

permanence are able to search for objects when they have gone missing, thus they can *represent* object locations, even when the object's movement was not previously observed (Goswami, 1998). Piaget suggested that it is only once children have an understanding of the permanent nature of objects and a series of well organised actions for dealing with their day-to-day environment (Crain, 1992; Furth, 1994) that they can begin to represent actions as symbols. This occurs at sensorimotor stage six, around the end of the second year[9] (Piaget, 1962). By the early preoperational stage at around 21-24 months, children begin to represent objects as other objects through symbolic play and can reproduce actions that they have seen previously (deferred imitation, Gallagher & Reid, 1981; Nielsen & Dissanayake, 2004). Language, Piaget argues, comes later on in development and is initially bound to children's immediately present action. These first attempts at language are personal to the child and only later in development does the child understand that linguistic signs are conventional (Nokony, 1978). In this sense, by 21 months children are expressing 'displaced reference' (Hockett, 1960; Liszkowski, Schafer, Carpenter, & Tomasello, 2009) in their actions with objects *and* in their conventional speech[10].

The initial ontogenetic development of symbolic representational abilities then, according to Piaget, emerges between the final sensorimotor stage and the early preoperational stage. The ability to symbolically represent events has been identified as being an important factor for later cognitive outcomes including theory of mind understanding and literacy (Astington & Jenkins, 1995, 1999; Bergen, 2002; Christie & Roskos, 2009; Leslie, 1987; Yawkey, 1983). This may be because the development of pretend play scenarios induces a complex state in the child that needs to be resolved through the accommodation and assimilation of concepts.

[9] This notion is based on Piaget's observation of his daughter imitating the action of a clown with her finger, trying to recreate the trajectory of movement the clown had just achieved.
[10] This increasing use of displaced reference has also been observed in deaf populations with their 'homesign' gestures (J. P. Morford & Goldin- Meadow, 1997). These gestures have similar characteristics to conventional language including a syntactic structure and vocabulary (e.g., Goldin-Meadow & Mylander, 1990).

One of the main criticisms of Piaget's theoretical perspective is that he views symbolic representation through pretense as egocentric in nature (Rakoczy, 2006). Piaget sees pretend play as a *solitary* attempt by children to extend their current repertoire of action schemas to new objects. This view has been recently criticised by a growing body of research that has highlighted a social foundation for pretend play development (Leslie, 2002; Lillard & Witherington, 2004; Nielsen & Christie, 2008). This research is broadly based on the perspective of Vygotsky, addressed in the following section.

1.3.2. Vygotsky's sociocultural approach

Piaget (1962) argued that children move from one developmental substage to another in a linear fashion, based on children's internal adaptations to their environment. Once children move into the final stage of the sensorimotor period, they begin to represent symbolically, initially through their symbolic play and imitation practices but later on through language (Watson & Jackowitz, 1984). Piaget (1962), in line with a number of other researchers (Bates, et al., 1979; Fein, 1981, 1987; Nicolich, 1977), suggests that pretend play becomes 'decontextualised' in the sense that the representations made during the pretense activity are no longer bound by the properties of the object itself. This view is shared by Vygotsky (1978), who saw the development of pretend play using substitute objects as an indicator that children are able to detach themselves from external stimuli.

However, Vygotsky theorised that children used symbols as a *tool for thought* rather than an *object of action* (Fein, 1979, 1981) and that symbolic thought was crucial to the development of higher mental functioning[11]. Vygotsky (1962, 1978, 1987) argued that producing symbols in a variety of contexts leads to advanced thinking and is not a by-product of general cognitive advancement. The use of symbols assists in the child's functioning in the mental world in a similar fashion to tools in the physical world (Holland

[11] Wertsch (1985) outlined four criteria for these higher functions: the shift from the environment to the individual (self regulation); the emergence of conscious realisation; the social origins of higher mental functions and, the semiotic mediation of these functions.

& Valsiner, 1988). Initially, children use practical tools in similar ways to primates (Vygotsky & Luria, 1994). However, once a child can use symbols to supplement these actions, a transformation occurs that gives rise to uniquely human cognitions (see also Liszkowski, 2011; Tomasello, 2008). Symbols are "a specific organizing function that penetrates the process of tool use and produces fundamentally new forms of behaviour" (Vygotsky, 1978, p. 24).

El'Konin (1966), a student of Vygotsky, argued that pretend play has a crucial role in the development of higher mental functions. According to Vygotsky (1978), pretend play has the features of creating an imaginary situation, and children adopting the roles dictated to them by the play scenario[12]. Symbolic play is a way for children to practice representing objects and events (Stone & Stone, 2010), it "prepares the foundation" (Bodrova & Leong, 2003, p. 162) for thinking and imagination. During this process, Vygotsky noted, children use similar representational abilities in both pretend play and speech.

In this sense, Vygotsky argued that pretend play is a useful medium for the child to attempt new forms of representation in a safe context. For example, children may attempt to feed a toy doll, an action that in reality would probably be beyond a young child. By carrying out this action in a pretend context, the child enters into a *zone of proximal development* (Vygotsky, 1978) where they can at least attempt these concepts. While Piaget saw pretend play as essentially solipsistic, Vygotsky saw it as more socially mediated (Howes & Tonyan, 1999; Parten, 1932). A body of research provides support for this view, showing that pretend play at around two years of age is facilitated by the presence of a more capable peer (Fiese, 1990; Garvey, 1990; Kavanaugh, 2002; Nielsen & Christie, 2008; O'Connell & Bretherton, 1984; Slade, 1987). For example, Nielsen and Christie (2008) found that adult models are able to act as a scaffold for the generation of

[12] See Kozulin, Gindis, Ageyev and Miller (2003).

novel pretend acts (see section 1.6.3 for further details on the imitative basis for pretend play).

A further point of departure between the views of Piaget and Vygotsky concerns the role of language in the development of pretend play (Rakoczy, 2006). Piaget suggested that both pretend play and language are manifestations of children's "underlying semiotic function" (Rakoczy, 2006, p. 115). On the other hand, Vygotsky saw an essential role for language in understanding the structure of the pretense acts modelled and sculpted by the caregiver (El' Konin, 1966).

1.3.3. Werner's organismic approach

Vygotsky's theoretical standpoint chiefly differs from Piaget's with respect to the role of culture and social interaction in children's symbol formation. While Piaget saw symbolic development as a consequence of children's individual adaptations to the environment surrounding them, Vygotsky saw children's cognition in social terms; firstly on an interpsychological plane, and then on a intrapsychological plane (Vygotsky, 1978). Like Vygotsky, and contrary to Piaget, the work of Werner (Werner, 1940; Werner & Kaplan, 1963) placed much emphasis on the interaction between the child and the adult.

Like Piaget, Werner saw development not as simple maturation or a passage of time (Crain, 1992) but as a change in psychological structures. Werner and Kaplan (1956) termed this the *orthogenetic principle*; where development is classed as a cognitive structure proceeding from a lack of differentiation to a level of greater differentiation. Beeghly and Cicchetti (1987) summarise development in Werner and Kaplan's organisational perspective as "a dynamic series of qualitative organisations among and within behavioural and biological systems that take place by means of increasing differentiation and hierarchical organisation" (p. 7). By the term 'differentiation' Werner and Kaplan (1956) mean that the cognitive structure is increasingly flexible and can separate into parts with different forms and functions, for example, like an embryo developing the ability to move its limbs separately (higher differentiation) after only previously being able to move itself as a whole (lower differentiation, Crain, 1992).

It is this process of differentiation that gradually allows a child to separate itself from its environment. Werner and Kaplan (1963) argued that early in development, children are bound to their ongoing, sensorimotor experience. The sensations, feelings and objects experienced are conceptually ‘close’ in the sense that they are in the child’s immediate perceptual realm. When the child cannot see or feel an object or a caregiver, the child shows no interest in them (similar to Piaget’s concept of object permanence). Werner and Kaplan (1963) suggested that beyond this stage, in order to use symbols children have to learn that objects are entities in their own right, and that objects can be experienced beyond perceptual processes (Hammes & Langdell, 1981). Once children are aware of the permanent nature of objects and people, they are then able to depict them when they are not present (e.g., through imitation). Werner and Kaplan (1963) argued that this developmental change was evidence of symbolic ‘distancing’. In other words, with respect to language symbolic development “consists of children achieving an increasing distance from the immediate concrete experience with which a word is initially associated” (Keil, 1989, p. 8). The concept of symbolic distancing has been found in a number of contexts including pretend play with objects (Bigham & Bourchier-Sutton, 2007; Elder & Pederson, 1978) and with gestures (Boyatzis & Watson, 1993; McNeill, 1985). For example Elder and Pederson (1978) found that in order to successfully ‘pretend’, three year old children required an object to look similar to what the experimenter asked them to pretend the object was. On the other hand three and a half year old children were more able to substitute one object for another, irrespective of the degree of similarity between the object and what had to be represented. This is what Fein (1987) calls *referential freedom* in that children are able to use objects flexibly, to refer to a multitude of differing symbolic identities.

This concept of distancing was also noted by Piaget (1962). However, unlike Werner, Piaget did not emphasise the social or environmental influences on symbolic performance. Werner and Kaplan (1963) argued that interaction with a caregiver (or a 'primordial sharing situation') is a crucial stimulator of symbolic awareness (Mundy & Sigman, 2006), seen for example through the coupling of children's earliest instances of symbolic labelling and their early pointing behaviours. They argue that pointing is an early indicator that the child is beginning to differentiate themselves from other objects and people (Goldfield, 1990). However, as pointing can only refer to entities in the immediate context, Werner and Kaplan (1963) regard pointing as an intermediate stage in symbol formation. Other theorists (Bates, et al., 1979; Bates, Camaioni, & Volterra, 1975; Bruner, 1975a, 1975b, 1983) argued similarly that early social awareness and coordination were crucial in the development of symbolic skills. For example, Slade (1987) argued that the caregivers' role in symbolic development was two-fold. First, they scaffold and support the child in communicating their communicative intention (Bruner, 1975a, 1975b, 1983). Second, they provide a general supportive presence and security during their interactions.

Indeed, contemporary researchers have become increasingly concerned with the underlying social-cognitive skills that act as a cognitive catalyst for children's ongoing symbol formation (Akhtar & Gernsbacher, 2007; Aureli, Perucchini, & Genco, 2009; Bates, et al., 1979; Bretherton & Bates, 1979; Bruner, 1975a, 1983; Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998; Jones, 2009; Meltzoff & Moore, 1977; Nielsen, 2008; Over & Gattis, 2010; Rakoczy, 2008; Tomasello, 1999, 2003; Tomasello & Farrar, 1986). Liszkowski (2011) in line with a number of theorists (Bates, et al., 1979; Bruner, 1975b; Tomasello, 1999, 2008) suggests that human communication relies on higher cognitive skills that run deeper than being able to use symbols, and that the uniquely human ability to use symbols is mediated by these social-cognitive skills and motivations. It is likely that children use these abilities, and the guidance of others (Braswell, 2006; Rogoff, 1990; Vygotsky, 1978) together in their developing use of symbols. The following sections explore this possibility by examining three social-cognitive skills that have been identified as important precursors for symbol formation in young children; joint attention (e.g., Bruner, 1975a), an understanding of intentions (e.g., Carpenter, Nagell, Tomasello, et al., 1998) and social learning (e.g., Striano, Tomasello, & Rochat, 2001). I also explore the role that these social-cognitive abilities play in children's symbol formation in the three domains outlined in section 1.2; speech, gestures, and pretend play.

1.4. Social cognition and symbol formation

1.4.1. Joint attention

Up until around nine months of age, children interact with objects and people in their environment through *dyadic* interactions. However, by around nine months of age, children are able to coordinate a *triadic* attentional frame between themselves, an object and a communicative partner (e.g., Tomasello, 1999; Tomasello & Rakoczy, 2003). This manifests itself through being able to reliably look where caregivers look (gaze following, Scaife & Bruner, 1975; Senju & Csibra, 2008), the use of adults as a social reference (Vaish & Striano, 2004; Walden & Ogan, 1988) and the establishment of joint attention. Joint attention skills refer to the ability to coordinate attention with a social partner in order to relate to an object or event of interest (Bates, 1976; Bates, et al., 1979; Mundy & Acra, 2006). This involves a transfer from dyadic interactions between a child and an object *or* person to a triadic interaction between a child, object *and* a person (Carpendale & Lewis, 2004; Trevarthen, 1979). There have been two main types of joint attention behaviour shown by children up to around 18 months of age (Carpenter, Nagell, Tomasello, et al., 1998). The first, which begins to occur at around three to six months of age (Scaife & Bruner, 1975) has been termed *responding to joint attention* (RJA), and is when a child is able to monitor and follow the gaze or gestures of another person (J. A. Hobson & Hobson, 2007). The second form of joint attention, which occurs later in ontogeny is called *initiating joint attention* (IJA), and is when the child uses eye gaze, gestures (or both) to coordinate attention with their social partner (Bates, 1976; J. A. Hobson & Hobson, 2007; Mundy & Acra, 2006). By two years of age, children are proficient at both these forms of joint attention and are capable of coordinating with their social partner through the use of vocalisations, eye gaze and declarative[13] gestures (Carpenter, Pennington, & Rogers, 2002).

Bruner (1975a, 1975b, 1983) argued that the development of joint attention is the cornerstone of all subsequent social interactions and cultural learning (Carpenter, Nagell, Tomasello, et al., 1998). According to Rogoff (1990) it is children's joint attentional abilities that mark the beginning of their understanding of the symbolic artefacts (e.g., words, signs or gestures that others use). Tomasello and colleagues (Tomasello, 1995; Tomasello & Carpenter, 2007) suggested that what makes joint attention different from simple gaze following is the *collaborative knowledge* between two people that they are experiencing something at the same time. This is more than merely experiencing the event at the same time because it allows two people to share common ground, which allows collaborative communication and shared goals.

The following sections explore the possibility that joint attention abilities in children make a significant contribution to the use of symbols in pretend play and word learning. In addition, there is a section that focuses on how children use gestures as a 'tool' for establishing joint attentional frames with communicative partners.

1.4.2. Joint attention and word learning

By around twelve months of age several joint attentional skills are observed in typically developing children (Bakeman & Adamson, 1984). This triadic coordination between a child, their communicative partner and a third entity has been identified as being of early importance for language development. Tomasello and Farrar (1986) videotaped naturalistic interactions between children and their mothers at 15 and 21 months of age.

[13] Declarative gestures were defined by Bates et al. (1975) as gestures that acted to draw the attention of a communicative partner to an event or object of interest. This contrasts with imperative gestures, where the intention of the signaller is to achieve some end (e.g., to be given an object).

They found that during episodes where caregivers and children were engaged in a joint activity, both children and mothers produced more utterances and engaged in significantly longer conversations. They argued that these episodes of joint attentional focus "provide important non-linguistic scaffolding for the young child's early linguistic interactions" (p. 1462). The link between joint attention and language development has focused in particular on children's vocabulary development, with Tomasello (1995) arguing that joint attentional episodes are the key to acquiring a new word (see also Bruner, 1983).

1.4.2.1. The case of autism

To understand the role that engaging in joint attention may have in children's early language abilities (vocabulary development), it is important to investigate clinical populations in which joint attentional skills are apparently lacking. Autism is an example of such a disorder, and is hallmarked by a triad of impairments (Wing & Gould, 1979) including impairment of social relationships, impairment of social communication and poor imagination skills. It is a robust finding that children with autism have poor joint attention skills (Mundy & Sigman, 2006; Mundy, Sigman, & Kasari, 1994), and the degree to which these skills are impaired has been found to correlate with autistic children's concurrent linguistic abilities (Sigman & Ruskin, 1999)[14].

Charman and colleagues (Charman, 1997, 2003; Charman et al., 2000) have argued that joint attention skills are pivotal in the development of language. Charman (2003) studied a sample of children with autism at 20 months and later at 42 months. At 20 months, he assessed spontaneous play, joint attention skills, goal detection, and imitation abilities and correlated these measures with a number of symptom severity measures at 42

[14] Intervention studies provide further support for the link between joint attention and linguistic skills. Kasari, Paparella, Freeman and Johromi (2008) found that children with autism who received a targeted joint attention intervention scored significantly higher than a control group on standardised language measures up to twelve months post intervention.

months. He found that one measure of joint attention (frequency of gaze switches) was concurrently and longitudinally associated with language ability[15].

This finding supplements earlier work on typically developing children that has established a link between joint attention and later language learning (Bates, et al., 1979; Carpenter, Nagell, Tomasello, et al., 1998; Tomasello & Farrar, 1986). However, this relation has been found to lose predictive strength over developmental time in children with autism. Morales, Mundy, Delgado, Yale and Messinger (2000) found that while measures of *responding* to joint attention were positively related to vocabulary development between the ages of 6 and 18 months, beyond this age the predictive relations weakened, leading to the suggestion by Tomasello (1999) that joint attention is a crucial skill for children's *earliest* language development.

1.4.2.2. Possible mechanisms for links between joint attention and word learning

The question at this point is how does joint attention contribute to children's symbolic language learning? Bruner (1983) argued that children's early interactions with their caregivers help "scaffold" their early language development. Tomasello and Todd (1983) found that individual differences in the ability of mothers and their children to maintain joint attentional frames were directly related to the children's later vocabulary size. Baldwin (1991, 1995) argued that joint attention skills help reduce the potential for referencing errors in language learning. For example, Baldwin (1991) found that 16 to 19 month old children used the non-verbal cues of an adult (eye gaze) to determine the label of objects. Children were able to select objects correctly in a comprehension task even when the object was labelled when the child was looking at a different object, while the adult was looking at the target object. During everyday interactions with a caregiver, a

[15] A longitudinal association was also found between imitation abilities at 20 months and language scores at 42 months. Carpenter et al. (2002) suggest that children with autism may use imitation to enter into the process of language acquisition before they have the ability to share attention.

child is provided with two main methods to achieve incidental word learning; by a caregiver referring to a new object in the environment, or by the child discriminating between different stimuli to create new word to object associations (Mundy & Acra, 2006). Children use joint attention to reduce the possible number of referents that may be attended to, or caregivers may use joint attention contexts to provide the child with a new word (Baldwin, 1995). Thus, children with an apparent lack of joint attention skills (such as children with autism) may struggle with language development as it reduces the possibility for incidental learning from interactions with more capable peers (Mundy & Neal, 2001).

The view outlined above suggests that joint attention is a necessary precursor to symbolic development in the linguistic domain. However, the majority of these studies have utilised methods that seek *overt* indicators of joint attention, while neglecting the possibility for *covert* attention (Akhtar & Gernsbacher, 2007). Akhtar, Jipson and Callanan (2001) found that 2 year old children learned a new word equally well when they heard the word as part of a direct interaction with a caregiver *or* after overhearing the word when an experimenter and a confederate were having a conversation. Akhtar and Gernsbacher (2007), in their review of research into joint attention, argued additionally that the overt measures used to establish joint attention (e.g., head turns, gaze alternation and pointing) may be too conservative in the sense that they may exclude instances of covert joint attention.

1.4.3. Gestures as a tool for achieving joint attention

1.4.3.1. Children's understanding of adult gestures to establish joint attention

In order to learn words children must find an efficient way to correctly map signifiers to referents. Children may utilise a number of social cues to facilitate the understanding of the communicative intention of an adult including their eye gaze and their facial expressions (Leekam, Solomon, & Teoh, 2010; Tomasello, Call, & Gluckman, 1997). Leekam et al. (2010) found that two to three year old children were more likely to correctly use a referent (a point, an arrow or a replica object) to locate a desirable object if the experimenter's face was engaging, as opposed to neutral. However, across all conditions and ages children were particularly efficient at interpreting the intentions of the experimenter's deictic gestures (see also Behne, Carpenter, & Tomasello, 2005).

1.4.3.2. Children's production of gestures to establish joint attention

As children are not yet proficient at establishing joint attentional episodes through their language during the first year, they appear to be able to utilise the non-verbal modality. The work of Bates and colleagues (Bates, 1976; Bates, et al., 1979; Bates, et al., 1975; Bates, Thal, Fenson, Whitesell, & Oakes, 1989; Bretherton & Bates, 1979) described children's early production of referential gestures during the first year of life, specifically between 9 and 13 months (Bates, 1976). These *performative* gestures serve to gain attention and to maintain it with an adult and have been identified as being crucial for creating language learning opportunities (Bruner, 1975b; Capone & McGregor, 2004; Volterra & Erting, 1990). Bates (1976) identified four types of *performative* gestures: ritualised requests (an action designed to invoke a behaviour response in the adult), showing (holding up an object so that the adult will pay attention to it), offering (holding up an object so the adult will take the object), and pointing. These distal gestures[16] are early indicators of a child's intention to request, declare or to draw an adult's attention to locations, objects or events of interest (Bates, et al., 1979; Capirci, Contaldo, Caselli, & Volterra, 2005; Pika, 2008a; Tomasello, 1999). This prelinguistic use of deictic gestures indicates that children have the means and the motivation to engage an adult before uniquely human forms of cognition (i.e., symbol use) are obtained (Liszkowski, 2011; Liszkowski, et al., 2009).

[16] The term 'distal' in this context refers to the fact that these performative gestures have no mechanical influence on the adult, although in the cases of showing and giving, the child is in contact with the third entity of interest (Camaioni, Perucchini, Muratori, & Milone, 1997; Tomasello & Camaioni, 1997)

According to a number of researchers, the act of pointing (a form of deictic gesture) has a special social significance (Bruner, 1975b; Crais, Douglas, & Campbell, 2004; Vygotsky, 1978), a view perhaps supported by the presence of pointing in all human societies (Kita, 2003). Vygotsky (1978) suggested that pointing gestures represent an interpersonal connection between individuals. According to Tomasello (2008), deictic gestures function by directing the attention of an individual to a location in the immediate perceptual environment. However, for the deictic gesture to be understood correctly, the recipient of the gesture must infer the social intention of the gesturer. Bates et al. (1975) identified two main intentions underlying children's early deictic gestures. *Imperative* deictic gestures are intended to get an adult to *do* something (e.g., to get a toy for the child); the target of the deictic gesture is physical action (Pika, 2008a). On the other hand *declarative* gestures are intended to *draw the attention* of the adult to an object, event or entity.

Liszkowski (2005) argued that there is a third category of deictic gesture, where the motivation of the signaller is to *inform* the recipient. Liszkowski, Carpenter, Striano and Tomasello (2006) tested this idea by showing 12 and 18 month old children a number of actions using an object. This 'target' object was then placed with a distracter object in the view of the child but not the experimenter. After the target object had been hidden, the experimenter searched for the object and children's gestural behaviour towards the experimenter was recorded. It was found that for both age groups, children pointed significantly more at the target object than the distracter object, indicating that children were motivated to inform the adult via deictic gesturing[17]. A leaner account for these findings is given by Moore and D'Entremont (2001). They found that 12 month old children pointed at an interesting event equally often if a caregiver was not looking at the event, compared to when they were. They suggest that infants point initially to orient their

[17] Southgate, van Maanen and Csibra (2007) suggest that this pointing may not necessarily be 'informative' but 'interrogative', a form of imperative gesture where the child is asking for the interesting action to be performed again. In other words, the gesture may not be altruistic in nature but self-serving.

own attention and not that of others. It is likely then that children point with a number of motivations in mind, including to orient themselves to interesting stimuli (Delgado, Gomez, & Sarria, 2009). However, Lizskowski and colleagues (Liszkowski, 2011; Liszkowski & Tomasello, 2011) contend that pointing, in particular pointing with the index finger as opposed to the whole hand (Franco & Butterworth, 1996; Lock, Young, Service, & Chandler, 1990), structures children's social communicative activities with their caregivers. Liszkowski and Tomasello (2011) found that 12 month old children's pointing behaviour was linked to the pointing of their caregivers, in that children who pointed often also had caregivers who pointed often. They interpret this finding as evidence that children "actively co-construct with their caregivers social interactional experiences" (p. 27).

1.4.3.3. Gestures and word learning

The question here is does the establishment of joint attentional frames through the use of gestures contribute to children's early word learning? Werner and Kaplan (1963) attribute great importance to children's earliest pointing behaviour. They suggest, in line with Bates et al. (1975), that the transition from gestures which require contact with the referent, to gestures that are distal from the referent (as is the case with pointing gestures) is a behavioural manifestation of 'distancing', and thus the act of pointing is an early step towards symbolisation. M. Harris, Barlow-Brown and Chasin (1995) found that instances of pointing occurred at approximately the same time as comprehension of verbal labels. Similarly, Camainoi, Caselli, Longobardi and Volterra (1991) found a predictive relation between the amount of pointing gestures produced by the child at 12 months and their subsequent speech production at 24 months, as measured by parental report.

It is implied that the act of pointing assists in the development of verbal symbolic labelling as it allows the child to direct the caregiver's attention effectively onto a third entity, which the caregiver subsequently labels, leading to word learning in children. However, this apparent method of learning is dependent on the caregiver responding appropriately to the child's attempts to refer to an object or event. R. P. Hobson, Patrick, Crandell, Garcia Perez & Lee (2004) tested this idea by measuring caregivers' sensitivity to the actions of their children on a five point scale while they were taking part in a teaching task (4 = very sensitive, 0 = not sensitive). Sensitivity was defined as being *aware* of the child's ongoing state and *adjusting* their state accordingly. The dyad's ability to engage in triadic interactions was measured using a 'secondary intersubjectivity scale', which included measures of point following, social referencing and reciprocal play. They found that high maternal sensitivity was correlated with children's propensity to engage the mother in triadic interactions.

There is the possibility then that sensitive caregivers may respond to the pointing behaviours of their children, as part of a triadic interaction, with verbal labelling (Vallotton, 2009). How do caregivers respond to these gestures? Bruner (1978) suggested that pointing gestures may evoke verbal responses from caregivers. Kishimoto, Shizawa, Yasuda, Hinobayashi and Minami (2007) tested this idea by observing nursery staff's immediate responses to pointing behaviour by 18 to 21 month old children. They compared this behaviour to a control measure where children were not pointing. They found that the staff responded quicker with a verbal label (within five seconds) in the post-pointing condition, compared to the control condition. Kishimoto et al. (2007) concluded that children's language acquisition is encouraged by caregivers' appropriate descriptions of objects or events that attract the child's interest. Caregivers may 'translate' the pointing gestures of the child into words, leading to lexical development (Goldin-Meadow, Goodrich, Sauer, & Iverson, 2007; Golinkoff, 1986). Goldin-Meadow et al. (2007) assessed this view by observing children between 10 and 24 months, as they took part in activities with their main caregiver. They found that in cases where the mother made an attempt to 'translate' the pointing gesture of the child (when the gesture was not accompanied by speech), those words were more likely to enter the child's vocabulary. Further, they found that mothers spoke for longer in response to their children's attempts to supply a supplementary word to accompany a pointing gesture (e.g., point to dad and say “lift”) instead of a reinforcing word (e.g., point to dad and say “dad”). Goldin-Meadow and colleagues (Goldin-Meadow, et al., 2007; Iverson & Goldin-Meadow, 2005) conclude that the child’s pointing gestures indicate a cognitive readiness to learn a word, and this in turn elicits a response from caregivers which facilitates this learning.

However, an alternative interpretation of these findings is that it is not the pointing act *per se* and its subsequent interpretation by the adult that facilitates language learning in children but the overall social context in which pointing gestures are produced (Petitto, 1988). Indeed, the Kishimoto et al. (2007) finding that pointing by the children evokes an immediate verbal response from the nursery staff suggests that pointing may be a strategy to elicit verbal exchange. To assess these competing views Colonesi, Stams, Koster and Noom (2010) performed a meta-analysis of 25 studies, published in the last thirty-two years, concerned with children’s early pointing behaviour and their language development. Colonesi et al. (2010) found a large effect size (r = .52) in favour of a *concurrent* relation between pointing and language development and a medium to large effect size (r = .35) in favour of a *longitudinal* relation between pointing and subsequent language development. Similarly, Brooks and Meltzoff (2008) found that whether a child pointed or not at 10 months was a significant predictor of children’s vocabulary growth at 24 months. Importantly, this predictive effect was found above and beyond the predictive effect of another joint attentional behaviour (gaze following). This suggests a unique contribution of pointing to word learning.

These findings taken together suggest a strong predictive effect of children’s pointing on later linguistic outcomes. Colonesi and colleagues note however, that this conclusion should be met with caution, as a meta-analysis cannot discount unwritten environmental factors that were not controlled in the original studies. Rowe and Goldin-Meadow (2009a) for example found a correlation between children’s early gesture use and the socio-economic status of their caregivers. They suggest, in line with Petitto (1988), that parental gesture rates are influenced by their socio-economic status. This results in children from lower socio-economic backgrounds producing fewer gestures and in turn, leads to lower subsequent vocabulary size, compared to children of caregivers with a high socio-economic status.

1.4.4. Joint attention and pretend play

According to Leslie (1987), pretend play is achieved when children are capable of separating a primary representation from a pretend act. The most famous example is the use of a banana to represent a telephone. Before this representational ability manifests itself in pretense action, a number of researchers suggest that an understanding of another person's mental state is reflected in children's triadic interactions (Baron-Cohen, 1989; Leekam, Hunnisett, & Moore, 1998; Leslie, 1987; Leslie & Happe, 1989), and that this understanding is an important precursor to later symbolic representation.

If it is indeed the case that joint attention behaviours (such as gaze following) are precursors to pretend play based on the same meta-representational capacity, then there should be a longitudinal relation between measures that tap into these abilities (Charman, 1997). Research addressing this theoretical notion has generally centred around children with autism, who are known to have a reduced frequency and complexity of pretend play behaviours compared to typically developing children (Baron-Cohen, 1987; Ungerer & Sigman, 1981). Mundy and Sigman (1989) found no significant correlation between autistic children's joint attention skills and their pretend play abilities, suggesting that they are not linked by an underlying metarepresentational ability. Instead, they suggest that the deficits expressed in pretend play by children with autism are an outcome of a series of interdependent cognitive and affective deficits, such as processing of social stimuli (e.g., Fletcher-Watson, Leekam, Benson, Frank, & Findlay, 2009). This view was supported by Rutherford and Rogers (2003) who used data from samples of typically developing, autistic and other developmentally delayed children to investigate which measures (joint attention, executive function[18] and non-verbal communicative behaviours) significantly predicted children's pretend play abilities. They found that the measure of *initiating* joint attention did not correlate significantly with the pretend play measure in any of the three groups, while generativity (an executive function measure) did significantly predict concurrent pretend play scores. However, a longitudinal study by the same research group (Rutherford, Young, Hepburn, & Rogers, 2007) reported that joint attention at 33 months was a significant predictor of spontaneous pretend play production at 58 months in a sample of children with autism. They suggest, in line with the metarepresentational theory of pretend play (Baron-Cohen, 1987; Leslie, 1987), that joint attention is a crucial building block for later advancements in pretend play. It may also be the case that there is a bidirectional influence between joint attention and pretend play, in the sense that pretend play indirectly enhances joint attention abilities (Kasari, et al., 2008; Stahmer, Ingersoll, & Carter, 2003). Indeed, pretend play interventions have been found to boost children with autism's joint attentional skills (Kasari, et al., 2008; Thorp, Stahmer, & Schreibman, 1995) and thus play generally has been utilised in interventions that have sought to improve children's joint attention (White et al., 2011).

1.5. Intention reading

According to the research outlined above, the capacity for children to engage in triadic interactions is a crucial social-cognitive ability which underlies symbol formation in the linguistic and the pretense domains. Tomasello (2000b) suggests that joint attention is crucial to linguistic symbol development in children as language itself is an advanced form of joint attentional skill. Children are also able to utilise their non-verbal communication via the use of deictic gestures to engage in triadic interactions which facilitate symbol learning.

[18] Executive function was measured by using a generativity task, which focuses on children's ability to generate novel acts, to explore new materials and to solve problems. This deficit has been previously linked to autistic children's deficits in pretense (Jarrold, 2003; Jarrold, Boucher, & Smith, 1993, 1994).

Tomasello (2000b) suggested that the reason children are able to establish joint attentional frames to aid language development from such a young age is due to a "dawning understanding of other persons as intentional agents" (p. 406). The term 'intention' in this context means a plan of action that an organism chooses and commits to in order to achieve a goal (Bratman, 1989; Tomasello, Carpenter, Call, Behne, & Moll, 2005). This understanding of intentions has been further sub-divided into an apparent understanding by children of *non-communicative* (i.e., the intention for a partner to perform an *action*) and *communicative* intentions (i.e., to inform, or make a partner aware of something). To understand the intentions of others to perform an action (a non-communicative intention), the child must understand both the means of an action *and* the goal for which the actor is aiming (Tomasello, 1999; Tomasello & Rakoczy, 2003). Children appear to have an understanding of others' action intentions from a young age. Carpenter, Ahktar and Tomasello (1998) found that 14 month old children were more likely to imitate an action when the action was vocally marked as being intentional (by saying "there") as opposed to being marked as accidental ("whoops"). Understanding of adults' intentions has also been found in children as young as nine months (Behne, Carpenter, Call, & Tomasello, 2005). Behne et al. (2005) found that nine to 18 month old children were more impatient with adults (e.g., by producing more reaching behaviours) when the adult was withholding an object from them by dropping the object 'intentionally', compared to when the object was withheld by 'accidently' dropping it. A number of studies have also shown that children adjust their reproduction of actions depending on the perceived goal of the demonstrator of the action (Bekkering, Wohlschlager, & Gattis, 2000; Gergely, Bekkering, & Kiraly, 2002; Meltzoff, 1995; Nielsen, 2006). This suggests that by nine months of age, children are aware that other people are in pursuit of action goals and that they persist with actions in pursuit of matching their goal with reality.

Children's understanding of *communicative* intentions has been less well studied (Aureli, et al., 2009) but there is some evidence that children through the second year understand the communicative intentions underlying adults deictic gestures (Behne, Carpenter, & Tomasello, 2005) and speech (Over & Gattis, 2010). Behne et al. (2005) for example found that 18 month old children were better able to choose a container with a toy held inside, when the experimenter informed the child using a *pointing* gesture, compared to a *gaze* towards the object. They suggest that children are aware of the communicative intentions that pointing gestures may have, and use this knowledge to increase task performance. Similarly, children during the second year have been found to comment on the object being indicated by a pointing gesture (Aureli, et al., 2009) and have been found to use gestures in the giving of information to an experimenter (Liszkowski, 2005; Liszkowski, et al., 2006).

Tomasello and colleagues have suggested that children use their understanding of intentions to develop a range of uniquely human skills of social cognition, for example pretend play, language learning and the use of a multitude of cultural artefacts (Rakoczy, 2008; Rakoczy, et al., 2005a; Striano, et al., 2001; Tomasello, 1999, 2003; Tomasello, et al., 2005; Tomasello & Rakoczy, 2003). The following sections will evaluate this possibility, first by assessing the potential for intention understanding to be specific to humans, and second by exploring research that has investigated a link between intention reading and symbol formation in the domains of speech and pretend play.

1.5.1. Is intention understanding unique to humans?

Tomasello (1999, 2003) argues that understanding intentions is uniquely human, and allows children to understand form to meaning pairings essential in the development of human's specific abilities with symbols in language and in other domains. However, the evidence for a species-specific intention reading ability in humans is mixed (Behrens, 2009). Research had found that chimpanzees are not able to utilise inferred knowledge from a human. For example, Povinelli and Eddy (1996) found that chimpanzees failed to discriminate between humans, of which one had knowledge of a desired object (by being able to see it) while another did not (had a bucket on their head). This suggests that chimpanzees have little knowledge of the mental states of others, and thus have no understanding of their intentions.

However, Tomasello, Call and Hare (2003) suggested that the lack of an ability to discriminate between ‘knowledgeable’ and ‘unknowledgeable’ humans shown by the chimpanzees in this study was only for subtle tasks concerning eye movements, while they were able to discriminate in situations which were less subtle (e.g., when the ‘unknowledgable person’s back was turned away). Phillips, Barnes, Mahajan, Yamaguchi and Santos (2009) and Call, Hare, Carpenter and Tomasello (2004) tested whether capuchin monkeys and chimpanzees respectively had an understanding of the intentions of an experimenter. They both used a paradigm where they manipulated their apparent intentions to give capuchin monkeys and chimpanzees food (unwilling to give them food versus unable to give them food). They found that in both studies (for each of the species of animal) less frustration behaviours were exhibited when the human experimenter appeared ‘unable’ to give the food to them, compared to when they were ‘unwilling’ to give them the food. In addition to this primary finding, Phillips et al. (2009) noted that capuchins understood that some *objects* could not act intentionally (e.g., sticks) while other objects (e.g., human hands) could, and responded accordingly.

Non-human primates also appear to produce *gestures* intentionally. Pika (2008b) suggested that in order to deduce whether non-human primates gestured intentionally, there needs to be evidence of flexibility of gesture use with respect to the goals of the gesture. She also suggested that there should be an audience effect, with non-human primates performing visual and auditory gestures at differing rates, depending on the orientation of the recipient (Liebal, Pika, Call, & Tomasello, 2004). Evidence for these behaviours in non-human primates comes from Cartmill and Byrne (2010), who observed 28 orangutans over a period of nine months. They found that orangutans used 40 different gesture types to achieve a number of goals (including initiating grooming, requesting objects, or stopping an action).

While the goals of Cartmill and Byrne (2010) were termed ‘social’, in the sense they involved a signaller and a recipient, the gestures were intended to achieve imperative aims (i.e., to instigate the recipient into action). According to Pika and colleagues (Pika, 2008a, 2008b; Pika, Liebal, Call, & Tomasello, 2005), the imperative nature of non-human primates’ gestures is one of the factors which distinguishes them from prelinguistic children, whose deictic gestures can be both imperative, declarative and informative (Liszkowski, 2005; Liszkowski, et al., 2006). In line with this view, Tomasello (2005) showed three chimpanzees an interesting event, while the experimenter pretended not to notice. The chimpanzees were then scored on whether they attempted to engage the adult into performing a behaviour (imperative) or to draw the experimenter’s attention to the event (declarative) via gesture. He found that all of the chimpanzees performed at least one imperative gesture but there were no cases of declarative gestures observed (although see Pika (2008a) and Lyn, Greenfield, Savage-Rumbaugh and Gillespie-Lynch (2011) for examples of declarative gestures in non-human primates[19]). The second factor that Pika and colleagues identified as separating non-human primates from their human counterparts is the fact that non-human primate gestures are by and large dyadic (i.e., refer to themselves) while children’s deictic gestures are triadic (i.e., refer to a third entity).

The issue raised here is that if chimpanzees and monkeys seem to have an understanding of intentional behaviour, and indeed express this knowledge through gestural means then it cannot be this social-cognitive skill alone which explains the uniquely human skills of symbolic understanding. Tomasello and colleagues (Tomasello & Carpenter, 2007; Tomasello, et al., 2005) argue that the crucial difference between human and non-human primates, which may account for the differences in symbol formation and

[19] These apparent declarative gestures in nonhuman primates only appear in highly structured, human-reared environments and not in the wild (Cochet & Vauclair, 2010; Leavens, 2009). It may be a case then that imperative and declarative gestures may have different origins; with different social cognitive skills responsible for both behaviours (Camaioni, et al., 1997) (see section 1.6.2.2).

use, might be humans' capacity to take part in collaborative activities by *sharing* intentions. 'Shared intentionality' (Gilbert, 1989; Searle, 1995) has a number of core characteristics (Bratman, 1992). First, the interactants are mutually responsive to each other. Second, the members of the interaction have a shared and mutual knowledge of the end goal and they are able to coordinate their plans of action in order to achieve it. Tomasello and Rakoczy (2003) suggest that coordinating with others' intentions at around 12 months of age is the "momentous leap" (p. 122) in human social cognition and separates humans from non-human primates. Tomasello et al. (2005) claim that although non-human primates interact with each other in complex ways "they are not motivated to share emotions, experiences, and activities with others of their own kind" (p. 686). This is indicated by non-human primates' apparent lack of collaboration with conspecifics (Hare & Tomasello, 2004) and the fact that they appear not to gesture declaratively (Pika, 2008a, 2008b; Pika, et al., 2005; Tomasello, 2005).

1.5.2. Intentions and symbol formation

1.5.2.1. Speech

According to the perspective outlined by Tomasello and colleagues, children's burgeoning intention understanding paves the way for their early pre-linguistic communication. At around ten months of age, children are able to draw their caregiver's attention to objects by holding them up or by pointing to them (Bates, et al., 1979; Bates, et al., 1975). Tomasello and Rakoczy (2003) argue that this early gestural behaviour is indicative that children understand communicative intentions. They can use this understanding to engage the caregiver in joint attentional frames which will assist in learning linguistic symbols (see section 1.4.2). However, as linguistic symbols are culturally defined in the sense that a lexical item often has a specific meaning, and they are introduced to the child in a number of different contexts, the child must have a coherent and flexible understanding of the intentions of the caregiver (Bloom, 2001; Tomasello, 2000b). Research has found that children indeed use their understanding of others as intentional agents in order to learn new words (Tomasello & Barton, 1994; Tomasello & Kruger, 1992). Tomasello and Barton (1994, study 4) found that 24 month old children were able to use social-pragmatic cues to understand the referential intention of the adult and to learn symbolic reference. In this study children were introduced to a new word (a 'toma'). After this introduction, the experimenter announced their intention to 'find the toma' and their initial success at performing this task was manipulated. They found that children learned the novel word just as well if the experimenter had performed an object search which consisted of two previous rejections compared to if she found the object straight away. This suggests that children are not mapping new words to referents on the basis of simple rules such as "the 'toma' is the next object the experimenter touches" but are able to make pragmatic inferences based on response of the adult to each object. Tomasello (2003) suggests that this domain-general ability to understand others' intentions, coupled with pattern finding abilities helps children learn linguistic symbols. Pattern-finding abilities allow children to identify frequently co-occurring linguistic units (Marcus, Vijayan, Rao, & Vishton, 1999; Saffran, Newport, & Aslin, 1996), while intention reading allows the pairing of form to meaning that creates knowledge of language (Bloom, 2001; Evans & Green, 2006).

On this basis, Preissler and Carey (2005) reasoned that if intention reading was necessary to learn new words, then children who were poor at inferring the intentions of others would have difficulties mapping novel words to referents. They compared children with autism, who have been identified as having poor intention reading (e.g., Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995), to typically developing children on their abilities to infer the experimenter's intention when referring to a novel object. First, they found that children with autism were more likely to choose the object *they* were looking at when the experimenter expressed an object label, instead of the object the experimenter was looking at. This suggests that children with autism are not able to use the intentions of adults as a method for learning new words. However, in a second experiment, children with autism were no different to typically developing children, when asked to select which object a novel word referred to (out of two possibilities) when one object had a known label (e.g., an apple). Preissler and Carey (2005) suggest that understanding of intentions may not be required to achieve object to referent mapping, and that both sets of children may have underlying language constraints that do not depend on social cues.

1.5.2.2. Gestures

It seems that adults are aware that gestures (coupled with speech) are produced with the overall intention to inform the recipient (see section 1.2.2.2). Kelly, Ward, Creigh and Bartolli (2007) for instance found that when adults were told that the gestures and speech they observed were produced by the same person (i.e., were intentionally produced as part of a communicative message) they responded differently (as shown by their ERP measures) compared to if they understood the same speech and gesture to be produced by different people. They suggest that adult recipients in everyday communication assume that gestures are produced with the intention of accompanying speech and thus integrate speech and gesture by default (Bavelas, et al., 2002; Beattie & Shovelton, 1999a). Indeed, there has also been a multitude of studies that have investigated how adult speakers adjust their gesture production depending on the visibility of the interlocutor and the knowledge state that both speakers share (Alibali, et al., 2001; Bavelas, Coates, & Johnson, 2000; Bavelas, et al., 2002; Beattie & Shovelton, 2005; Holler, 2010; Holler & Beattie, 2005; Holler & Wilkin, 2009; Hostetter, 2011; Kelly, Ozyurek, & Maris, 2010; Ozyurek, 2002). For example, Bavelas et al. (2002) manipulated whether the speaker thought that their descriptions were going to be *heard* by an imaginary interlocutor, or whether they would be *seen*. They found that speakers gestured significantly more in the *seen* condition, suggesting that speakers have an intention to be informative through their gestures[20].

However, there has been no research that has investigated whether intentional production of a gesture by an adult is any more likely to be utilised by a child than unintentionally produced gestures. This may be because it would be difficult conceptually as gestures, unlike actions on objects, are inconceivably interpreted as 'by accident'.

1.5.2.3. Pretend play

With regards to symbol formation with objects via pretend play, Rakozcy and colleagues (Rakoczy, 2006, 2008; Rakoczy, Tomasello, & Striano, 2005b) argue that this behaviour is an early form of a unique cooperative activity based on both members having an understanding of 'shared' intentions. Previous research suggests that children as young as 14 months are able to coordinate actions with a partner to achieve a goal (Warneken, Chen, & Tomasello, 2006; Warneken & Tomasello, 2007). Warneken et al. (2006) found that children at 18 and 24 months were able to play games that required two people to perform successfully. They also attempted to reengage the partner (after the partner was interrupted) through the use of vocalisations. In developing a pretense scenario with a caregiver, the child makes a commitment to a joint action (e.g., we pretend that object X is an object Y, I am a robot and you are a monster). In creating this scenario, the rules of the interaction are implicitly set and the scenario rests on each member applying the set 'status functions' (Searle, 1995; Walton, 1990). Indeed, children have been found to exhibit protest when an adult who was bound in a created pretense scenario later violated it (Wyman, Rakoczy, & Tomasello, 2009a, 2009b). This suggests that children are motivated to engage in collaborate symbolic 'pacts' with others and are upset when they are broken.

[20] It is perhaps surprising that if iconic gestures are produced to serve communicative intentions, that their production persists in situations where there is little face-to-face context (e.g., when speaking on the telephone). This production of gestures has been attributed to habit (Alibali, et al., 2001), creation of imaginary interactants (Fridlund, 1994) and the properties of the lexical item being spoken (Pine, Gurney, & Fletcher, 2010).

This view that pretend play is a shared intentional act has been challenged by researchers who claim that children do not need to have an understanding of the cognitive attitudes or intentional state of the play partner to produce pretense actions (Lillard, 1993a, 1993b; Nichols & Stich, 2000). According to this ‘behaving as-if’ perspective, children base their judgements about whether someone is pretending or not on that person’s actions, not on an inference of their mental state or intentions (i.e., whether the partner is acting appropriately if X was a Y, Lillard, 1993a; Lillard & Witherington, 2004). The classic evidence in favour of this perspective comes from the ‘Moe’ task (Lillard, 1993b). During this task children were explicitly told that ‘Moe’ (a troll doll) had no knowledge of kangaroos (as he had never seen one before). However, when ‘Moe’ was made to hop, and the children were subsequently asked whether they thought ‘Moe’ was pretending to be a kangaroo children tended to respond “yes”, suggesting that children did not account for the mental state of ‘Moe’ (i.e., that he does not know about kangaroos).

To test whether pretend play is an intentional symbolic action Rakoczy and Tomasello (2006) manipulated whether 27 month old children saw modelled pretense actions that were (1) successfully performed or (2) unsuccessful (as marked by signs of disappointment). If children understand pretend play acts as intentional, then Rakoczy and Tomasello hypothesised that in both conditions children would perform the previously modelled actions, but in different ways as the children would adjust their responses to maintain the collaboration. This was indeed found to be the case. When children saw successful models, they reproduced these actions and *extended* them. When they saw unsuccessful models, they attempted to ‘complete’ the pretense model by acting on the object appropriately. Rakoczy (2008) suggested that by the beginning of the third year, children understand pretense as an intentional, non-serious activity.

1.6. Social learning and symbol use

From the sections above, it appears that children are able to engage adults in triadic interactions, and appear capable of intention reading, which together facilitate their learning of symbolic skills across representational domains. The evidence above suggests that by 14 months of age, children are adept at engaging others in group activities. They understand that adults may have a ‘plan of action’, which in turn influences a child’s response to the adult’s actions. However, the question remains as to how children utilise the symbols they observe intentionally produced by adults into their own symbolic representations. According to Tomasello and Rakoczy (2003), children begin to appreciate the intentional nature of symbols by observing and learning from more capable peers. The observational learning processes involved in human and non-human primates has been of interest to researchers for a number of years (Bekkering, et al., 2000; Call, 1999; Flynn & Whiten, 2008; Hopper, 2010; Huang & Charman, 2005; Meltzoff & Moore, 1977; Schwier, van Mannen, Carpenter, & Tomasello, 2006; Whiten, Custance, Gomez, Teixidor, & Bard, 1996; Whiten & Ham, 1992; Zentall, 2001). Call (1999) broadly defined the term ‘social learning’ as “a group of learning mechanisms in which observation of other individuals facilitates or enables the acquisition of a novel behaviour” (p. 317). Researchers generally identify four main modes of observational learning (Carpenter & Call, 2002; Zentall, 2001). These are mimicry, local and stimulus enhancement, emulation, and imitation[21].

Imitation in particular has been linked to the development of symbolic abilities in children. Thorpe (1963) argued that imitation is defined as the copying of a novel or improbable act or utterance, while Whiten and Ham (1992) suggest that it is a process where an observer learns the *form* of an act from a demonstrator. Previous research has

[21] Mimicry is defined as the low level copying of sensorimotor acts (Hamilton, 2008). Local and stimulus enhancement occur when an individual’s attention is oriented towards an object due to the mere presence of others (Hopper, 2010). While local enhancement refers to when the observer is directed to a particular locale, stimulus enhancement refers to when the observer is drawn to an object (Zentall, 2001). Emulation is defined as the reproduction of an *end* state of a demonstrated action (Heyes, 2001), that is, when the observer pays attention, not to the actions of the model, but “to the displacements and effects of the various objects involved” (Want & Harris, 2002, p. 3).

suggested that the ability of humans to perform imitative behaviours[22] is due to the structure provided by the caregiver in the natural environment (Tomasello, Savage-Rumbaugh, & Kruger, 1993; Vygotsky, 1978). Tomasello et al. (1993) compared four groups on their imitative learning of actions on objects: mother-reared chimpanzees, human-reared chimpanzees, 18 month old children and 30 month old children. It was found that mother-reared chimpanzees imitated the demonstrated acts significantly less than the other three groups. Additionally, human-reared chimpanzees showed no difference to either group of human children. Tomasello et al. (1993) concluded that the differences between the two chimpanzee groups was due to the unique nature of human interaction; in particular the scaffolding of attention. Carpenter, Tomasello and Savage-Rumbaugh (1995) argued that there is "something very important about the role of the socio-cultural environment in the ontogeny of human-like skills of joint attention and imitative learning" (p. 235). Specifically, they argue that intentional instruction from adults, use of symbols, encouragement of attention and reinforcement of imitative behaviours all act to explain complex imitative behaviours in children.

The following section explores the possibility that children may learn to use symbols effectively through social learning processes. In particular, this section will focus on the possibility that children's early linguistic productions are imitative of their caregivers. I then address research that has investigated children's earliest gesture production. Specifically, this section evaluates the possibility that these gestures are learned during interactive routines with a caregiver, and the underlying assumption that these early forms of gesture are truly symbolic. Finally, I investigate the apparently social foundation of pretense acts.

[22] Whiten and Ham (1992) and Heyes (1993, 2001) suggest that human's ability to imitate is unique. Indeed, evidence for imitation in non-human primates is mixed (Horner & Whiten, 2005). Studies using the so called "artificial fruit" paradigm, an analogue of non-human primates' natural foraging behaviours, have found some evidence for imitation in chimpanzees (Carrasco, Posada, & Colell, 2009; Custance, Whiten, & Fredman, 1999; Whiten, et al., 1996). However, other research has found that chimpanzees do not imitate, when they are asked to perform actions on objects (Call, Carpenter, & Tomasello, 2005; Call & Tomasello, 1994).

1.6.1. Imitation and speech

In their early review of the literature on the imitative processes involved in the first stages of language production, Whitehurst and Vasta (1975) argued that children imitate the *structure* of their caregivers utterances but not necessarily the content of these utterances. Research has also suggested that children may have their previously incorrect utterances interpreted and modelled back to them by a caregiver, leading to the child imitating the correct utterance (Brown & Bellugi, 1964; Slobin, 1968). These ‘expansions’ or ‘recasts’ (see Saxton, 2005) have been found frequently in child-adult discourse (e.g., Brown & Bellugi, 1964) and have been identified as having a role in children reproducing grammatically correct utterances. Slobin (1968) for instance found that 50% of two to three year old children’s utterances following a recast by the caregiver added important grammatical corrections to the utterance. Further, Strapp and Federico (2000) found that 27 month old children were more likely to revise their speech after receiving feedback from their caregivers, compared to if they did not receive any feedback (see also Farrar (1992) for evidence in younger children).

The suggestion here is that children use the models of the caregiver as a “corrective signal” (Saxton, 2005, p. 26) for future reference in their later grammatical constructions. However, this view has been criticised on the basis of the burden placed on the child to decipher that the recast is a signal concerning grammatical form, given the potential for the recast to differ from the original utterance in not just this way but also in terms phonology or pragmatics (Saxton, 2005). Evidence is also mixed in response to the question of whether children actually imitate the correct grammatical forms modelled. For instance, Farrar (1992) and Saxton (1997) found that following a recast children were just as likely to repeat their previous grammatical error as they were to correct it.

A role for imitation in the early learning of specific grammatical constructions has also been suggested as being a *starting point* for later knowledge of abstract linguistic categories essential for proficient language use. Tomasello (2000a, 2003) argued that children's early language is based around their imitative learning of specific grammatical combinations or constructions, from which more abstract linguistic categories are gradually constructed over the course of development (Abbot-Smith, Lieven, & Tomasello, 2008; Abbot-Smith & Tomasello, 2006; Carpenter, Tomasello, & Striano, 2005; Lieven, Behrens, Speares, & Tomasello, 2003; Savage, Lieven, Theakston, & Tomasello, 2003; Tomasello, 1999, 2003). Tomasello and Brooks (1998) for example found that two to three year old children did not tend to produce a newly learned novel verb in a transitive subject-verb-object utterance, when they had previously learned the verb in an intransitive subject-verb frame. Children's early syntactic structure also appears to have some imitative properties. Three to four year old children have been found to produce more passive transitive constructions when asked to describe pictures if they initially heard an experimenter use this form of construction (Shimpi, Gamez, Huttenlocher, & Vasilyeva, 2007). The same effect was found for active constructions (see also Allen, Haywood, Rajendran and Branigan (2011) for related findings in older children and children with autism).

However, imitating the exact form of the utterance is not always appropriate. For example in an interaction with a child the adult may say "do you want me to *pick you up*?" Dale and Crain-Thoreson (1993) found that over half (17 out of 30) children aged 20 months made I-you reversal errors (in the current example saying "pick you up", when requesting to be picked up). Carpenter et al. (2005) suggested that to use a linguistic symbol in an adult-like way, children must be able to perform the conventionalised symbol "in the same way the adult used it toward them" (p. 255). This 'role reversal' imitation (Tomasello, 1999) is argued as being different to conventional imitation because it is not performed with the same symbolic 'object' that the demonstrator used. This involves a different level of intention understanding, as the observer has to understand that the end goal may involve taking the perspective of the demonstrator. Carpenter et al. (2005) hypothesised that children's role reversal abilities at 12 and 18 months would be correlated with their abilities on a vocabulary measure. In particular they hypothesised that children's abilities at other-other[23] role reversal imitation would correlate strongly with the correct use of pronouns, as this form of role reversal imitation with objects is similar to the reversal required to use a pronoun correctly (i.e., substituting *you* with *I*).

They found that children's other-other role reversal imitation at 18 months significantly correlated with their comprehension and production of pronouns at the same age. However, there was no correlation between other-other role reversal abilities and the general vocabulary measure. Carpenter et al. suggested that to learn arbitrary linguistic symbols, children may require a 'threshold' level of role reversal abilities, while "stronger skills in understanding social interactions holistically" (p. 275) are required to use pronouns appropriately.

1.6.2. Social learning and gestures

1.6.2.1. Gestures as input

To explore whether children socially learn the gestures of adults, it is first necessary to determine whether children are aware of the gestures that adults produce. Kelly (2001) found that three to five year old children were better at comprehending indirect requests (shown to them on video) when the request included a deictic gesture, compared to when there was no deictic gesture. He found that children responded to the interpretation questions (e.g., what did the mother want the child to do?) with significantly more *action* interpretations[24] in the gesturing condition compared to the no gesturing condition. He also found an age-related difference. While three year olds required both gesture and speech together in order to make the correct *action* interpretation, older children were able to use

[23] An example of an 'other-other' role reversal imitation would be the adult placing their hand on the head of the child, with the child subsequently placing their hand on the adult's head. Contrast this to 'self-self' role reversal imitation, which is when the child and adult perform the same self-adjusting actions (e.g., both reaching down with both hands to tap their feet).

[24] *Action* responses were coded when the child said that the mother in the observed scenario wanted the child to perform an action (e.g., put on his coat). The other possible responses coded were *reiteration*, when the child interpreted the mother's speech as a literal statement, and *no understanding*, when the child was not sure of what the demands of the task were.

gesture or speech alone to make the correct pragmatic inference. Older children have also been found to glean the information contained in their teachers' gestures to help them solve cognitive tasks (Goldin-Meadow, 2003; Singer & Goldin-Meadow, 2005). Singer and Goldin-Meadow (2005) gave 160 children aged between eight and ten years different instructions for solving a mathematical equivalence task. They found that when the instruction given by the teachers contained a 'mismatching' gesture (one where the gesture conveyed different information than the speech) children performed significantly better on post-test compared to children who were shown a 'matching' gesture or were not shown a gesture at all. Hostetter (2011) in a recent meta analysis concluded that while gestures appear to communicate in a number of contexts across a number of research studies, there are a number of moderating factors including the semantic information that the gesture contains relative to the speech, whether the gesture contains motor information and the age of the recipient of the gestures. She concludes that children in particular benefit from gestures as they may assist in children's understanding of abstract concepts (e.g., Goldin-Meadow, 2006a; Ping & Goldin-Meadow, 2010) or in the maintenance of attention (e.g., Kelly, 2001; M. Morford & Goldin-Meadow, 1992).

1.6.2.2. Observational learning of gestures

It seems then that listeners can use gestures as a source of information, in addition to the speech they hear. Indeed, Southgate et al. (2007) suggest that children may use gestures with the specific motivation to learn from others. The first question to be addressed here is whether children learn to *produce* gestures through observation of adults and/or peers. The second question is whether children incorporate the *symbolic* (iconic) gestures of others into their own representations of objects or events. This is of importance to the present thesis, as research on pretend play and speech has identified that children learn symbolic relations through the scaffolding provided by adults.

In response to the first question, Cochet and Vauclair (2010) suggested that imperative and declarative pointing gestures may be learned via different learning processes. They argue that imperative pointing gestures may be learned via a process of *ontogenetic ritualization* (Tomasello & Call, 1997). Through this process an action becomes a communicative signal, due to the recipient's consistent response to the action. On the other hand, declarative gestures may be learned through a process of *deferred imitation*, as children refer to their previous knowledge of declarative situations and use a similar strategy when they have the same declarative intention. To investigate the potential differences between imperative gestures and the two forms of declarative gestures (expressive and informative), Cochet and Vauclair (2010) gave children aged between 15 and 30 months a number of tasks to tap into how they request objects, draw an experimenter's attention to objects and inform an experimenter as to the location of an object through pointing. They measured gaze direction, duration of gazes, whether these gestures were accompanied by vocalisations and the hand shape of the gestures. They found a number of differences in the measures depending on the type of deictic gesture produced. First, both declarative gesture types were more tightly linked to vocalisations compared to imperatives. Second, both declarative gestures were maintained for longer periods on average compared to imperative gestures. Third, imperative gestures were more closely linked to pointing with the whole hand, while declarative gestures used the index finger (see also Franco & Butterworth, 1996). Cochet and Vauclair (2010) conclude that imperative and declarative gestures may develop ontogenetically through different learning processes.

The question here is do children learn gestures that have *symbolic properties* through observation and interaction with more capable peers? At approximately ten months of age, children begin to use representational gestures to refer to objects in their environment. For example, they may flap their hands to refer to a bird's wings or sniff to represent a flower (Acredolo & Goodwyn, 1985, 1988). These gestures have been placed at the forefront of children's early symbolic representation. Acredolo and Goodwyn (1988) suggest, in line with Werner and Kaplan's (1963) theoretical perspective, that these gestures are early examples of contextualised symbols, which are then replaced by more 'decontextualised' symbols which take the form of words. To test this idea they used parental interviews and a longitudinal study where they asked caregivers to keep a record of children's verbal and non-verbal behaviour. They found that representational gesturing was a common phenomenon in children's early communication, with 80% of the symbolic gestures recorded being observed before the 25 word stage. This led them to conclude that acquisition of representational gestures occurs simultaneously with early vocabulary development, and that both are fuelled by a "common developmental advancement that enables the child to grasp the general value of symbolic function for communication" (Acredolo & Goodwyn, 1988, p. 461).

The production of these representational gestures and its apparent relation to early vocabulary development (Namy & Waxman, 1998) has led to the view that these gestures are symbolic, are intended to be used communicatively, and are learned primarily through interactive routines with a more capable peer (Acredolo & Goodwyn, 1985; Bates, et al., 1989; Bruner, 1983; Goodwyn & Acredolo, 1993; Goodwyn, Acredolo, & Brown, 2000). However, this view has been challenged for two reasons. First, these early symbolic gestures have been inconsistently measured. Nicoladis et al. (1999) argued that studies of early gesture use vary widely with regards to which non-verbal behaviours are categorised as gesture and subsequently the types of gestures identified. While some researchers have placed actions with objects under the umbrella term of 'gestures' (Andren, 2010; Bates, et al., 1989; Caselli, 1990), others have followed the categories outlined in gesture research on adults which focus more on empty handed movements and exclude actions on objects (Camaioni, Aureli, Bellagamba, & Fogel, 2003; Iverson, Capirci, & Caselli, 1994; Mayberry & Nicoladis, 2000; Nicoladis, et al., 1999).

Second, the symbolic status of these early gestures has been questioned (Liszkowski, 2008, 2010). Liszkowski (2008) suggests that in order to reproduce these gestures, children at this age need do not need to have the "cognitive ability to decouple an action directed at an object from the communicative act of representing a referent with an action" (p. 187). The symbolic element of the gesture is in the eyes of the observer, not in the intention of the child performing the gestural action (Tomasello, et al., 1999). Additionally, the highly context-dependent nature of these early gestures may mean that they are part of a social maintenance strategy, not a strategy to refer to objects of interest outside the interactive routine, a necessary element of symbolic reference (Bates, et al., 1979; Deacon, 1997; Namy & Waxman, 2005; Piaget, 1962; Werner & Kaplan, 1963). In his criticism of Acredolo and Goodwyn (1988), Liszkowski (2008) argued that only a small set of gestures referred to objects (2 per child), and that these gestures only generalised to similar referents in similar contexts to where they were originally used. Instead, he calls for a re-interpretation of these prelinguistic gestures that, while not symbolic themselves, may serve a social role in the maintenance of interactive routines which make symbol learning possible.

So far, there has been very little research on whether children incorporate symbolic gestures they have observed into their communication about an object. There is some evidence however, that children, by approximately age two, are beginning to understand the symbolic potential of gestures. Namy, Campbell and Tomsello (2004) found that 18 month old children were poor at using the iconic gestures of an adult to assist in choosing the correct box in the context of a 'finding game'. By 26 months, they were more likely to make use of these gestures, suggesting that by around the end of the second year, children have acquired an understanding of the symbolic potential of iconic gestures (Ozcaliskan & Goldin-Meadow, 2011).

There are two key questions that have yet to be addressed. First, once preschool children have achieved an understanding of the communicative potential of co-speech symbolic (iconic) gestures, do they incorporate their interlocutor's gestures into their gestural 'lexicon'? Second, if children do learn symbolic gestures from adults, is this gesture 'uptake' related to the properties of the gesture itself, *or* its perceived usefulness as a communicative strategy? For adults, iconic gestures have been linked to the processing of spatial information at the moment of speaking (Alibali, Kita, & Young, 2000; Cook & Tanenhaus, 2009; Feyereisen & Havard, 1999; Hostetter & Alibali, 2008, 2010; Hostetter & Skirving, 2011), and specifically to the processing of *motor* imagery. The 'gestures as simulated action' (GSA) perspective (Hostetter & Alibali, 2008, 2010; Hostetter & Skirving, 2011) suggests that speakers are more likely to produce a gesture when their 'simulations' of what they are describing involve high amounts of motor imagery, as this imagery is more closely linked to the motor cortex, which ultimately performs the gesture. This framework has been supported by studies that have manipulated adults' motor experiences with objects (Cook & Tanenhaus, 2009; Hostetter & Alibali, 2010; Hostetter & Skirving, 2011) or have compared differences in iconic gesture rates depending on the nature of the objects being described (Feyereisen & Havard, 1999; Pine, et al., 2010). Pine et al. (2010) asked adult dyads to describe objects, half of which were *praxic* (easily manipulated using hands, e.g., scissors), while the other half were *non-praxic* (e.g., fish). They found that participants gestured significantly more when describing the *praxic* objects than when describing the *non-praxic* objects. They suggest that participants gestured more when describing *praxic* objects because certain lexical items (activated when describing *praxic* objects) are closely tied to motor imagery, which is linked to the representation of action in motor systems (Feyereisen & Havard, 1999; Morsella & Krauss, 2005; Rauscher, Krauss, & Chen, 1996). It may be the case then that gestures that depict motor properties are more likely to be reproduced by children than gestures that depict physical features of objects, because of the different imagistic properties of these gestures. This question is investigated in the current thesis.

1.6.3. Imitation and pretend play

A body of work has identified a social element to pretend play behaviour (Fein, 1981; Fiese, 1990; Garvey & Kramer, 1989; Howes, 1985; Howes, Unger, & Seidner, 1989; O'Connell & Bretherton, 1984; Slade, 1987; Tamis-LeMonda & Bornstein, 1994). Fiese (1990) found that 15 to 24 month old children performed more complex pretend play when in the company of their mothers compared to when they were playing alone. The question then is how does the social context influence pretend play behaviours? According to Rakoczy and colleagues (Rakoczy, et al., 2005a, 2005b) and the cultural learning theory of Tomasello (Tomasello, 1999; Tomasello, Kruger, & Ratner, 1993), the social learning of tool use in children is directly related to their development of symbols in pretend play. A number of studies have identified imitation as an important social-learning tool, which helps children learn how to use objects (Flynn & Whiten, 2008; Gergely, et al., 2002; Nielsen, Simcock, & Jenkins, 2008; Strouse & Troseth, 2008). Rakoczy (Rakoczy, et al., 2005a, 2005b) argues that children’s learning of symbolic relations in pretend play is similarly achieved by imitative learning based on the children’s reading of intentions. In order to pretend effectively with a caregiver, children need to understand that the caregiver has ‘set the scene’ that ‘X’ is a ‘Y’ (for example that a pen is an aeroplane, Leslie, 1987; Lillard, 2002). Once understanding of these intentions is obtained, children are able to learn pretense behaviour as a result of their collective activity with an adult. In other words, pretend play actions are “inherently social; they are actually constituted by collective intentionality” (Rakoczy, et al., 2005b, p. 58). There have been a number of studies that have highlighted the idea that children come to understand the symbolic potential of objects through imitation of the symbolic models shown to them by an adult. Tomasello et al. (1999) gave children two sets of objects during a free play session for two minutes, followed by the experimenter demonstrating potential pretend actions. It was found that all three ages of children (18, 26 and 35 months old) generated significantly more novel pretend play acts *after* demonstrations than *before* demonstrations.

However, the objects used in the Tomasello et al. (1999) study were criticised on the grounds that they were overly familiar to children. Striano et al. (2001) attempted to solve this issue by giving children three different kinds of object (a replica, a natural object and an instrumental object). After an initial warm up period, where the natural levels of pretend play were recorded, children were shown a number of pretense actions by the experimenter. They found that much of two year old children's pretend play acts were imitations of the experimenter's demonstrated actions, while children who were three years old produced more novel pretend play behaviours after demonstrations (see also Nielsen & Christie, 2008). Striano et al. (2001) argues that children's "earliest symbolic play is most likely imitative in nature, either directly from social interaction or less directly through deferred imitation" (p. 453). Moreover, from these and similar findings, imitation has been identified as a potential catalyst for the generation of novel pretense (Kavanaugh, 2002; Libby, Powell, Messer, & Jordan, 1997; Nielsen & Christie, 2008; Nielsen & Dissanayake, 2004). In a longitudinal study that followed children during the second year, Nielsen and Dissanayake (2004) found that children's *deferred* imitation abilities at 15 months of age significantly correlated with their later pretend play scores at 18, 21 and 24 months. This suggests that the capacity for imitation may be a precursor to the development of pretend play. Indeed, teaching children with autism to imitate also appears to have an effect on their propensity to produce spontaneous pretend play acts (Ingersoll & Schreibman, 2006). Ingersoll and Schreibman (2006) provided an intervention to five children with autism, designed to encourage their development of imitation behaviours. This intervention was designed to use techniques linked to learning success (multiple trials, prompting and reinforcement) in a context which initially involved the modelling familiar actions, followed learning of novel actions. Post-intervention, they found that four of the children showed significant increases in pretend play. For two of the children, *spontaneous* pretend play also increased, suggesting that this increase in pretense was not merely due to an improved capacity for deferred imitation (i.e., reproducing what they had previously seen), but that these children gained enhanced knowledge of symbolic relations in a pretense context.

1.7. Conclusions

Humans appear to be the only species capable of utilising symbols as part of their everyday activities (Deacon, 1997; DeLoache, 1995; DeLoache & Burns, 1994). The first aim of this review was to define what is meant by a symbol and to identify the types of behaviours that can be classed as symbolic in the three domains of interest in the present thesis (speech, gestures and play). Speech appears to be a natural candidate for symbolic expression in children. However, not all behaviours related to gestures and play can be classed as symbolic in nature, as they do not appear to meet the criteria of a symbol, in that they are used intentionally and have a clear signifier-signified relation. For gestures, I have argued that iconic gestures are symbolic, while *pretend* play has been given a symbolic status as opposed to sensorimotor or functional play.

Theorists interested in the development of these symbolic abilities have suggested a gradual transition from the concrete to the symbolic (Piaget, 1962; Werner & Kaplan, 1963). At around the end of the second year, children are able to refer to objects and events without having a sensorimotor link to the referent (e.g., through being able to see it). Children are able to move away from referring to their *current* perceptions and activities and instead recall *past* experience. While Piaget emphasised the role of children's individual adaptations to their environment in their symbolic advancements, Vygotsky and Werner argued that advancements in pretend play and language are due to social cognitions. By around nine months of age, children are capable of engaging in triadic interactions between themselves, a caregiver and a third entity such as an object (e.g., Tomasello, 1999). This chapter has assessed how children's understanding of others as intentional agents (manifest in their joint attentional and social learning abilities) contributes to their future advancements in the symbolic domains of language, gesture and pretend play. Children appear to demonstrate these social-cognitive abilities before the ontogenesis of symbol production, through their use of deictic gestures to express a variety of intentions in a multitude of possible contexts (see section 1.4.3). The apparently unique abilities of children to use symbols and to understand others' intentions (section 1.5.1) may be interdependent (Bates, et al., 1979; Tomasello, 1999) but a substantial body of research implies that there is a causative effect of social-cognitive abilities on humans' unique capacity with symbols (Liszkowski, 2011; Tomasello & Rakoczy, 2003). This review has found that children's learning of symbols, in the three domains of interest in the present thesis, is facilitated by social-cognitive skills that lead to unique forms of interaction, resulting in the learning of symbolic relations (Carpendale & Lewis, 2004; Rakoczy, et al., 2005a; Tomasello, et al., 2005). Interestingly, and importantly in the context of the present thesis, little research has investigated whether preschool children learn iconic gestures from adults, and use these gestures when referring to novel objects. Previous research on younger children's learning of 'symbolic' gestures within interactive routines (Acredolo & Goodwyn, 1985, 1988; Goodwyn, et al., 2000) has been criticised on the basis of the status of these gestures as symbols (Liszkowski, 2008, 2010; Tomasello, et al., 1999). An aim of the present thesis then is to assess whether children incorporate iconic gestures into their own gestural 'lexicon' when referring to the same object as when the gesture was first used.

Chapter 2 evaluates research that has sought relations between the three symbolic domains of interest in the present thesis, and addresses the theoretical accounts that have been used to explain research findings. Much of this work focuses on the relations between pretend play and speech at around two years of age, when pretend play and multi-word speech are beginning to emerge. Chapter 2 will also address research that has investigated children's iconic gesture production, and how this specific form of gesture relates to symbolic abilities with objects and advancements in the spoken domain.

Chapter 2: Ontogenesis of Symbolic Abilities in Children and their Relations

This chapter evaluates research exploring potential relations between pretend play, speech and iconic gestures in the preschool years. First, research on the relation between pretend play and speech will be assessed, followed by a section about how these abilities may be related in the later preschool years. Later I focus on children's gesture production and their burgeoning linguistic capacities, in particular examining how children use gestures to facilitate later linguistic advancements (for example between the one and two word stage) and whether there is a relation between children's iconic gesture production and their advancements in speech.

2.1. Pretend play and speech at emergence

Both speech and pretend play have been linked to children's ability to decontextualise themselves from their perceptions and represent symbolically (Andresen, 2005; Piaget, 1962; Vygotsky, 1978; Werner & Kaplan, 1963). This view has been further explored in clinical populations (Jarrold, 2003; Jarrold, et al., 1993; Lewis, 2003), showing that low levels of pretend play are found in children with poor language skills, for example children with autism and Down syndrome (Sigman & Ruskin, 1999).

The main theoretical premise underlying these research findings has been termed by Bates and colleagues (1979) as ontogenetic homology. The key idea is that there is a common cognitive structure (a shared program) that expresses itself behaviourally in two domains; that of speech and pretend play (Piaget, 1962; Vygotsky, 1978; Werner & Kaplan, 1963). In this view, symbolic representation is the end result of competence in a number of specific skills, borne out of old functioning parts. These component parts that participate in symbolic representation are based on ancient mechanisms such as attention, perception, emotional regulation and memory (Bates, 1999) or children's underlying social-cognitive capacities (see sections 1.4-1.6) .

The question here is whether this change in symbolic understanding is reflected in two domains where children use symbols; in their speech and in pretend play. Both are symbolic behaviours in the sense that there is an abstract signifier that stands in for a referent (see section 1.1). However, while language has a formal structure and conventions that are used for the specific purpose of communication, pretend play is often non-conventional, personal and in many cases temporary (Fein, 1987; P. L. Harris & Kavanaugh, 1993). Fein (1987) terms this *denotative license*, in that anything (an object, person etc) can, in a pretense context, stand in for anything else.

If language and pretend play both reflect the development of an underlying symbolic capacity, it is reasonable to hypothesise that these abilities will develop in parallel, with changes in one domain being mirrored by changes in the other (Bates, 1976; Bates, et al., 1979; McCune-Nicolich, 1981; McCune, 1995; Nicolich, 1977). There have been a number of studies that have investigated this hypothesis in children during the second year of life (Casby, 1992; Lyytinen, Laakso, Poikkeus, & Rita, 1999; McCune, 1995; Shore, O'Connell, & Bates, 1984; Tamis-LeMonda & Bornstein, 1994; Ungerer & Sigman, 1981, 1984). McCune (1995) found that children between 8 and 24 months of age began to combine words at approximately the same time as they began to combine play schemes with objects. While McCune (1995) acknowledged the potential role that related factors may have in the temporal relations between pretend play and speech development (such as control of the vocal tract), she argued that these abilities are expressed behaviourally at the same time because they both rely on an underlying capacity to represent symbolically. Lyytinen et al. (1999) extended these findings by using a larger sample of children (171), and collecting measures for expressive speech, receptive speech and a measure of children's pretend play[25]. They found concurrent relations between pretend play and both measures of speech (comprehension and production) at 14 and 18 months. Additionally, they found that the pretend play score at 14 months significantly

[25] The measures used were the MacArthur Communicative Development Inventories, and the Symbolic Play Test.

predicted children's later vocabulary score at 18 months. Interestingly, the concurrent correlations between speech and pretend play measures found in the Lyytinen et al. (1999) study were stronger for comprehension than production measures. This finding is supported by Tamis-LeMonda and Bornstein (1994), who found that at 13 months, language comprehension rather than production was related to pretend play. At 20 months of age, children's semantic diversity (the variety of meaning categories children express) was more closely related to pretend play. They argue that at this age, expressive language is not a reliable measure of symbolic abilities because children are hesitant in their propensity to engage in talking (Bates, et al., 1989). Petitto (1988) suggested that pretend play at this age may be linked specifically to comprehension, because the formulation of pretend scenarios is led by the adult (e.g., Fiese, 1990), and so children's comprehension of the adults' directive speech will affect their subsequent pretense behaviour.

These accounts are broadly in line with the theoretical perspectives outlined by Piaget, Vygotsky and Werner, who argue that children's emerging symbolic representational abilities will be reflected across domains where these abilities can be utilised. Tamis-LeMonda and Bornstein (1994) concluded that "variation among children in emerging aspects of language and symbolic play may reflect variation in an underlying capacity to understand and express experiences in several modalities" (p. 290). However, the studies outlined above, while being robust in their findings of a relation between pretend play and speech, have only investigated relations at the *starting point* of these symbolic abilities (Bergen, 2002). It is thus unclear whether this relation between symbolic measures is maintained, or whether the relation changes over developmental time (i.e., Karmiloff-Smith, 1992). The following section evaluates research that has explored *how* older preschool children use their symbolic abilities in speech to structure their pretense effectively.

2.2. Pretend play and speech beyond emergence

Beyond the initial emergence of symbolic representational abilities in pretend play, pretense becomes increasingly social in nature (Bateson, 1955; Fein, 1981; Fiese, 1990; Nishida & Lillard, 2007; O'Connell & Bretherton, 1984). P.L. Harris and Kavanaugh (1993) for example found that 28 month old children were able to complete pretense themes that had previously been established by an experimenter. Two year old children are also able to describe these pretense scenarios. When an experimenter pretended to pour milk over a cat, children were able to answer a query about the status of the cat (i.e., he is "wet", P. L. Harris, Kavanaugh, & Meredith, 1994). Parten (1932) in a classic work on American preschool children between the ages of two and five identified three main categories of play. These categories were not mutually exclusive stages, but highlighted trends in children's behaviour across the preschool years. The first category, *solitary play* (most common at two to three years), is when the child remains focused on their own individual activity. This is followed by *parallel play*, where children play adjacent to each other, but do not have the intention to influence the behaviour of others. Finally, in the later preschool years children are able to assign roles to others, and play becomes increasingly organised through *cooperative play*.

These categories were not developed specifically with pretend play in mind, but there has been a body of research that has investigated how children develop pretend play schemes effectively. Howes, Unger and Seider (1989) noted that pretend play follows a similar developmental trajectory, with pretend play acts being performed individually up until around 20 months, followed by engagement in similar activities with limited social exchanges (smiles etc.) from 20-30 months, and beyond 30 months joint pretend activity including the assignment of complementary roles (e.g., player A is a doctor, player B is a patient). The research outlined in section 1.6.3, coupled with research that has found that pretense is marked by particular social behaviours such as smiling and social gazes (Lillard & Witherington, 2004; Nielsen & Christie, 2008; Rakoczy, 2006; Rakoczy, et al., 2005a, 2005b; Randell & Nielsen, 2006; Striano, et al., 2001) combine to suggest that pretend play is influenced by social factors, for example through the modelling of potential pretense acts by the caregiver (e.g., Nielsen & Christie, 2008; Rakoczy, et al., 2005b). However, this research has not assessed how older preschool children (from three years old) create their own instances of pretense and establish this pretense socially. As *pretend* play becomes more cooperative in nature, children have to establish pretend play themes, negotiate roles for play partners, and maintain these themes for the duration of the play period (Doyle & Connolly, 1989). In the words of Howes et al. (1989) this social pretend play “requires the child to manipulate symbolic transformations *and to communicate them to a partner*” (p. 77, italics added, see also Howes & Tonyan, 1999).

In this sense it appears that children need to be effective communicators in order to structure pretend play between two (or more) partners. As children’s pretend play becomes more sophisticated and social, they are involved in the creation of chronological narratives (Howe & Bruno, 2010; Sachs, 1980) and the establishment of play themes that are maintained (Garvey, 1990; Garvey & Kramer, 1989; Tykkylainen & Laakso, 2010; Wyman, et al., 2009a, 2009b). Indeed, Wyman et al. (2009a) found that when an adult joined a pretend game with a three year old child and then proceeded to use an object in a way dissimilar from what was appropriate in the pretense scenario, the children showed signs of protest (for example telling the adult what the object 'status function' was, Searle, 1995). This suggests that at this age, children are aware that certain objects must maintain the same symbolic status if the play act is to be maintained.

The question to be addressed here is how children use speech as a strategy to establish sophisticated forms of pretend play. Piaget (1962) and others (Garvey, 1990; Vygotsky, 1978) suggested that establishing collective symbols through pretend play involves negotiation of themes, roles and rules. The first step in this process is ‘recruitment’; the induction of play partners into the pretense scenario to be performed. Howes (1985) investigated social play and social pretend play in children aged between 16 and 30 months. First she found that both forms of play became more prevalent between these ages, but that social *pretend* play increased from 11% of children performing at least one instance of cooperative social pretend play at 16-17 months, to 100% at 32-33 months, while social play was common at all ages (78% at 16-17 months, 100% at 32-33 months). Second, use of verbal recruitment strategies (consisting of performing the pretend action and telling the potential play partner about it) increased as a method to engage others in pretend play, whereas there was no increase in the use of non-verbal strategies (e.g., eye gaze).

The first finding suggests that children are unlikely to engage in pretend play with partners until they have achieved an understanding of the potential for objects etc. to be utilised as symbols (Charman, et al., 2000; Dixon & Shore, 1993; Howes, 1985). Charman et al. (2000) suggested that up until age two there may be an underlying symbolic representational ability underlying speech and pretend play, which is linked to children's social-cognitive capacities (Piaget, 1962; Werner & Kaplan, 1963). However, they speculated that these abilities may diverge over time as different factors influence development. In the Howes (1985) study, children's ability to utilise linguistic resources to recruit others into a pretend play scheme seems to have an important influence.

A possibility then is that for older preschool children, speech abilities mediate their relative successes at establishing and maintaining pretend play acts. Farver (1992) found age-related differences in children's communicative strategies to structure social pretend play. Two year old children who had short social pretend play episodes generally engaged in calls for attention and repetitions. These communicative strategies did not act to elaborate on the pretense that had already been established. Four and five year olds, who had longer social pretend play episodes, tended to describe the pretend actions taking place, and added a tag question at the end of a conversational turn to elicit a response (e.g., "We're playing hospitals now, aren't we?"). These strategies act to engage a play partner and elaborate on the current pretense. Similarly, Howe, Petrakos, Rinaldi and LeFebvre

(2005) found that there was a significant relation between children's use of speech (for example to extend the play partner's previous contribution by adding more information or building on a shared idea or concept) and frequency of pretense.

These verbal strategies appear to facilitate the construction of shared meaning between play partners (Goncu, 1993; Goncu & Kessel, 1988; Goncu, Patt, & Kouba, 2002). However, the studies described above (Farver, 1992; Howe & Bruno, 2010; Howe, et al., 2005) are correlational in nature and so it is difficult to determine the causal effect of how speech may influence pretend play development in the later preschool years. It has also focused on children's *social* pretend play, not on their individual pretend play abilities, which is still prevalent in everyday contexts (Bergen, 2002).

In conclusion, no research to date has assessed (1) whether the relation between pretend play and speech is maintained beyond its initial emergence in terms of a shared cognitive capacity to represent symbols or (2) whether children's general speech abilities perform a mediating role in children's later pretend play abilities. There are two main possibilities that the present thesis aims to investigate. First, in line with the perspectives of Piaget, Werner and Vygotsky (see sections 1.3.1-1.3.3) if speech and pretend play are influenced by a mutual underlying capacity to represent symbolically, then there should be significant concurrent correlations between these measures in a sample of children where these abilities have become increasingly complex. Second, if speech has an overall mediating effect on the communicative success of establishing play schemes as play becomes more social, then it might be expected that speech abilities will be significant predictors of later pretense abilities. This may be the case as children expressing a high level of linguistic competence may engage others in more pretense opportunities and thus become more advanced in their pretend play capacities.

A second issue with the research assessed above is that speech is considered as the *only modality* of language of interest. The research addressed in the following sections challenges this assumption, by evaluating research that has sought relations between children's gesture production (both symbolic and non-symbolic) and their linguistic advancements.

2.3. Relations between speech and gesture in children

Previous research on gesture production in relation to spoken language has revealed that gestures function in a variety of ways in conjunction with speech (Bavelas, et al., 2000; Brookes, 2005; Holler, 2010; Holler & Stevens, 2007; Hostetter & Alibali, 2008, 2010; Rauscher, et al., 1996). For instance, Hostetter and colleagues (Hostetter & Alibali, 2008, 2010; Hostetter & Skirving, 2011) suggest that the main function of iconic gestures is to communicate imagistic properties of objects and events during the process of speaking[26]. The exact role that gestures have to play in the communicative process of adults is highly debated by theoreticians (Alibali, et al., 2000; Bavelas & Chovil, 2000; Butterworth & Beattie, 1978; Butterworth & Hadar, 1989; de Ruiter, 2000; Gullberg, et al., 2008; Kita & Ozyurek, 2003, 2007; McNeill, 1985, 1989, 1992). Gullberg et al. (2008) split these perspectives into two, depending on their view of the relative importance of gesture to the communicative process in comparison to speech. These include theories that regard gestures as *auxiliary* to the speech production process, such as the *Lexical Retrieval Hypothesis* (Butterworth & Hadar, 1989; Krauss, Chen, & Gottesman, 2000; Rauscher, et al., 1996) and the *Information Packaging Hypothesis* (Alibali, et al., 2000) and theories that regard gestures as an integral part of the utterance. These theories include the *Growth Point Theory* of McNeill (McNeill, 1992, 2005) and the *Interface Hypothesis* (Kita & Ozyurek, 2003; Kita et al., 2007; Ozyurek, 2010; So, Kita, & Goldin-Meadow, 2009).

For children, research concerning their gesture use has focused on whether gestures can serve as a cognitive aid, to facilitate learning of complex tasks (Cook & Goldin-Meadow, 2006; Cook, Mitchell, & Goldin-Meadow, 2008; Goldin-Meadow, 2004; Goldin-Meadow & Singer, 2003) or whether gestures indicate future advancements in speech

[26] See also Alibali, Kita and Young (2000) and Feyereisen and Havard (1999) for related accounts.

(Capirci, et al., 2005; Capirci, Iverson, Pizzuto, & Volterra, 1996; Capirci & Volterra, 2008; Ozcaliskan & Goldin-Meadow, 2005a, 2005b). The following sections focus on the latter, first by exploring the role that non-symbolic gestures (specifically deictic gestures) may serve in the transfer from one to two word speech and second, by investigating whether children's production of symbolic iconic gestures is related to advancements in their speech. This second question focuses on children between the ages of two and three, as iconic gesture production emerges at the beginning of the third year (McNeill, 1985; Ozcaliskan & Goldin-Meadow, 2011).

2.3.1. Gesture and its relation to early multiword speech

As seen in sections 1.4.3.1 to 1.4.3.2, it appears that early pointing gestures may serve as an important facilitator for linguistic change in children's early word learning, as they may provide a temporary way (in lieu of speech) to communicate about objects (Acredolo & Goodwyn, 1985, 1988; Gullberg, et al., 2008; Iverson & Goldin-Meadow, 2005; Werner & Kaplan, 1963). However, the question here is whether children's pointing behaviour is predictive of a change in children's linguistic abilities from the one to the two-word stage. If this is the case, Iverson and Goldin-Meadow (2005) reasoned that children's use of gestures in combination with words should reliably relate to their early production of two word utterances. To test this idea, they observed children between 10 and 24 months longitudinally at home in interaction with their caregivers. They found a high correlation between the age at which children first used *supplementary* gesture-speech combinations (i.e., gestures that provided different but related information about the referent, e.g., pointing to a cat and saying 'nap') and their first use of two word combinations. They therefore suggested that supplementary combinations are children's first attempts at combining semantic elements into one communicative utterance. Furthermore, they found that *complementary* gesture-speech combinations (e.g., pointing to a cat and saying 'cat') did not correlate with the onset of two word utterances, suggesting that it is not gesture *per se* that instigates linguistic change but the combination of two semantic elements into one utterance (Butcher & Goldin-Meadow, 2000; Goldin-Meadow & Butcher, 2003).

It may be the case that early gesture use by children is merely an index of an all round ability to communicate. To test this idea, Rowe and Goldin-Meadow (2009b) measured children's 'gesture vocabulary' (the number of different meanings conveyed by gesture) and 'gesture and speech combinations' (the number of utterances which contained gestures and speech that conveyed a sentence-like idea) at 18 months and correlated them with equivalent speech measures at 42 months (vocabulary size and sentence complexity respectively). They reasoned that if children's gesture use at 18 months selectively predicted specific linguistic outcomes, then a significant correlation would be found between gesture vocabulary at 18 months and spoken vocabulary at 42 months. In addition, there would be a relation between gesture and speech combinations at 18 months and syntactic complexity at 42 months. This pattern of correlations was found, suggesting that gestures are selective predictors of later linguistic outcomes. Ozcaliskan and Goldin-Meadow (2005b) suggested that if children's early deictic gestures were selectively indexing linguistic change then precursors to *specific* linguistic constructions should be observed in speech and gesture before they are expressed in speech alone. They focused on three main forms of construction (predicate + predicate, argument + argument, and predicate + argument) in children between 14 and 22 months. They found that children produced these specific constructions first using gesture and speech and later in speech alone. Crucially, there were very few exceptions to this developmental path, suggesting that it is a robust trajectory of development. However, by 22 months, one of the constructions (predicate + predicate) was still not produced by children using speech alone, although they were doing so readily in combination with gesture. Ozcaliskan and Goldin-Meadow (2009) extended the longitudinal study using the same children until they were 34 months of age. They found that by 26 months, children were using the predicate +

predicate construction equally in gesture and speech and using speech alone. By 30 months, children had a preference for using speech only, similar to the findings for the other two forms of construction (see also Namy & Waxman, 1998).

The question raised here is why do children use gesture for their early syntactic combinations? Goldin-Meadow and colleagues outline two possibilities. First, gesture may serve as a signal to the child's communicative partner that the child is receptive to 'translation' of longer utterances (Goldin-Meadow, et al., 2007; Goldin-Meadow & Singer, 2003; LeBarton & Goldin-Meadow, 2011). Second, gesture may reduce the cognitive load by providing an easier way of expressing information (Goldin-Meadow, 2003, 2006b; Ozcaliskan & Goldin-Meadow, 2005b). In this sense, children may use gestures to "off-load cognitive work onto the environment" (Wilson, 2002, p. 626). We use the environment in strategic ways to compensate for information processing difficulties. For children, this may involve the use of a deictic gesture to help them in their attempts to communicate using a higher number of predicates. Children then may use their hands to overcome limits in their speech and other areas of cognition like memory (Cameron & Xu, 2011). Goldin-Meadow (2006a) suggested that at the very least the close relation between children's early gesture use and their subsequent early multi-word combinations is evidence for an integrated language system (McNeill, 1985, 1992). She argues that if gesture and speech were independent of each other, then combinations of the two would be classed as random events, with no developmental consequence. However, the findings above show that children's early pointing behaviour is inextricably linked with their early multiword utterances, suggesting a consistent relation between gestures and speech (Capirci, et al., 1996; Iverson, et al., 1994).

Ozcaliskan and Goldin-Meadow (2009) however note that this predictive relation between children's deictic gestures appears limited to the transition between one and two word speech. In their sample, when children were increasing their utterances beyond two words to include additional arguments, they used the constructions equally often utilising both gesture and speech, and in speech alone. It seems then that children use pointing gestures to initialise the basic linguistic construction, but then flesh out these constructions using the vocal modality (Capone & McGregor, 2004; Namy & Waxman, 1998; Ozcaliskan & Goldin-Meadow, 2009; Pizzuto & Capobianco, 2005). If this were the case, then there would be little role for gestures beyond the two-word stage, as children would have mastered multiple vocal strategies for communication. In reality, however, children from around two years old begin to use *iconic* gestures to provide additional semantic information to their speech (Mayberry & Nicoladis, 2000; McNeill, 1985, 1992; Nicoladis, 2002; Nicoladis, et al., 1999; Vallotton, 2010). The following section outlines research that has investigated the development of iconic gestures in children before three years of age.

2.3.2. Relations between iconic gestures and speech

According to McNeill (1985, 1992) children begin to use iconic gestures at the ontogenesis of multiword speech (approximately two years of age). This view has been supported by longitudinal work that has assessed children's iconic gesture production beyond the second year (Nicoladis, et al., 1999; Ozcaliskan & Goldin-Meadow, 2011). Ozcaliskan and Goldin-Meadow (2011) reanalysed their data from a previously collected longitudinal sample (Ozcaliskan & Goldin-Meadow, 2005b, 2009), specifically focusing on children's production of iconic gestures between 14 and 34 months of age. They found that a higher proportion of children performed at least one iconic gesture in their sample at 34 months (98%) compared to children at 14 months (8%). This sample of data revealed a leap in iconic gesture production at 26 months of age. Before 26 months, children produced very few iconic gestures (mean of 1 gesture per observation session). At 26 months and beyond this mean rose to 4 iconic gestures per session (see also Zlatev & Andren, 2009). Ozcaliskan and Goldin-Meadow (2011) suggest that this late occurrence of iconic gestures, relative to deictic gestures is due to the difficulty of mapping the referent to the symbol. While deictic gestures map onto the world directly, and are linked typically to children’s ongoing perception, iconic gestures can relate to a number of different concepts and can be influenced by the language of the speaker (Kita, 2009; Kita & Ozyurek, 2003, 2007; Kita, et al., 2007). McNeill (1992, 2005) argued that this ‘gesture explosion’ begins with children enacting the target movements, using their own bodies as a centre point (Sekine, 2009; Werner & Kaplan, 1963). Over time, this minimal distance between the gesture and the concept being represented is replaced by gestures in which the properties (size, shape etc) are not restricted to the body, but are freely assigned (Doherty-Sneddon, 2003; McNeill, 1985). For instance Sekine (2009) found that when describing familiar routes (e.g., to nursery from home), children showed age-related changes in their frame of reference. Four year olds used a much larger gesture space and their gestures were closely related to the direction they were referring to. On the other hand six year olds tended to create a gesture space in front of themselves, suggesting that by this age children are capable of separating themselves from their environment, relying instead on their mental ‘image’ of the route being described (Doherty-Sneddon, 2003; Werner & Kaplan, 1963).

Ozcaliskan and Goldin-Meadow’s (2011) suggestion that children’s production of iconic gestures is linked to their understanding of symbols is supported by a number of research studies that have found age-related changes in the form of children’s gestures when asked to describe actions to an experimenter. For instance, Boyatzis and Watson (1993) found that three year old children, when asked questions about everyday actions (e.g., “how do you brush your teeth?”) used mainly *body part as object* (BPO) gestures (e.g., using their finger to represent the stem of the toothbrush), while five year old children used *imaginary object* (IO) gestures (e.g., pretending to hold an imaginary toothbrush in their hand). This trajectory of understanding was also found by Bigham and Bourchier-Sutton (2007), who measured children’s *comprehension* of BPO and IO gestures (see also O'Reilly, 1995). These researchers and others (Elder & Pederson, 1978; Jackowitz & Watson, 1980) suggest that children’s iconic gesture production and understanding is linked to their ability to flexibly use symbols (Werner & Kaplan, 1963). Namy et al. (2004) suggest that at around 26 months children are able to map iconic gestures onto actions because (1) they are able to perceive the gesture-to-referent mapping required to understand that an iconic gesture is representational in nature, and (2) they have an increased understanding of the communicative intentions that an iconic gesture may have. This body of research suggests that children's iconic gestures become more abstract, in Werner and Kaplan's sense 'distanced' from bodily perception and experience (McNeill, 1985). This gradual flexibility in using gestures to represent referents is mirrored by children's increasingly flexible use of objects during pretend play (see section 1.2.3).

Importantly, these iconic gestures are *coupled* with speech rather than *in place* of speech[27] (Colletta, Pellenq, & Guidetti, 2010; McNeill, 1992; Nicoladis, 2002; Zinober & Martlew, 1985). These gestures can encode different semantic relations to those expressed in speech (Alibali, Evans, Hostetter, Ryan, & Mainela-Arnold, 2009; Goldin-Meadow, 2003). So-called 'non-redundant' (Alibali, et al., 2009; Alibali, et al., 2000), 'complementary' (McNeill, 1992) or 'supplementary' (Ozcaliskan & Goldin-Meadow, 2005b, 2009) gestures contain semantic information which does not overlap with speech. In contrast, 'redundant' gestures (Alibali, et al., 2009; Alibali, et al., 2000) are those where the semantic content maps closely to the concurrent speech. Alibali and colleagues (2009) argued that non-redundant iconic gestures may be used more frequently by children as a communicative strategy to counteract difficulties of expression in the spoken modality (Göksun, Hirsh-Pasek, & Golinkoff, 2010; Kendon, 2004; Kidd & Holler, 2009). They tested this hypothesis by collecting narrative data from 17 children aged between five and ten years, along with 20 adults. They compared their speech (at the level of the word and the clause) to a gesture 'lexicon' developed previously with a sample of 30 children of the same age. They found that children produced significantly more non-redundant gesture-

[27] Recently, Ladewig (2010) reported research which emphasised that speakers may use iconic gestures to 'fill in' for a word (e.g., "the ball went like [gesture]"). However, this example, while in isolation to speech temporally, still only has real meaning when considered in the context of the complete utterance (Andren, 2010).

speech combinations at both the level of the clause and word compared to adults. They argue that this may result from children having fewer linguistic resources at their disposal so they consolidate their spoken message with gestures that contain additional semantic information. This view is supported by Kidd and Holler (2009), who studied children's homonym disambiguation strategies. They found that children resolved lexical ambiguity (e.g., whether 'bat' refers to an animal or sporting object) using differing communicative strategies at different ages. Three year olds tended to use speech coupled with a deictic gesture to resolve lexical ambiguity, an ineffective strategy in the context of the task as there were no concrete entities to which the child could orient the naïve experimenter. Four year olds made a significantly higher proportion of disambiguation attempts using both iconic gestures and speech, than either three or five year old children in this sample. Kidd and Holler (2009) argue that while three year old children's high use of deictic gestures may reflect general difficulties with the task, children at four years old are using iconic gestures as a compensation strategy to help them "coordinate their linguistic knowledge with the pragmatics of the communicative event" (p. 910). On the other hand, five year olds were more likely to make exclusively verbal disambiguation attempts, with Kidd and Holler suggesting this is due to an enhanced understanding of the pragmatics required for the task of disambiguation.

The Kidd and Holler (2009) study suggests that iconic gestures are a 'crutch' for speech for children as they attempt to deal with the linguistic demands of the task. This is in line with previous research on younger children that suggests that once children master linguistic skills in the verbal modality they prefer that modality over the gestural one (Acredolo & Goodwyn, 1985, 1988; Goodwyn, et al., 2000; Namy & Waxman, 1998; Stefanini, et al., 2009). For example, Stefanini et al. (2009) asked children between the ages of two and seven to take part in a task where they had to name a number of pictures that were presented to them by an experimenter (depicting animals, objects and objects). They found an age-related difference in the number of representational (iconic) gestures that the children produced, with children producing a similar amount of representational gestures between the ages of two and three, but by age four this number dropped significantly. They suggest that in the context of a naming task, where children have to represent an image related to the word, these gestures support this representation by providing additional motor information. As children get older (around six to seven years of age) and become more competent in linking a referent to a word, Stefanini and colleagues (Stefanini, et al., 2009; Stefanini, Recchia, & Caselli, 2008) suggest that they no longer need representational gestures to boost linguistic representations and they become 'optional'.

This suggests that iconic gestures become redundant as a communicative tool as spoken language skills increase. However, the idea that gesture plays merely a compensatory role for speech (Goldin-Meadow, McNeill, & Singleton, 1996) and is not important for communication in general has come under criticism from a number of researchers (Holler & Beattie, 2003; Kendon, 2004; Mayberry & Jaques, 2000; Mayberry & Nicoladis, 2000; McNeill, 1992, 2005; So, Demir, & Goldin-Meadow, 2010; So, et al., 2009). Indeed, Kidd and Holler (2009) themselves suggest that children's use of iconic gestures may depend on the specific task demands and the communicative context. For example, recent research on 'common ground' in adult speakers (Clark, 1996; Clark, Schreuder, & Buttrick, 1983; Clark & Wilkes-Gibbs, 1986) has found that manipulating the shared knowledge between two interlocutors has a significant effect on iconic gesture rates (Gerwing & Bavelas, 2004; Holler, 2010; Holler & Beattie, 2005; Holler & Stevens, 2007; Holler & Wilkin, 2009).

The question to be addressed here is whether iconic gesture production in preschool children is a reliable index of children's advancements in speech. Nicoladis and colleagues (Mayberry & Nicoladis, 2000; Nicoladis, 2002; Nicoladis, et al., 1999) suggest that children's use of iconic gestures is mediated by status of their speech abilities, rather than a domain-general cognitive ability. They hypothesised that children who have been exposed to two languages from birth (and thus have different language abilities depending on the language being spoken), should have different iconic gesture rates in each respective language. To test this hypothesis, Nicoladis et al. (1999) observed five French-English bilinguals between the ages of 2 and 3 ½ years of age, and measured the number of deictic, iconic, beats and conventional gestures that children produced in each of their two languages. They found that iconic gesture rates (and beats) increased significantly over time, while there was no increase in deictic or conventional gestures across age groups. Additionally, mean length of utterance (MLU, which is calculated by dividing the number of morphemes produced divided by the total number of utterances) was also significantly correlated with iconic gestures per utterance in both languages. Children who were stronger in English tended to produce more iconic gestures in English compared to French, while the opposite trend was found for strong French speakers.

Nicoladis (2002) suggests that while deictic and conventional gestures may be acquired independently of speech, iconic gestures are tied to speech development generally. Supplementing the findings of Nicoladis et al. (1999), she found a clear language dominance effect for the number of iconic gestures produced in a sample of French-English bilingual children. Children also produced longer utterances when they used iconic gestures compared to when they used conventional or deictic gestures. Nicoladis et al. (1999) suggested that children’s iconic gestures may be correlated with utterance length due to their attempts to express more complex concepts. Iconic gestures, for example, have been linked to verb use (Kita & Ozyurek, 2003; Nicoladis, et al., 1999; Ozcaliskan, Gentner, & Goldin-Meadow, under review). Ozcaliskan et al. (under review) suggest that if iconic gestures are closely tied to the production of children’s early verbs, then children should produce iconic gestures that represent specific semantic meanings before they do so in speech. They found that even though children produced their first verbs on average seven months before they produced their first iconic gestures, children used iconic gestures to convey action meanings not expressed by their early verbs.

Importantly, these iconic gestures do not appear to be compensating for poor speech production abilities. The children in the Nicoladis (2002) study relatively rarely used iconic gestures at points where they were having trouble finding words (20% of the total iconic gestures produced). In addition, there were relatively few iconic gestures produced *without* speech (21% of total iconic gestures) suggesting that children were not using iconic gestures as a compensatory strategy, to be used in place of speech.

2.4. Conclusions

These two chapters have assessed the development of symbol use in three domains, speech gestures and pretend play. The first aim of the thesis was to define what is meant by the term 'symbol' and to discriminate symbolic activities from other activities that are related, but do not meet the criteria of being truly symbolic. Speech is inherently symbolic, as speakers intentionally represent concepts through the use of words that (in most cases) bear little relation physically to the concept itself. In the case of gesture production, iconic gestures have been identified in the literature as a candidate for symbol use in both adults and children (e.g., McNeill, 1985, 1992). Therefore, the focus of the present thesis with regards to gesture production will remain with children's iconic gesture production. For children's play behaviours, researchers have distinguished between sensorimotor, functional and pretend play acts (e.g., Leslie, 1987; Piaget, 1962). Pretend play acts are symbolic because they involve the intentional use an object or the creation of a role that is counterfactual to the properties of the object or person (Baron-Cohen, 1987; Leslie, 1987; Lewis, et al., 2000; Lillard, 1993b, 2001).

This chapter reviewed research that has explored the possibility that the relations between pretend play and language are due to a mutual underlying symbolic representational system. For children up until two years of age, there is a body of empirical evidence that suggests a link between pretend play and language (Casby, 1992; Lewis, et al., 2000; Lyytinen, et al., 1999; McCune, 1995; Shore, et al., 1984; Tamis-LeMonda &

Bornstein, 1990, 1994; Ungerer & Sigman, 1984). However, the conclusions drawn from these findings that both abilities are shaped by the same capacity to represent symbolically is flawed for two main reasons. First, the overall focus of these research studies is on the initial stages of symbolic representation in these two domains, and is limited to children aged two years and below. Beyond this initial emergence, there is evidence for a changing relation between language and pretend play, in the sense that children use one symbolic ability (language) to structure and maintain another (pretend play, e.g., Goncu, et al., 2002; Howe, et al., 2005). Second, as emphasised throughout the present review, speech is not the sole symbolic modality in language. Children's earliest deictic gestures, although not symbolic, are indicative and predictive of the ontogenesis of multi-word speech (Capirci, et al., 2005; Iverson, et al., 1994; Iverson & Goldin-Meadow, 2005). In addition, at around the same age as children begin to use objects to represent symbolically through pretend play, they are also supplementing their spoken utterances with iconic (symbolic) gestures (McNeill, 1985; Nicoladis, et al., 1999). These gestures in the second to third year have been related to children's advancements in speech (Nicoladis, 2002; Nicoladis, et al., 1999). This increase in children's iconic gesture production has also been attributed to their understanding of the communicative potential of gestures as a symbolic medium to supplement the semantic information contained in speech (Alibali, et al., 2009; Boyatzis & Watson, 1993; Namy, et al., 2004; Ozcaliskan & Goldin-Meadow, 2011). Other studies that have investigated children's iconic gesture production predicted that as children become more competent representing through the modality of speech, then iconic gesture production will reduce in frequency (Kidd & Holler, 2009; Stefanini, et al., 2009). However, it is a possibility that the differences in iconic gesture production across these studies may reflect differences in the demands of the task. For example, Nicoladis et al. (1999) used observational data with a small sample of five bilingual children, while the Stefanini et al. (2009) study utilised a picture naming task, which was more restrictive in nature as successful responses could be made with one word answers.

Finally, no research study to date has investigated the three domains of symbolic development of focus in the present thesis together in a sample of preschool children. This is perhaps surprising given their apparent temporal relations at around the end of the second year (McCune, 1995; McNeill, 1985) and the apparent similarities between representing symbolically using objects and using gestures (Andren, 2010; Bigham & Bourchier-Sutton, 2007; Boyatzis & Watson, 1993; Werner & Kaplan, 1963; Zlatev & Andren, 2009). An aim of the present thesis is to address this important issue by analysing measures of these three abilities for concurrent and longitudinal relations.

Chapter 3: Research Questions for Present Thesis and Methods

The following sections outline the specific research questions that will be addressed in the present thesis and present an overview of the methods utilised. There is also a section justifying the selection of the standardised measures and the outlining the task designed to elicit gestures from the children in the present study.

3.1. Research question 1: Are there associations between linguistic ability and the development of pretend play in children between 3 and 4 years of age?

The concurrent emergence of receptive, expressive and pretend play skills in the earliest stages of development has led a number of theorists to hypothesise strong conceptual relations between these processes (Bergen, 2002; Piaget, 1962; Werner & Kaplan, 1963). Both speech and pretend play have been linked to children's ability to decontextualise themselves from their perceptions and represent symbolically (Andresen, 2005; Piaget, 1962; Vygotsky, 1978; Werner & Kaplan, 1963).

The research that has investigated the relation between speech and pretend play has chiefly focused on the age when both skills are *emerging* (Lewis, 2003; Lewis, et al., 2000; Lyytinen, et al., 1999; McCune, 1995; Tamis-LeMonda & Bornstein, 1994; Ungerer & Sigman, 1984). Little research has assessed whether the relations obtained in these earlier studies hold beyond the early multi-word stage, when naturally both abilities are becoming more complex. By age three, pretend play has been identified as having a role to play as a tool for language growth (Andresen, 2005; Yawkey, 1983) and is involved heavily in the negotiation of play schemes and the distribution of roles (Goncu, 1993; Goncu & Kessel, 1988; Howe & Bruno, 2010; Howes, 1985; Howes, et al., 1989). However, the question of *whether* speech and pretend play emerge due to the same underlying cognitions, and subsequently whether this relation is maintained over the preschool years, is lost in favour of *how* these abilities interact in pretend play scenarios. To deduce clearly the cognitions underlying pretend play and speech it is necessary to investigate relations between these domains of symbolic representation beyond their initial emergence (Charman, et al., 2000; O'Reilly, Painter, & Bornstein, 1997). I hypothesise that if the symbolic link between pretend play and speech is maintained beyond the initial emergence of these abilities, first there would be evidence of a significant concurrent relation between these two measures even when non-verbal ability is controlled for. Second, there would be a longitudinal relation between measures of pretend play and speech. Specifically, both measures will make a significant *individual* contribution to later scores (Card & Little, 2007; Rutherford, et al., 2007). For example, when predicting a later pretend play measure, *both* the earlier pretend play and the speech measures should make a significant predictive contribution. If an underlying symbolic capacity underlies both abilities then the opposite predictive effect should also be found.

The present thesis investigates this question by giving children a standardised assessment of receptive and expressive speech, along with a standardised measure of pretend play abilities. These measures are taken a total of three times for each child during the period of one year, between the ages of three and four (each testing phase approximately six months apart).

3.2. Research question 2: How does children’s iconic gesture use relate to their linguistic abilities?

The second important issue raised from the research explored as part of this review has been that ‘language’ should not be considered as uni-modal. An increasing body of research has identified that gestures are inextricably linked to ongoing speech, in both the emergence of speech in children, and in adult communication (Alibali, et al., 2009; Alibali, et al., 2001; Kendon, 1994, 2004; Kita & Ozyurek, 2003; McNeill, 1985, 1992; Nicoladis, 2002; Nicoladis, et al., 1999). Of particular interest to the present thesis are *iconic* gestures, which appear to have symbolic properties (Bavelas & Chovil, 2000; DeLoache, 2004; McNeill, 1985; Saussure, 1969).

For children at the earliest stages of language development, gestures seem to indicate and reflect linguistic change (Camaioni, et al., 2003; Capirci, et al., 2005; Capirci, et al., 1996; Goldfield, 1990; Goldin-Meadow, 1999; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Ozcaliskan & Goldin-Meadow, 2005b, 2009). Deictic gestures in particular appear to be used by children to help them flesh out longer linguistic constructions during the transition from one to two-word speech (Capirci, et al., 2005; Iverson & Goldin-Meadow, 2005; Ozcaliskan & Goldin-Meadow, 2005b). However, few studies have investigated children's iconic gesture use in relation to their developing abilities in speech and those that have investigated this issue have used a variety of different gesture elicitation methods (Nicoladis, 2002; Nicoladis, et al., 1999; Ozcaliskan & Goldin-Meadow, 2011; Stefanini, et al., 2009).

To assess whether children's iconic gesture uses are related to their capacities in speech, children were given a task where they had to describe geometric shapes to their caregiver (Graham & Argyle, 1975). This task was collaborative in the sense that the child described the shapes to their caregiver, so that the caregiver could express their understanding of the description by drawing it. Like the measures of children's pretend play and speech abilities this was done three times over the space of a year. From this task, a number of measures were obtained relating to children's *overall* gesture use and specifically to their *iconic* gesture use.

There are two competing possibilities. First, if iconic gesture production is linked to a general capacity to represent symbolically in a flexible way (Boyatzis & Watson, 1993; Namy, et al., 2004; Ozcaliskan & Goldin-Meadow, 2011), we may expect to find that children's symbolic gesture production (as indicated by their iconic gestures) relative to other forms of gesture production would increase over developmental time. We also expect to find that children's iconic gesture production would have a concurrent relation to another symbolic measure, that of speech (Nicoladis, et al., 1999). However, a second possibility is that children's iconic gesture production reduces over time, as children come to prefer the spoken modality (Iverson & Goldin-Meadow, 2005; Kidd & Holler, 2009; Stefanini, et al., 2009).

3.3. Research question 3: To what extent are the three symbolic representational capacities of spoken language, gestural communication, and pretend play related between 3 and 4 years of age?

The first two research questions both investigate whether there are pairwise relations between two symbolic domains (pretend play and speech, and speech and gestures respectively). The theoretical position explored by this research revolves around the view that if one symbolic system underlies these three domains then correlations and predictive relations should be found between them (Piaget, 1962; Werner & Kaplan, 1963). Thus far, no research study has investigated these three areas of symbolic understanding simultaneously. Studies exploring the early relations between pretend play and speech have neglected the communicative role of gesture. Given the temporal relation between the ontogeny of children's multiword speech, their pretend play and the production of their iconic gestures, an aim of the present thesis is to fill this gap in knowledge by assessing the relations between all three symbolic domains during the fourth year. For this purpose the present study uses a longitudinal design, which is able to assess different accounts for the development of the specific symbolic abilities of interest in the present thesis (e.g., Rutherford, et al., 2007).

The first paper examines concurrent relations between pretend play, speech and iconic gesture production in a sample of children aged 3;3 years. I predict first that there will be a 'triad' of concurrent relations consisting of significant associations between speech and pretend play, speech and iconic gesture production and finally between pretend play and iconic gesture production, when non-verbal ability is controlled for. If the capacity to represent symbols in these three domains is indicative of a shared cognitive ability underlying them, then the same triad of relations is expected to be found across development. I test this hypothesis in the first paper, which focuses on data collected when the children were between 38 and 40 months old. In addition to investigating relations between pretend play and speech, and gesture and speech (research questions 1 and 2), this correlational analysis extends to relations between pretend play and gesture production. Previous research (Bigham & Bourchier-Sutton, 2007; Elder & Pederson, 1978; Tomasello, et al., 1999) has suggested that pretend play and gesture use may be part of the same 'representational continuum', and related to similar abilities in using a signifier *flexibly* to indicate the signified. If this is the case then there should be a concurrent relation between children's pretend play and their iconic gesture production even when non-verbal ability is controlled for. In the second paper, this analysis is again performed on the same sample of children at 3;9 years and 4;3 years of age, and aims to explore the possibility of developmental changes in the relations between these abilities during the fourth year.

Second, in addition to the triad of concurrent relations predicted *within* testing phases that constitute part of the present thesis, a domain-general capacity for symbols underlying these three abilities would also reveal itself *between* testing phases. The second paper focuses mainly on data points taken approximately six and twelve months after the initial testing date. This longitudinal data enables the tracking of developmental changes in each of the three symbolic abilities of interest here, with the possibility of finding predictive relations (Baddeley, Gathercole, & Papagno, 1998; Card & Little, 2007).

As for the first research question, we would expect earlier measures to make a significant predictive contribution to later scores. Specifically, if all three of the symbolic abilities of interest are mutually influenced by an underlying ability with symbols, we would expect to find that all three of these measures would make an individual and significant predictive contribution to later scores. For example, pretend play scores at the final testing phase would be predicted by (1) pretend play score six months previous, (2) speech score six months previous *and* (3) the iconic gesture measure six months previous.

An alternative possibility is that an initial domain-general capacity to understand symbolic reference up to around the end of the second year, begins to ‘branch out’ as other external factors take hold on each of the three symbolic capacities. For example, as discussed in section 1.6.3, pretend play success in older children is governed in part by their abilities to recognise pretense in others and their understanding of the intentions underlying the actions of peers. Other influences on the development of pretend play include the ability to maintain pretend ‘worlds’, which is likely to be influenced by increases in working memory (Skolnick & Bloom, 2006; Wyman, et al., 2009b), and object recognition, which influences how children understand the ‘symbolic affordances’ of a toy (Smith & Jones, 2011). For speech, O’Toole and Chiat (2006) suggest that what initially begins as a domain-general capacity to represent symbols in the spoken domain (reflected in increases in vocabulary) specialises into a more specific ability, as children become more exposed to linguistic input. According to Karmiloff-Smith (1998) over developmental time, children’s ever-increasing experience with different kinds of linguistic input contributes to the development of a specialised capacity for language, which is separate from other symbolic domains, notably pretend play. However, as discussed in section 2.2, the links between these abilities are not lost, as pretend play success is dependent on children being able to introduce and maintain pretend play scenarios. It may be found then that there is a particular predictive direction, where speech ability influences children’s later pretend play abilities but not vice versa. Iconic gestures in turn may have no *predictive* relation with either pretend play or speech, but may be paced by the development in the spoken domain (Nicoladis, et al., 1999; Ozcaliskan & Goldin-Meadow, 2011).

3.4. Research Question 4: How do children incorporate symbolic gestures into their own gesture repertoire?

In the current longitudinal study, I hypothesise that over time children, in the context of a picture description task, will increase their use of iconic gestures relative to their overall gesture use. I also predict that this development will bear a close relation to their individual advancements in speech, as measured by a standardised test. These predictions are based on previous research that has emphasised a strong relation between speech and gestures at emergence (section 2.3.1), and in adults (section 2.3). However, currently there is little knowledge about how children incorporate gestures into their descriptions of novel objects. For example, are children's gestures influenced by conventional routines established with the caregiver? There are two motivations for asking this question in the present thesis. First, research has shown that children can learn symbolic pretend play actions with novel objects by imitating the actions of an adult (Nielsen & Christie, 2008; Rakoczy, et al., 2005a, 2005b; Striano, et al., 2001). If children learn iconic gestures through imitative processes, it would inform the findings of the longitudinal study because it would be evidence that iconic gestures, like pretend play are both influenced by similar social learning processes. Second, children's earliest representational gestures emerge around the same time as their first words, and appear to be part of specific interactive routines with their caregiver (Acredolo & Goodwyn, 1985, 1988; Capone & McGregor, 2004; Goodwyn, et al., 2000). However, the symbolic status of these gestures has been challenged (Caselli, 1990; Liszkowski, 2008, 2010; Tomasello, et al., 1999). By three years old, children have begun to use iconic gestures as part of their communicative repertoire *with speech* rather than *in place* of speech (McNeill, 1992; Namy, Acredolo, & Goodwyn, 2000).

So far, no study has investigated whether children use the gestures of an adult to help them describe a novel object or entity of interest, and if they do so whether the imagistic properties of the gesture itself has a role in its use as a representative strategy

(Cook & Tanenhaus, 2009; Feyereisen & Havard, 1999; Hostetter & Alibali, 2010; Hostetter & Skirving, 2011). The third paper presented in this thesis aims to address this question by asking children to describe a number of novel objects to their caregiver (who can't see the objects), after (a) seeing gestures that highlighted a property of the object (a physical feature or a potential movement of the object), or (b) not seeing a gesture at all.

3.5. Methodological considerations and rationale

To address the first three research questions concerning concurrent and longitudinal relations between three symbolic domains, it was necessary to identify measures that tested the children's abilities in these areas. It was also important to focus on the *symbolic* aspects of these domains, not just on the generalised behaviour. For example pretend play can be defined separately from functional play, which contains fewer symbolic elements (Lewis, et al., 2000; Seefeldt & Barbour, 1987; Ungerer & Sigman, 1981; Williams, Reddy, & Costall, 2001). It was also necessary to consider both the analyses possible from the measures obtained, and the practical considerations of performing the longitudinal study itself (e.g., demands on children's time and concentration). The following section introduces the measures adopted throughout the longitudinal study and provides a rationale for their selection.

3.5.1. The Test of Pretend Play (ToPP)

The ToPP (Lewis & Boucher, 1997) is a standardised measure for children between one and six years old. It is designed to assess children's abilities in the three main forms of pretend play that have been previously identified in the literature (reference to absent objects, object substitution, and attribution of pretend properties, Baron-Cohen, 1987; Leslie, 1987). The ToPP also has the added advantage of being able to favourably score children who are able to combine play schemes, or to follow a sequence of pretend play behaviour.

The ToPP is designed to be an assessment of the child's ability to engage in pretend play using a variety of age appropriate objects. Previous research suggests that children's pretend play is boosted by adults taking an active role in the creation of the pretend scenario (Fiese, 1990; Haight & Miller, 1993; Laakso, Poikkeus, Eklund, & Lyytinen, 1999; Slade, 1987; Tamis-LeMonda & Bornstein, 1994). The structured section of the test (used in the present study) allows the caregiver to be present during the administration of the pretend play assessment, but the actual administration of the test is highly controlled in terms of the objects used and the manner of administration (i.e., the experimenter tests each child). For the items which involve an instruction element, the administrator is given strict verbal instructions which they quote verbatim after presenting each object. For the modelled pretend play actions, the administrator has specific guidelines for how to present the pretense to the child. For example, when the administrator 'makes the teddy feel poorly', they are instructed to place the hand of the teddy on the stomach region and supplement this with groaning noises. This means that it is possible to separate the role of the caregiver from the child's symbolic representational abilities shown through pretend play (Lyytinen, et al., 1999). However, the pretense scenarios, while controlled by the administrator, are still social in nature as the administrator actively engages the child by demonstrating ways to play with the objects.

Finally, the structured version of the ToPP has been tested for test re-test validity (Clift, Stagnitti, & DeMello, 1998; Stagnitti, 2004). This suggests that it is appropriate for multiple uses with the same sample of children (see Table 3.1 for item list).

3.5.2. Clinical Evaluation of Language Fundamentals- Preschool (CELF)

The CELF (Wiig, Secord, & Semel, 2000) is a UK based language measure which contains a number of subtests designed to assess both receptive and expressive language in children aged between three and seven years old. These separate subtest scores can be standardised separately and added together to provide a composite score. In the present

Table 3.1: Item list for the Test of Pretend Play (adapted from Lewis and Boucher, 1997).

Section: Item	Materials	Play Type	Instructed/ modelled play act
I:1	Bowl and spoon	Reference absent object	"Show me how you eat your breakfast"
II:1	Doll and top	One substitution	"Show me how the doll puts on her hat"
II:2	Doll, counter and box	Two substitutions	"Show me how the doll puts a plate on a table"
II:3	Doll, tub, cloth and stick	Three substitutions	"Show me how the doll rows a boat on the water"
II:4	Doll, perspex reel, board, and box	Four substitutions	"Make the doll go down a hill in a sledge into snow"
III:1	Teddy	Reference absent object	Teddy driving a car "Show me how teddy has a drink"
III:2	Teddy	Property attribution	Teddy feeling poorly "Show me how teddy feels sad"
III:3	Teddy	Substitution	Teddy being a bridge "Make teddy be a bird"
III:4	Teddy	Scripted play	Teddy going shopping "Make teddy get ready for bed"
IV:1	None	Substitution	Being a tree "Show me how you can be a rabbit"
IV:2	None	Reference absent object	Eating ice cream "Show me how you ride a bicycle"
IV:3	None	Property attribution	Feeling cold "Show me how you feel happy"
IV:4	None	Scripted play	Bathing baby "Show me how you get up in the morning"

study a shorter version of the test ('quick test') was used as it reduced the length of the test from around 44 minutes to 19 minutes, thus reducing the likelihood of child fatigue during the course of testing. This consisted of one receptive and one expressive subtest.

The CELF has also been subject to reliability testing (see Wiig, et al., 2000). Although there is some evidence for practice effects, in that children's re-test scores were consistently higher than initial test scores, the difference was non-significant[28]. Internal consistency was high, with Cronbach's alpha ranging between 0.84 and 0.92. The CELF has also been used in previous longitudinal research (Poe, Burchinal, & Roberts, 2004). See Table 3.2 for the item list for the receptive subtest of the CELF.

3.5.3. Raven's Coloured Progressive Matrices (Raven's)

The first two measures assess children's capacities to represent symbolically in pretend play and speech (production & comprehension). However, there is the possibility that correlations or predictive relations between these measures may be due to a general cognitive capacity, not to a specific symbolic capacity. To remedy this potential issue, it was necessary to obtain a general cognitive measure that could act as a control, suitable for partial correlation analysis. Raven's Coloured Progressive Matrices (Raven, 2004) is a thirty six item test which asks participants to select the correct piece (out of six options) that completes a main picture. The main advantage of using Raven's is that involves very little verbal instruction to be understood, and so scores are unlikely to be influenced by children's speech comprehension. Therefore, performance on the task is not likely to be due to children's understanding of the demands of the task.

Additionally, Raven's only takes a short time to administer (15 minutes) and as a result is appropriate given the potential for child fatigue while performing a battery of tests. A number of studies have found good levels of test-retest reliability in a number of populations (Brouwers, Van de Vijver, & Van Hemert, 2009; Cotton et al., 2005; Facon & Nuchadee, 2010). As Raven's was not standardised to the age of the children used in the present study, the raw scores were used.

[28] For the two measures that constitute the 'quick test' (linguistic concepts and recalling sentences in context) the difference in standardised scores between test and re-test were 0.4 and 0.7 respectively.

Table 3.2: Item list for receptive subtest of the CELF (adapted from Wiig et al., 2000).

Item	Picture Description	Instruction
1	Four bears	Point to one of the bears
2	One, bear, one elephant, one giraffe and one monkey	Point to the elephant first, and then point to the giraffe
3	One bird, two cats and one dog	Point to either the dog or the bird
4	Three dogs. One eating, two not eating	Point to a dog, but not the one that is eating
5	Three fish and two cats	Point to a fish or a cat
6	Two tigers and two giraffes	When I point to a tiger, you point to a giraffe
7	One bird, one tortoise, one dog and one cat	Point to the cat and then to the bird
8	Three giraffes and two elephants	Point to the elephant next to the giraffe
9	One tortoise, one fish, one bear and three birds	Point to the bear, the tortoise and the fish
10	Three elephants	Point to the first elephant in the line
11	Two elephants, two giraffes and two monkeys	After I point to a monkey, you point to an elephant and a giraffe
12	Four fish and one tortoise	Point to the tortoise before you point to a fish
13	One cat, one tortoise, one bird, one dog and one fish	Point to the animal in the middle
14	One monkey, one dog, one cat and one tortoise	Point to the monkey before you point to the tortoise and the cat
15	One bear, one monkey, one tortoise and one bird	Point to all the animals except the bird
16	Four birds	Point to the last bird in the line
17	Three tigers and one monkey	Point to either of the monkeys and all of the tigers
18	Three tigers and two bears	Point to some of the tigers
19	Four tigers and one bear	Before you point to the bear, point to a tiger
20	Two elephants, one, tiger, one giraffe and two monkeys	Point to the giraffe after you point to an elephant and a monkey

3.5.4. Gesture Elicitation task[29]

Children were asked to describe five pictures to their caregiver, so that the caregiver could attempt to draw each picture on a blank piece of paper (Graham & Argyle, 1975). Piloting with this method found that the collaborative nature of the task made it highly engaging for children to participate in, and the complexity of the shapes was appropriate for the age of the children. Other possibilities for the gesture elicitation task

[29] Called “picture description task” throughout study chapters.

included a picture naming task (Botting, Riches, Gaynor, & Morgan, 2010; Stefanini, et al., 2009; Stefanini, et al., 2008) or asking children to narrate a video (Alibali, et al., 2009; McNeill, 1992, 2005). As the naming task utilised by Stefanini and colleagues could be completed successfully with one word responses, this task was not deemed suitable as a measure of children's iconic gesture production relative to their overall speech performance. Pilot studies using a narration task found that children almost exclusively produced iconic gestures, but only in small numbers compared to the picture description task (many not producing any gestures at all). As the present research focused on preschool children's iconic (symbolic) gestures relative to other non-symbolic forms of gesture, it was decided to use the picture description task to generate a gesture measure for each child.

In addition to the gesture elicitation task, naturalistic data was also obtained across the three testing phases. For this naturalistic data, children and caregivers were left alone for a period of ten minutes with the instructions to act as naturally as possible. They were given some information about potential subjects to talk about and picture cards to stimulate interaction. These data were not analysed for the purposes of the present thesis, but will be utilised for the purposes of ongoing and future research studies (see section 7.6.1).

3.6. Data collection and coding

Out of the 49 caregivers and children recruited at the initial testing phase, 36 expressed a preference for being tested at home. For the 13 laboratory based children, testing took approximately two hours in total at each of the three testing phases. This was extended however if children revisited the laboratory due to testing fatigue. This occurred seven times during the first testing phase, four times in the second testing phase and twice at the third testing phase. For the home tested children, the approximate travel time for each testing session was an hour, in addition to the time taken for testing to take place. Overall, data collection took over 400 hours.

Taken together, scoring of the standardised tests took approximately 75 hours (about 10 minutes per test). Coding of the gesture elicitation task took a significant amount of time, as it included transcription of the utterances, identification of the gestures and the coding of each of these gestures. There was also additional time taken to train the reliability coder. Coding of the task was done over 20 months at approximately 20 hours per week. Taken together, transcribing, coding and reliability training took an estimated 2000 hours.

3.7. Longitudinal method

Two aims of the present thesis are (1), to establish whether concurrent relations found between symbolic measures before children reach two years of age are observed beyond this stage, and (2), to find whether there are predictive relations between these measures developmentally. For the first aim it is possible to use correlational analyses at each of the three testing phases to determine to what degree a relation exists between two quantifiable variables at a single time point. Of course, this concurrent correlational method cannot imply causality. In the present study, the hypothesis is not that one symbolic domain (e.g., speech) *causes* another (e.g., pretend play) but that they may both have the same cognitive origin (Bates, et al., 1979; Piaget, 1962; Werner & Kaplan, 1963).

As the present study focuses on the development of these abilities between the ages of three and four, it was appropriate to investigate these abilities across time. Using a between-participants design, although it would have had the advantage of reduced participant attrition (Breakwell, Hammond, & Fife-Schaw, 2000), has the problem of confounding age and the abilities of the cohort (Card & Little, 2007). Removal of the potential for a cohort effect is beneficial for the present study, as it negates the possibility that the changes observed across the three testing phases are due to individual differences, and not due to maturity in children’s symbolic cognitions (Coolican, 2004).

A typical issue with longitudinal research is *practice effects*. It is possible that children will improve on the tasks due to having performed them before. Of course, this is a possibility in the present study. However, it's expected that the stability across time for the measures obtained will be high, as previous research using the standardised measures has found good levels of test re-test stability (see sections 3.5.1 – 3.5.3). In other words, any potential practice effect found across the three testing phases will be similar for each child, and therefore should not significantly impact on the results obtained.

3.7.1. The longitudinal sample

Overall, 49 caregiver-child dyads were recruited for the studies using a number of strategies (see paper one for details of the methods of recruitment, and appendices 1-2 for the parent information sheet and consent form). Data was collected from the caregivers on their first follow-up visit to gather information about their age, education and current employment (Table 3.3, see appendix 3 for questionnaire).

In general, the sample consisted of caregivers above the age of 33 who were educated to degree level or above (62%). There were only five caregivers aged 32 or below who had not attained an undergraduate degree (11%). This distribution may reflect older and more educated caregivers' increased interest in studies focused on child development generally. 33 (70%) of caregivers were in either full or part-time employment.

3.8. Structure of the empirical chapters

The following three chapters constitute three empirical studies, preceded by a short introduction. Chapter 4 investigates the concurrent relations between the three domains of interest (speech, gestures and pretend play) in the thesis in children aged between 3;2 and 3;4 years, using both standardised measures and a task designed to elicit gestures. Chapter 5 extends these initial findings further, by examining the potential for longitudinal relations between these measures. Chapter 6 aims to explore children's iconic gesture production in

Table 3.3: Age and education category membership for caregivers

	Age			
Education	19-24	25-32	33-40	41+
High school	2	0	2	1
College/sixth form	0	3	5	0
Undergraduate degree	1	2	12	4
Postgraduate degree	0	2	6	7

more detail, by exploring how children incorporate the gestures they have previously observed into their own descriptions of previously unseen objects. In the general discussion section, I summarise the main findings and relate them to theories of symbol development in preschool children. I address potential limitations of the research and outline directions for future study.

Theories of symbolic development in children have mainly focused on the ontogenesis of these abilities before the end of the second year. As assessed in detail in chapter 1, there are three symbolic capacities that emerge at around this age: the use of speech as a communicative medium, the capacity of children to use objects or themselves as a symbolic medium through pretend play, and the use of gestures to represent events or objects through the body and hands. In this view, children are initially context bound to their ongoing sensorimotor perceptions. Over developmental time, sensorimotor activites reduce in prevalence, while symbolic activities become more frequent. In sections 1.3 to 1.6, the theories of Piaget, Vygotsky and Werner were outlined and the social-cognitive underpinnings of children's symbolic development were assessed. Taken together, the body of research explored in the present thesis suggests that children's symbolic capacities are governed by similar processes and thus manifest themselves behaviourally at similar times.

In sections 2.1 to 2.3, the potential for pairwise relations between the domains of interest were reviewed. For speech and pretend play, a number of theoreticians and researchers have argued that pretend play and speech are inextricably linked (Andresen, 2005; Bates, et al., 1979; Bruner, 1966; Fein, 1981; Nicolich, 1977; Piaget, 1962; Shore, et al., 1984; Vygotsky, 1978; Vygotsky & Luria, 1994). Historically, this connection has derived from the constructivist perspective of Piaget, which suggested that pretend play provides an important opportunity for cognitive and speech development in children (Yawkey, 1983). The apparent shift from sensorimotor to symbolic representation is regarded by theorists as a major cognitive achievement, which is *expressed* through both speech and pretend play (McCune-Nicolich, 1981; McCune, 1995; Piaget, 1962; Werner & Kaplan, 1963). Werner and Kaplan (1963) proposed that this shift from the sensorimotor to the symbolic is caused by children achieving a 'distance' between what they perceive and what they represent (Keil, 1989). By going through this 'distancing' process, children learn that they are separate from other people, and that objects can be represented using signs and symbols (Bruce, 2005).

Symbolic development in speech is the increasing use of linguistic symbols in an decontextualised way (Andresen, 2005). Over time, there is a shift to conventionalised speech, with increased symbolism and arbitrariness involved (Crain, 1992). In Werner and Kaplan's own words, there is "a progressive differentiation or distancing between the inner form of a symbol (the connotational dynamics) and the external form (the phonic or written vehicle)" (Werner & Kaplan, 1963, p. 238). At around the same time that children are using their first arbitrary symbols in the domain of speech, they are also beginning to develop skills in pretend play (Bergen, 2002; Fein, 1981). This has been linked to both the emergence of social-cognitive capacities (sections 1.4 - 1.6) and to a domain-general symbolic ability (section 2.1). However, there were two main issues raised with this research. First, no research had investigated the potential for relations between pretend play and speech to be maintained beyond the end of the second year. From section 2.2 it became apparent that the focus of research on older preschool children had changed from exploring the potential for predictive relations between symbolic measures, to *how* children use their symbolic capacities in speech to structure their pretend play activities. Second, no previous research investigating relations between pretend play and speech has investigated 'language' bi-modally. It seems that children's *iconic* gesture use is linked to their symbolic language proficiency (Capone, 2007; Gullberg & Narasimhan, 2010; Nicoladis, 2002; Nicoladis, et al., 1999; Sekine, 2008, 2009). Iconic gestures are naturally occurring symbols that are a regularly produced in speaker's everyday communication (McNeill, 1992) and begin to be produced from around the beginning of the third year, which matches temporally with the emergence of multi-word speech and pretend play.

I hypothesise that if all three symbolic domains of interest here are influenced by a general representational capacity *beyond* initial emergence then there will be a triad of relations found between three measures that tap into children's symbolic capacities in these domains. This would include not just pairwise relations between pretend play and speech, and pretend play and iconic gesture production, but also a significant relation between pretend play and iconic gesture production. A number of previous studies have placed symbolic representation with objects and gestures on the same representational ‘continuum’ (Bigham & Bourchier-Sutton, 2007; Boyatzis & Watson, 1993; Jackowitz & Watson, 1980; Tomasello, et al., 1999). This is linked to children’s use of objects and gestures as flexible signifiers (DeLoache, 2000; Werner & Kaplan, 1963).

An alternative possibility is that although an underlying symbolic ability explains the emergence of the symbolic behaviours observed in children at around two years of age, these three domains are about to diverge as different demands take hold on their success (Charman, et al., 2000; Karmiloff-Smith, 1992; O'Reilly, et al., 1997). If this were the case, then there would be a specific pattern of results found. First, there may be a relation found between speech and pretend play, as success with pretense has been linked to children’s abilities to negotiate and comprehend play activity (see section 2.2). Second there may be a relation between iconic gesture production and the speech measure, as previous research in younger children has found that iconic gestures are produced with longer utterances (see section 2.3.2). However, the third relation between pretend play and iconic gesture production would not be found.

The first paper that follows investigates these questions. This paper is currently submitted for publication, and is co-authored by Simon Child, Anna Theakston and Simone Pika.

Paper one: Investigating preschool children's symbolic representation in three domains: Pretend play speech and gestures

4.1. Introduction

The burgeoning cognitive capacities of children have long been of interest to psychologists (Bates, et al., 1979; Goswami, 1998; Karmiloff-Smith, 1992; Piaget, 1962; Tomasello, 1999; Vygotsky, 1962; Werner & Kaplan, 1963). Children are unique in their exceptional abilities to engage in language and pretend play, and one skill identified as potentially underlying both of these abilities is symbolic representation (Deacon, 1997; DeLoache, 2004; DeLoache & Burns, 1994; Piaget, 1962; Werner & Kaplan, 1963). Deacon (1997) for instance argued that humans' unique ability to use language is borne out of their ability to symbolically represent objects, events and scenes of interest beyond their ongoing perception. In other words, they are able to remove themselves from sensorimotor perception, and discuss events not present in their immediate world (Piaget, 1962).

There is some evidence that behaviours that appear intertwined with children's symbolic representational ability emerge over the same developmental trajectory. For example, at nine months of age children begin to represent objects and events symbolically in a number of cognitive domains such as communication and play (McCune-Nicolich, 1981; McCune, 1995; Shore, et al., 1984). However, in order to examine the cognitive underpinnings of these symbolic representational abilities it is important to demonstrate not only concurrent emergence, but also relations between them. The following section presents an overview of the research that has investigated the development of representational abilities in young children that make use of symbols, and has sought to find links between them.

4.1.1. Relations between pretend play and language

So far, researchers have mainly focused on the relation between pretend play and language abilities[30]. Language has been identified as consisting of two modalities; that of speech *and* movement of the hands and arms, termed gestures (Kendon, 2004; McNeill, 1992). Research that has investigated the relation between play and language has focused mainly on the speech modality (Bates, et al., 1979; Fein, 1981; Garvey & Kramer, 1989; Lewis, et al., 2000; Lyytinen, et al., 1999; Shore, et al., 1984; Werner & Kaplan, 1963). Speech is symbolic because the form of the word itself (in the written or spoken form) bears no physical resemblance to what it represents. Pretend play is symbolic because children have to readily represent an object or themselves as having properties or attributes that differ to the physical or emotional reality, for example pretending a block is a car, or that a bear is 'sad' (Garvey, 1990; Leslie, 1987; Lewis, et al., 2000). These forms of pretend play begin to be a prominent part of children's behaviour from around eighteen months (Nicolich, 1977), coinciding with the onset of multiword phrases and considerable increases in vocabulary in the linguistic domain (Bates, Bretherton, & Snyder, 1988). It has been argued that the parallel improvements observed in these two domains are suggestive of a common cognitive symbolic capacity underlying both (Bergen, 2002; McCune-Nicolich, 1981; McCune, 1995; Piaget, 1962; Werner & Kaplan, 1963). In other words, pretend play and speech are equally dependent on a general ability for children to use and manipulate symbols. Indeed significant relations have been found between children's earliest pretend play acts and their early language use (Charman, et al., 2000; Lyytinen, et al., 1999; McCune, 1995; Tamis-LeMonda & Bornstein, 1994; Ungerer & Sigman, 1984).

A problem for current research assessing the relation between language and play in children is that it has so far only considered language in one modality; that of speech. However, an increasing amount of research has highlighted the apparent link between what

[30] We distinguish here between 'pretend' or 'symbolic' play and 'functional' play. Functional play is defined as the appropriate use of an object for the purposes it was designed for (Lewis, et al., 2000; Seefeldt & Barbour, 1987; Ungerer & Sigman, 1981; Williams, et al., 2001), while pretend play involves using an object or action with the intention of representing something else (e.g., Leslie, 1987).

is expressed verbally via speech and what is represented visually through movements of the arms, hands, head and postures in the form of gestures (Kendon, 2004; McNeill, 1992). Researchers suggest that gestures and speech are part of the same computational system on the basis of their concurrent nature and their semantic relation to one another (McNeill, 1992, although see Kita (2000) for criticism of this view), and may coordinate at the conceptualisation stage (Levelt, 1989) of language production (de Ruiter, 2000; Kita, 2000; Kita & Davies, 2009; Kita & Ozyurek, 2003). These gestures include so called *iconic* gestures which are imagistic, typically co-occur with speech, and are often reliant on speech to provide context (Goldin-Meadow, 2003). In addition to iconic gestures, *deictic* gestures are pointing movements that are not bound to speech but are used to show or request concrete elements of the gesturer's environment (McNeill, 1992).

While research has tended to focus particularly on the adult speech-gesture system, there is evidence that gestures form an important part of children's earliest communicative repertoires (Bates, et al., 1989). We will now consider the development of gestures in young children.

4.1.2. Development of gesture use in children

Gestures have been identified as having a unique impact on children's speech development at its early stages. For children, deictic gestures are an integral part of their earliest communication at around 10 months of age; providing a useful means for establishing an adult's attention or requesting something from them (Bates, et al., 1979; Bates, et al., 1975; Capone & McGregor, 2004). Research has suggested that deictic gestures enable children to communicate longer and more complex propositions in the transition from the one to two-word stage (Capirci, et al., 2005; Ozcaliskan & Goldin-Meadow, 2005b). Capirci and colleagues (2005) for instance found that prior to 16 months, children communicated in the gestural modality to point out objects and to request actions. By around 17 months they were able to convey two pieces of information together; one by using a deictic gesture and one by using speech. At the age of 23 months however, children were able to communicate two pieces of information in the verbal modality alone (see also Ozcaliskan & Goldin-Meadow, 2005b). In addition, it has been found that gesture production at nine months can predict later speech competence at around 15 months (Carpenter, Nagell, Tomasello, et al., 1998) and vocabulary development at 42 months (Rowe & Goldin-Meadow, 2009b).

Children have also been found to use iconic gestures to represent objects *before* they obtain a verbal label for them (Acredolo & Goodwyn, 1988; Namy & Waxman, 1998). Iconic gestures are interesting to researchers because they symbolically represent an action or event through the hands (Goodwyn, et al., 2000). Namy and Waxman (1998) found that at 18 months children readily learned iconic gestural labels and verbal labels to represent objects, and these symbolic labels showed little overlap (i.e. children used *either* a verbal label or a gestural label for each object). However, by 26 months of age children were less likely to learn gestural labels for objects, instead opting to learn verbal labels, suggesting a movement to the verbal symbolic domain.

Together, these studies suggest that advances in gestural communication may precede and be predictive of advances in spoken language. However, research has only investigated the link between speech and gesture at the earliest stages of language ontogenesis. As children begin to produce multiword utterances more often, they also begin to use more iconic gestures parallel to their speech (Capone & McGregor, 2004; McNeill, 1985, 1992; Nicoladis, 2002; Nicoladis, 2007; Nicoladis, Mayberry & Genesee, 1999; Nicoladis, Pika & Marentette, 2009; Ozcaliskan & Goldin-Meadow, 2011). So far, the development of iconic gesture use in preschool children has not been studied in detail. Mayberry and Nicoladis (2000; see also Nicoladis et al., 1999) showed that children increase their use of iconic gestures over time. Nicoladis et al. (1999) for instance observed the gestural behaviour of five French-English bilingual children between the ages of 2 years to 3½ years and found that the use of iconic gestures was directly correlated with the language proficiency in each respective language. When children were speaking their second and in this subject group their weaker language, they tended to produce fewer iconic gestures to accompany their speech compared to their first and stronger language. This suggests that iconic gestures in particular are closely tied to higher levels of linguistic ability in preschool children (Nicoladis, et al., 1999; Ozcaliskan & Goldin-Meadow, 2011). Contrary to this view, Stefanini et al. (2009) showed that children with higher linguistic abilities (4-year-olds) appear to use *less* representational iconic gestures to help them complete a naming task than children with less advanced linguistic skills (2-year-olds). They argue that 3-4 year old children are capable of providing a verbal label for each picture, thereby negating the need to use representational iconic gestures to compensate for poor linguistic abilities. However, it is clear that naturalistic interaction differs considerably from a naming task, and thus these apparent differences in gesture use may reflect task demands.

4.1.3. Research questions

To summarise, studies to date have focused on spoken language, pretend play and gesture at the earliest stages of development. However, no research has thus far investigated the possible relations between symbolic domains *beyond* the second year. This is crucial when considering the merits of the claim that abilities that rely on an understanding of symbols are linked because of a domain-general symbolic system (Deacon, 1997; Piaget, 1962; Werner & Kaplan, 1963). For children beyond the second year, research on speech and pretend play has mainly focused on how children use speech to negotiate the increasingly intersubjective and social nature of pretend play (Farver, 1992; Goncu, 1993; Goncu & Kessel, 1988; Howe & Bruno, 2010; Howe, et al., 2005; Howes, 1985; Howes, et al., 1989; Le Normand, 1986; Tykkylainen & Laakso, 2010; Vygotsky, 1978). Vygotsky (1978) for example argues that pretend play and speech are both examples of children’s early attempts to indicate meaning. Through pretend play, Vygotsky suggests, children are able to practice the referential function of symbols and transfer this understanding into the domain of words (Fein, 1979). However, this line of research has focused on how children beyond age three use speech as a 'tool' for pretense negotiation and maintenance, not whether both skills stem from the same underlying cognitive ability to use symbols, as has been suggested for children before 24 months (Bergen, 2002; Lyytinen, et al., 1999; McCune, 1995). From this age children are more adept at combining verbal symbols (i.e., words in multiword utterances) and engage in more complex pretend play (e.g., using many objects, like blocks or animals to create a complex pretence scenario). The first question addressed by the present study is to what extent do associations between linguistic ability and the development of pretend play, which have been observed in children up to 24 months of age, continue in children at 3 years of age? To address this question, we have used a standardised test of pretense that assesses children's symbolic abilities in this domain *individually,* not when scaffolded by others. We hypothesise that if there is a common symbolic capacity underlying both abilities (Lyytinen, et al., 1999; McCune, 1995) then a significant association and predictive relation should be observed between these measures, even when controlling for non-verbal abilities. Alternatively, it may be the case that by three years old, children's speech and pretend play is influenced not *just* by their underlying capacity to use symbols but by other cognitive demands. Some evidence in support of this view has come from research on children with autism, which found that children with autism showed *less* pretend play compared to language-matched controls (see Jarrold (2003) for a review). Additionally, Charman et al. (2000), found no significant association between a composite play score at 20 months and language ability at 44 months. The present study tested these competing views by assessing children's abilities in pretend play and spoken language, while also controlling for their non-verbal aptitude.

The studies outlined above suggest, however, that it is important not to limit our assessment of children's linguistic abilities to the *verbal* modality of language (Kendon, 2004; McNeill, 1992). Evidence suggests that gesture plays a role in children's early language development, in particular from the one to two-word stage (Bates, et al., 1979; Bates & Dick, 2002; Bates, et al., 1989; Capirci, et al., 2005; Capirci, et al., 1996; Capirci, Montanari, & Volterra, 1998; Capone & McGregor, 2004; Göksun, et al., 2010; Goldin-Meadow, et al., 2007; Gullberg, et al., 2008; Iverson, Capirci, Longobardi & Caselli, 1999; Iverson & Goldin-Meadow, 2005; Kidd & Holler, 2009; Mayberry & Nicoladis, 2000; Nicoladis, 2007; Nicoladis, et al., 1999; Nicoladis et al., 2009; Nicoladis et al., 2007; Ozcaliskan & Goldin-Meadow, 2005b; Rowe & Goldin-Meadow, 2009b). By the second year, children are capable of supplementing speech with iconic gestures that can symbolically represent a multitude of semantic elements. However, it appears that there is some lack of clarity as to how this gesture use changes over time as linguistic expression becomes more complex (Mayberry & Nicoladis, 2000; Nicoladis et al., 1999; Stefanini, et al., 2009). The second aim of the present study is to address this issue by asking how does children's iconic gesture use relate to their linguistic abilities? One view (Mayberry & Nicoladis, 2000; Nicoladis, 2002; Nicoladis et al., 1999) suggests that as iconic gestures represent aspects of the complex concept being represented in speech, they are tied to the development of predicate structures in children's speech (e.g., verbs). The second view (Stefanini, et al., 2009; Stefanini, et al., 2008), sees iconic gestures as a compensatory strategy "to help create a more precise and concrete image linked to the word" (Stefanini, et al., 2009, p. 185). We predict that if iconic gesture use is linked to a child's general symbolic representational capacity we should find a positive association between children's iconic gesture use and their linguistic ability. In addition, if children use iconic gestures when attempting more complex utterances (Nicoladis et al., 1999) we may expect to find that children who score highly on measures of linguistic ability would be more likely to have a higher frequency of iconic gestures relative to gesture use because as they attempt more complex speech streams which contain predicate structures (verbs, adjectives etc.) they will supplement them with gestures, in particular iconics (Nicoladis, 2007; Nicoladis et al., 1999).

The third question addressed by the present study is to what extent are the three symbolic representational capacities of spoken language, gestural communication, and pretend play related at 3 years of age? The relation between play and speech has been explained by a general underlying cognitive capacity for representing objects and entities symbolically, whereas for speech and gesture relations, explanations have tended to centre on the potential for speech and gesture to share the same computational system. The present study is the first attempt to consider all three symbolic domains (speech, gesture and pretend play) concurrently. At present it is an open question as to whether gesture use in children is related to concurrent abilities in other domains linked to symbolic representation. However, given the representational nature of iconic gestures, this gesture form in particular may be the best candidate for finding relations between symbolic domains. If a general capacity for symbolic representation underpins all three expressions of symbol use we would expect to find that, in addition to a relation between speech and pretend play (research question 1), and speech and iconic gesture use (research question 2), we would also find a third significant association between children's iconic gesture production and pretend play. Specifically, we would expect to find that children who show greater use of iconic gestures will score highly on a measure of pretend play. If there is no general capacity underlying these three abilities, we may expect to find fewer pairwise relations between measures. Specifically, we may still find a relation between iconic gesture production and speech measures, but not a relation between speech and pretend play measures or iconic gesture production and pretend play.

4.2. Method

4.2.1. Recruitment and participants

The participants were 51 monolingual English-speaking children (21 girls; 30 boys) aged between 38 and 40 months (Mean = 39 months 19 days). All of the children were born in the UK. Participants were recruited via the University of Manchester Max Planck Child Study Centre database, via letters distributed through local nurseries, through posters placed in and visits to local play centres, and via an advertisement in a local parents' magazine. Before the children took part in the study, the caregivers were given a short screening form to assess if the children had any ongoing or previous health issues that may have made the study unsuitable for their child. Two children were excluded prior to becoming part of the sample, due to their caregivers declaring their child had a history of atypical language development, leaving a total sample of 49 children. 70% of caregivers were educated to a least degree level, and 79% were employed in either full or part-time work.

4.2.2. Materials

Three standardised instruments were used to assess each child's level of development. These were the Test of Pretend Play (ToPP) (Lewis & Boucher, 1997), the Clinical Evaluation of Language Fundamentals- Preschool 'quick test' (Wiig, et al., 2000) and Raven's Coloured Progressive Matrices (hereby referred to as Raven's) (Raven, 2004). Furthermore, we used a Picture Description task designed to elicit gestures.

4.2.2.1. Test of Pretend Play

The test of pretend play is a standardised measure for assessing symbolic play in children between the ages of 1 and 6. The structured version of the test encourages children to play with a number of representational and non-representational toys in a set order. The ToPP assesses the three main types of pretend play identified previously in the literature

(Baron-Cohen, 1987; Leslie, 1987). These include the following: Object substitution (e.g., pretending a teddy bear is a bird), property attribution (e.g. pretending a doll is sad) and reference to absent objects (e.g., pretending a bowl is full of cereal). The ToPP also assesses children's abilities to combine play schemes in a scripted way. The present study used the verbal version of the test, which is designed for children with language ability in the normal range.

The ToPP is divided into four sections. In sections 1 and 2 children are given a number of different play materials and encouraged to play with them. In sections 3 and 4, the experimenter demonstrates to the child a number of different pretend play acts. This is so the child is aware of the nature of the play required for the assessment (Lewis, et al., 2000).

4.2.2.2. CELF-preschool

The CELF-preschool is a standardised measure designed to assess language ability in children between the ages of 36 and 83 months. It comprises six subtests of which three assess receptive language and three assess expressive language. Due to time constraints, the shorter 'quick test' version of the test was used. This 'quick test' consists of one receptive subtest (linguistic concepts) and one expressive subtest (recalling sentences in context). For the receptive subtest, children are required to point to a number of animals following four practice trials which establish that the children know the animals and are able to follow the experimenter's instructions. For the expressive subtest, children read a story called 'Moving House' with the experimenter. The experimenter read parts of the story and children are asked to repeat back a section of the text that was read to them. There are three practice trials and 18 test trials. For both subtests of the CELF-preschool, if children get five consecutive answers incorrect (or they decline to respond) then the subtest is stopped.

4.2.2.3. Raven's Progressive Matrices

In total there are 36 items. For each item, children are presented with a coloured pattern which has a small shape missing. Children are instructed to point to which one of six possible options they think best completes the pattern. Each option matches the shape missing from the coloured pattern but only one option correctly completes the pattern.

4.2.2.4. Picture description task

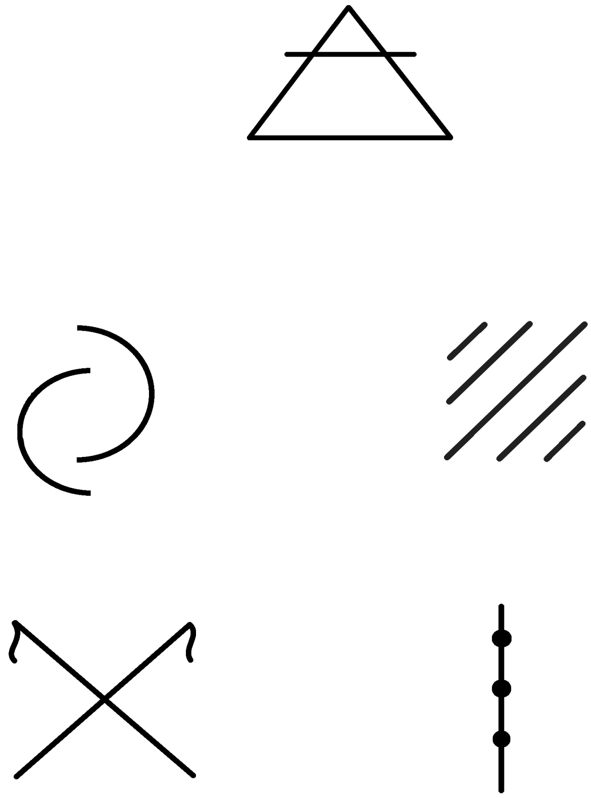
Children were shown a total of five picture cards and asked to describe them to their caregiver. These cards were printed on A4 paper in black ink, which was then laminated. The pictures used for the present study were used previously with adults (Graham & Argyle, 1975, see Figure 4.1). Caregivers were asked to draw the picture, based on the information given to them by their child. For this caregivers were supplied with an A4 pad of paper and a dark ink pen.

4.2.3. Procedures

Children were tested either in the laboratory at the University of Manchester (13 children) or at their home (36 children). Home testing took place in a main living area of the home, which was cleared of distractions (e.g., the child's toys). Before testing began, the experimenter introduced himself to the child. The order of administration of the four tasks was the same for all children. The picture description task was first, followed by the CELF- preschool, Raven's and finally the ToPP[31]. As it took around two hours to complete testing, children were given breaks as required. Occasionally (seven children), testing was stopped and finished at a later date less than two weeks from the original test date.

[31] The ToPP was administered last because the test instructions stated that children should have some experience interacting with the tester before the ToPP should commence. The tasks previous to the ToPP were deemed sufficient for this purpose.

Figure 4.1: Pictures used for gesture elicitation task (adapted from Graham and Argyle, 1975)



4.2.3.1. Standardised instruments

For the CELF-preschool and Raven’s, children sat on age-appropriate seating. A small table was used to place the test booklets on at a level where the child could comfortably see each item. Caregivers were able to observe the testing but were instructed not to comment or provide assistance to their child. For the ToPP, children were told that they would be playing with a number of different toys. They were then given the option of playing with the toys on the floor or at the table. Once the child had stated a preference, the experimenter sat next to the child and introduced the test. The instructions provided in the test manuals for all three standardised procedures were followed precisely.

4.2.3.2. Picture description task

This task was videotaped for coding purposes using a Sony HDD DCR-SR75E digital camera. Children sat on age appropriate seating, directly opposite their caregiver who was given a pad of paper and a pen. The experimenter sat next to the child and opposite the caregiver, ensuring that the camera had an unobstructed view of the child and caregiver. He then introduced the game to both the caregiver and the child as a describing game saying "*Now we are going to play a describing game with your mum/dad. I am going to show you some pictures and you will tell your mum/dad what the picture looks like so that they can draw it! Your mum/dad can't see the picture so you have to tell them everything you can about it so they can draw it.*"

The experimenter then introduced the practice trial picture by placing it in front of the child so only the child and experimenter could see it. The caregiver could only see the blank side of the picture card. The experimenter then said, *"Here is the first picture. Can you tell your mum/dad what it looks like so that s/he can draw it?"* If the child appeared unsure or reluctant, the experimenter offered general encouragement to the child by saying *"Can you tell your mum/dad anything about the picture?"* If the child was still reluctant, the experimenter asked the child some specific questions to elicit some dialogue (for example "*What is the shape of the picture?*"). While this questioning was used for the practice trial, the experimenter avoided using specific questions for the test trials. Once the child had made an attempt at describing the picture and the caregiver had drawn a shape, the experimenter asked the caregiver to show the child what they had drawn. The child was then asked by the experimenter if there was anything else their caregiver could draw to make their picture look more like the picture on the card. If the child answered in the affirmative, they were encouraged by the experimenter to tell their caregiver more about the picture. Once the child was happy that the picture was correctly drawn by their caregiver, the first test picture, selected at random, was introduced with the experimenter saying, *"Can you tell your mum/dad what this one looks like?"* The same trial termination criterion that was used for the practice trial was used for the main trials (see Figure 4.2).

4.2.4. Coding

4.2.4.1. Standardised tests

The CELF, Raven's and the ToPP were all coded and scored based on the administration instructions in their respective manuals. The ToPP and Raven's provided a raw score for each child, which consisted of each of subsections for the respective subtests added together[32]. For the CELF, the raw scores of the receptive and expressive subtests were separately converted into standardised scores. In addition, these separate subtest scores were added together to give a total standardised score for each child.

4.2.4.2. Picture description task

All speech produced by the child, the caregiver and the experimenter was transcribed. All gestures by the child and the caregiver were coded according to the gesture categories outlined by McNeill (1992, 1998). Hand movements that were not communicative (e.g., manipulation of objects) were not classified as gestures. To be classed as communicative, there had to be an attempt by the child to transfer meaning to another person (either the experimenter or the caregiver).

Beats - were classed as small, often bi-directional movements by the child or caregiver which added emphasis to their speech.

Conventional gestures – were gestures where the form and meaning have been established by specific groups or communities (McNeill, 1998), for example holding up the index finger to represent the number one.

Deictic gestures – were gestures that pointed out some concrete element in the environment, either to request an action on that object or to draw attention to it. If the

[32] The maximum possible score for the ToPP was 34; for Raven's 36.

Figure 4.2: Video still of picture description task

gesture appeared to show the position of the object, relative to other features of the object, but contained no information about the shape of the object itself, these were classed as deictic.

Iconic gestures - the hand movement or position resembled a feature of the picture or the event being described (for example the hand moving up and down to represent a long line). These included gestures that took the form of the child 'drawing' a feature of the object of interest in the gesture space in front of them (Kita & Davies, 2009). Gestures where children drew with their finger on a blank piece of paper that the caregiver was due to draw on were classified as iconic because although the positioning of the gesture was different, these gestures were deemed to have the same properties as gestures that were positioned in the space in front of the child. If a child did a gesture that showed the position of the object but it also had a movement which indicated the shape of the object, these were classed as iconic.

Finger traces – this gesture category was created after piloting found that children often placed their hand on the picture cards while performing the task. These gestures were hand movements used by the child, which moved over the stimulus cards which were deemed not to be deictic. These gestures were not classed as iconic as it was unclear whether the child intended to convey any meaning about the object to the caregiver (who could not see the picture card). Moreover, when the child traced the picture card when speaking about the picture, these were conservatively categorised as finger traces as it was unclear whether the child was actually representing the object through gesture or if this was a lower level sensorimotor reaction to the picture being in close proximity (see Table 4.3 for examples of each gesture type).

4.2.5. Reliability and statistical analyses

In order to test intercoder reliability of the above gesture categories 11% of the videos were coded by a second coder, who was blind to the aims and questions of the study. We found that overall agreement was good, with a Cohen's *kappa* = .834 (88% agreement).

As there was likely to be high variability in children's talkativeness during the task, and the main focus of the present study was children's iconic gesture production, the gesture measure adopted to explore gesture's relation to other forms of symbol use was the *proportion of iconic gestures* (Mayberry & Nicoladis, 2000; Nicoladis, 2002). This measure gives information about the prevalence of iconic gestures as a function of overall gesture use.

4.3. Results

4.3.1. Screening

In order to verify that differences in performance were not simply due to differences in testing environments (home setting versus lab), we first screened the location data for differences between groups. Independent samples t-tests (lab vs home) revealed no significant differences between the two groups on any of the standardised measures (all $p > .05$). For the gesture measures, Mann-Whitney tests showed that there were no significant differences between location groups for the total number of iconic gestures ($U = 212.5$, $z = -.49$, $p > .05$), words to gesture ratio ($U = 159$, $z = -.95$, $p > .05$) or

Table 4.3: Example of each gesture type coded for in picture description task

Gesture type	Example
Beat	Child lifts then lowers hand when saying "yes"
Conventional	Child sticks up one finger after being asked "how many lines?"
Deictic	Child points and says "put a triangle on mummy"
Iconic	Child sweeps hand in front of them indicating the shape of a picture
Finger traces	Child follows lines of picture on the stimulus card with finger

proportion of iconic gestures (U = 205, z = -.232, p > .05). An independent samples t-test showed no significant difference according to location in the total number of gestures produced (t(47)= .45, p > .05). As there were no significant differences found on any of the measures collected, the data was collapsed across location groups for subsequent analysis.

We also screened for whether the gestures of the caregivers during the picture description task was related to the iconic gestures produced by the children. There was no significant correlation found between the number of iconic gestures per utterance by the children or by the caregivers (r = .13, p > .05), or between proportion of iconic gestures by the caregiver and the child (r = .10, p > .05). This suggests that children's iconic gesture in this task was not influenced by the iconic gesture production of the caregiver.

4.3.2. Research question 1: Play-speech relations

To investigate whether there is an association between children's pretend play capacities and their verbal language development in the preschool years, the CELF and ToPP data were analysed. Table 4.4 shows the means and ranges for the two CELF subtests, the total CELF score, the ToPP score and the non-verbal intelligence (Raven's) scores.

Table 4.4: Means and standard deviations for the standardised tests

Standardised test	Mean	SD	Range
CELF (receptive)	10.57	3.11	5-17
CELF (expressive)	10.18	2.62	6-17
CELF (total)	20.39	5.19	10-33
ToPP	17.73	4.84	8-29
Raven's	11.07	3.13	3-18

Pearson's partial correlations controlling for Raven's showed significant associations between the children's ToPP score and receptive CELF score (r = .39, p = .011), expressive CELF score (r = .33, p = .032) and total CELF score (r = .38, p = .011), with children who scored highly on the CELF also scoring highly on the ToPP. Receptive CELF scores accounts for 15% of the variance shown in ToPP score, while expressive CELF and total CELF account for 11% and 14% respectively.

4.3.3. Research question 2: Speech- gesture relations

To address whether there is a relation between children's use of gesture and their abilities in speech, proportion of iconic gestures was used. Overall 46% of the iconic gestures were performed in space (total 186) while the remaining 54% (total 216) were gestures where children traced a feature of the picture on a blank piece of paper. Out of the 186 'airborne' iconic gestures, 19 (10%) occurred without speech.

Table 4.5: Examples of gesture production during picture description task

Example 1	*MOT:	That line, down like that?
	*CHI:	Yeah, (a line down there)
		Iconic: index finger moves down
Example 2	*MOT:	I've drawn a straight line so far
	*CHI:	There (is a big one, so), mummy (have to draw a little) one [1] [2]
		[1] Deictic: points to picture [2] Iconic: finger moves up and down rapidly

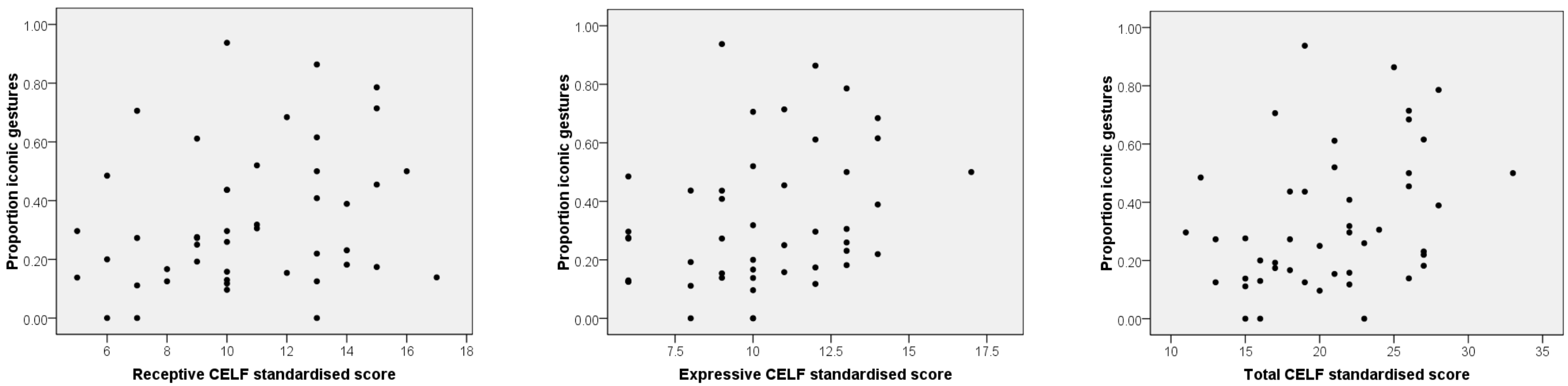
Out of 216 'finger draw' iconic gestures, 53 (25%) were without speech (see Table 4.5 for examples of iconic gestures). The amount of 'gesture only' airborne iconic gestures did not correlate with either mean length of utterance (MLU, calculated by dividing the total number of morphemes produced by the total number of utterances, $r = -.13$, $p > .05$) or total CELF score ($r = .01$, $p > .05$). This pattern of results was also found for the 'gesture only' finger draw iconic gestures for MLU ($r = -.64$, $p > .05$) or total CELF score ($r = .14$, $p > .05$), suggesting that there is no difference in which form of iconic gesture children produce depending on their linguistic ability. The 'airborne' and 'finger draw' iconic gestures were therefore collapsed for further analyses below. Overall, 33% of the total gestures produced during the gesture elicitation task were iconic (either 'airborne' or 'finger draws'; SD = 24%; see appendix 4 for descriptive statistics of other gesture measures[33]).

Using Spearman's partial correlations (controlling for Raven's), a non- significant correlation was found between proportion of iconic gestures and the receptive CELF scores ($r = .22$, $p = .16$), a marginally significant correlation with the expressive CELF scores ($r = .29$, $p = .053$) and a significant correlation with the total CELF scores ($r = .33$, $p = .029$)

[33] None of these additional gesture measures correlated significantly with any of the three CELF measures (all $p > .05$).

(see Figure 4.6). Proportion of iconic gestures accounts for only 5% of the variance in receptive CELF score, but accounts for 8% of the variance shown in expressive CELF score and 11% of the variance for total CELF score.

Figure 4.6: Scatter plots for proportion iconic gestures and three CELF measures



4.3.4. Research question 3: Gesture- pretend play relations

In addressing our first two research questions we have established a relation between speech and pretend play and between children's iconic gesture use and speech. To address the third research question of whether all three symbolic abilities are related, we explored whether children's pretend play abilities were related to their iconic gesture use. Spearman's rank order correlations (controlling for non-verbal intelligence, Raven's), showed that there was a trend suggesting a relationship between the ToPP score the proportion of iconic gestures ($r = .27$, $p = .091$), suggesting that children's iconic gesture use is linked to their pretend play behaviour[34]. Thus proportion of iconic gestures accounted for 7% of the variance shown in ToPP score.

4.4. Discussion

The aim of the present study was to investigate whether three abilities that make use of symbols (speech, pretend play and gestures) were related in the preschool years. This was in order to investigate the potential for these three abilities to be explained by a single underlying capacity to represent symbols (Deacon, 1997; Piaget, 1962; Vygotsky, 1978; Werner & Kaplan, 1963).

There were three main research questions addressed in the present study. First, we asked whether symbolic representation in one domain (pretend play) was related to that in another domain (speech) by 3 years of age, when both domains are increasing in complexity. This followed previous work that established such a link at earlier ages (Bates, et al., 1989; Charman, et al., 2000; Lyytinen, et al., 1999; McCune-Nicolich, 1981; McCune, 1995; Tamis-LeMonda & Bornstein, 1994; Ungerer & Sigman, 1984). Second, we asked whether children's spoken language abilities were related to their gestural abilities at 3 years of age, as previous research has identified the gestural modality as making an important contribution to the overall language system in adults

[34] There was no significant partial correlation between the ToPP score and the total number of gestures ($r = .12$, $p > .05$).

and children (Capirci, et al., 2005; Capirci & Volterra, 2008; Capone & McGregor, 2004; Goldin-Meadow, et al., 2007; Iverson & Goldin-Meadow, 2005; Mayberry & Nicoladis, 2000; McNeill, 1992; Nicoladis, et al., 1999; Stefanini, et al., 2009; Stefanini, et al., 2008). In particular we were interested in children's use of iconic gestures, which can represent entities symbolically. Third, we asked whether there was a relation between these three symbolic abilities (pretend play, speech and gesture) concurrently by investigating the relation between gesture and pretend play. We investigated these questions by testing preschool children on a number of standardised measures designed to assess their current levels of symbolic representation in pretend play and speech. These measures were coupled with an assessment of their non-verbal ability and a task designed to elicit gestures. Importantly, in all of our analyses we partialled out any contribution of non-verbal aptitude to the children's performance, thus our findings relate specifically to children's symbolic representational skills.

The first research question investigated the potential for a relation between pretend play and speech. We found consistent evidence to suggest that there is a relation between these two symbolic domains beyond the second year. A significant association was present between scores on the ToPP and all three of the CELF scores.

The present research then provides evidence in favour of the theoretical perspective that places both speech and pretend play as two behavioural manifestations of the same underlying symbolic cognitive system (Piaget, 1962; Werner & Kaplan, 1963). This perspective has been influenced by the definition of 'symbol' itself. Peirce (1955) highlighted the arbitrary relation between the form of the symbol itself and what it actually stands for. For object play and speech, the developing understanding of this arbitrary relation appears to be prominent. From a young age, children appear capable of using vocal labels for an ever increasing number of objects through words whilst at the same time they are capable of using one object to represent another object that bears no physical resemblance to it (e.g., pretending a block is a car). However, particularly in later years different demands are placed on the child in these two domains. For preschool children, speech moves beyond using single words to label objects and events towards a greater reliance on multiword utterances which requires a greater understanding of grammatical rules and pragmatics. For pretend play, children have to maintain many representations at once and to combine them in a way that does not violate the play scheme that has been previously introduced (Wyman, et al., 2009a, 2009b). It may be the case that the associations found in the present study are indicative of a mutual symbolic system that is about to diverge and be influenced by other general cognitive capacities (Charman, et al., 2000; Karmiloff-Smith, 1992). In ongoing work we are reassessing the same sample of children approximately six months and a year later with the aim of investigating the play- speech relation developmentally. If the same underlying symbolic system maintains its influence over both pretend play and speech, we would expect to find a similar pattern of results found in the present study at later developmental stages. However, if different cognitive influences are shaping the developmental pattern of speech and play separately in later preschool years, we may expect to find that CELF scores are related over time, and that ToPP scores are related over time, but that the relation between ToPP scores and CELF scores diverges.

The second research question aimed to investigate the relation between speech and children's gesture use in the preschool years. The focus of the present study was on iconic gestures, which have been identified as representing a semantic or imagistic element of the ongoing speech. Our picture description task successfully elicited a high number of gestures from the children. It was found that the proportion of iconic gestures produced by the children was related to their total CELF scores. In addition, proportion of iconic gestures was significantly correlated with both the expressive CELF and the total CELF score. These findings suggest, in line with some earlier work on gestures, that iconic gesture use is inextricably linked to linguistic development generally (Mayberry & Nicoladis, 2000; Nicoladis, 2002; Nicoladis et al., 1999; Ozcaliskan &

Goldin-Meadow, 2011). However, if this was the case, we may have also expected to find a significant relation between the words per iconic gesture measure and the CELF scores, reflecting the expectation that as children attempt longer utterances to perform the task, they will supplement these utterances with a richer stream of iconic gestures (Nicoladis et al., 1999). It may be that the demands of the picture description task itself influenced these findings. As the pictures were static (not dynamic video as in classic examples of gesture elicitation tasks, see McNeill, 1992) a high proportion of the gestures observed in the task took the form of 'air finger draws' or 'paper draws'; children drawing the shape of the object with their finger in the air or on a blank piece of paper. These gestures were classified by Ekman and Friesen (1969) as pictographic gestures, which was one of three main iconic gesture types they defined (the others being spatial movement gestures and kinetographic gestures). It may be the case that children were inclined to produce these gestures in the absence of speech, meaning that the speech-gesture relation was weakened.

Comparing the proportion of iconic gestures between adults (Mayberry & Shenker, 1997) and 3 ½ year old children (Nicoladis et al., 1999) Mayberry and Nicoladis (2000) found that adults use a significantly higher proportion of iconic gestures in comparison to preschool children. We may then expect to find longitudinally that children's gesture-speech system becomes more organised at later time points and hence more 'adult like'. This would express itself developmentally as an increase in the proportion of iconic gestures that children use over time (as McNeill, 2005 termed the 'gesture explosion'). We are currently investigating this idea by giving the sample of children the same picture description task six and twelve months after the initial visit.

Finally, the third research question asked whether the observed association between speech and pretend play, and iconic gesture use and speech was indicative of all three abilities being influenced by a mutual cognitive capacity. This was predicted on the basis of the early link between pretend play and speech and between speech and gesture at the computational and conceptualisation levels (Kita & Ozyurek, 2003; Kita, et al., 2007; McNeill, 1992). The present study found a third marginally significant association between children's propensity to represent objects through pretend play and their capacity to represent entities through representational iconic gestures. Importantly, this relation was linked specifically to children's production of iconic gestures, which have been identified as having symbolic properties (McNeill, 1985), rather than children's overall gesture production. Taken together with the associations between speech and pretend play, and speech and iconic gesture, this suggests that all three abilities may be related on the basis of a shared cognitive mechanism. These associations found are reasonably strong (J. Cohen, 1988). However, as we speculated above, pretend play and language may diverge at later time points as different cognitive demands and considerations take hold. If iconic gesture use maintains or strengthens its relation to speech scores over time but loses its association with pretend play scores, it will be evidence in favour of both the strengthening link between representations in the vocal and gestural domains and also the weakening of the common symbolic bond between symbolic representation displayed by play and language.

4.5. Conclusions

The current study is a first attempt to analyse three domains concurrently (pretend play, speech and gesture) that become increasingly prevalent in children's everyday behaviour. For preschool children, pretend play is an ever-expanding opportunity to create scenarios, to symbolise and to represent others. The current study provides evidence that for 38 to 40 month olds, this pretence behaviour is tightly coupled with speech. In addition, speech appears to have some relation to gesture use, in that children with more advanced symbolic abilities in speech are also more able to represent iconically through gesture. However, future research is required in order to test these findings over developmental time. If a general symbolic ability is underpinning the advancements observed in all three of these symbolic domains, we would expect to find similar patterns of improvement across domains in later years.

Chapter 5: Empirical Paper Two

The first paper of this thesis extended previous research on the development of symbolic abilities in children in two main ways. First, the paper analysed a sample of three year old children, who were beginning to use symbols in a more complex manner, for example, by using increasingly sophisticated speech streams to communicate, and combining play schemes using multiple objects or maintaining a number of pretend worlds (Skolnick & Bloom, 2006; Wyman, et al., 2009b). Second, it took a bi-modal view of language that had not previously been assessed in this field. In particular, *iconic* gestures are thought to have a symbolic status (McNeill, 1985, 1992), and this gesture category formed the principal measure of children's symbolic representation through the non-verbal modality of language.

The first paper investigated whether three abilities that have been linked to children's underlying symbolic representational skills (pretend play, speech and gestures) in the second year of life were related in children aged 3;3 years. Significant pairwise correlations between a measure of pretend play (ToPP) and receptive and expressive speech (CELF) were found, in addition to a significant correlation between a measure of children's symbolic gesture production (proportion of iconic gestures relative to other forms of gesture) and speech abilities. In addition, a third marginally significant correlation between ToPP and proportion of iconic gestures was observed. Importantly, these relations were found when children's non-verbal capacities were controlled (using Raven's Coloured Progressive Matrices).

This series of concurrent relations between the three symbolic measures supports previous research that has suggested that children's expressions of symbol production are indicative of a mutual underlying cognitive capacity to represent symbols (Bergen, 2002; Lewis, et al., 2000; Lyytinen, et al., 1999; Ungerer & Sigman, 1984). Previous studies had identified relations between children's earliest linguistic productions and their emerging pretend play skills. A limitation of the first paper is that the relations established between the three measures provide only a ‘snapshot’ of children’s symbol use and understanding at a particular time on a particular day. Although the study is suggestive of a continuing link between symbolic domains beyond their initial emergence, it is not certain whether the relations between measures are mediated by a central ability. Previous research has found the dual links between pretend play and speech (e.g., McCune, 1995) and between speech and iconic gesture production (e.g., Nicoladis, 2002). It is still a possibility then that the relation found in the previous paper between pretend play and iconic gestures is determined not by children’s general symbolic capacities but is evidence of their mutual relation to speech production. A longitudinal study using the same sample of children is important as it will reveal any directional predictive effects that one measure may have on another. For example, in section 2.2 of this thesis, I assessed research that found that children’s abilities to extend pretense through speech was related to social pretend play success. It is a possibility that there is a particular directional effect between these two measures; that pretend play at later phases is predicted by earlier speech abilities but not the other way around. This would suggest that the relations observed between pretend play and speech in the first paper are not due to an underlying symbolic ability but due to the mediating role that one ability (speech) has on the success of another (pretend play). With regards to iconic gesture production and its relation to speech, if the iconic gesture measure makes a significant predictive relation to speech scores at later testing phases *over and above* the contribution made by earlier speech scores (and vice-versa), then it would imply a general symbolic capacity is influencing development in these measures. However, if this predictive effect is not found, but concurrent relations are consistent, it would suggest that children’s iconic gesture production is not a function of general symbolic abilities but it in fact *paced* by children’s development in the spoken domain.

To examine this possibility, the following paper will report data from the same sample of children on the same measures that were obtained in the first paper (age 3;3

years) at six and twelve months after initial testing. This will extend the findings of the previous paper in two ways. First, it will assess the stability of the measures obtained between testing phases, and will investigate whether the pattern of correlations observed at phase 1 (3;3 years) are also observed at testing phases 2 (3;9 years) and 3 (4;3 years). This is important to establish as it would provide further evidence for concurrent relations between the three symbolic domains. Second, it is possible to perform analyses to establish whether earlier measures of symbolic abilities make a significant contribution to later test scores. For example is the ToPP score at testing phase 2 significantly predicted by the ToPP, CELF score and proportion of iconic gestures at phase 1? If CELF score and proportion of iconic gestures at testing phase 1 make a unique, individual contribution to the ToPP at testing phase 2, above and beyond the contribution made by ToPP at phase 1 then it would be further evidence in favour of the view that these three abilities are linked by a shared cognitive capacity to represent symbolically (Piaget, 1962; Werner & Kaplan, 1963).

This paper is currently in preparation for submission to a relevant journal and is co-authored by Simon Child, Anna Theakston and Simone Pika.

Paper two: Symbolic relations during the fourth year: A longitudinal investigation

5.1. Introduction

Human beings appear unique in their capacity to utilise symbols in their day-to-day activities (Deacon, 1997). Although there is much debate about the definition of a symbol (e.g., Deacon, 1997; DeLoache, 1995; Peirce, 1955) it is widely agreed that humans are able to represent symbolically in a number of domains including but not limited to their vocalisations, their actions with objects and through the use of gestures. For children, the interpretation and production of symbols forms a crucial part of their everyday interactions with their caregivers (Bruner, 1975a; Vygotsky, 1978). From around 18 months, children appear capable of using symbols to represent events, objects and actions, even when the object of interest is no longer present in their environment (Gallagher & Reid, 1981; Piaget, 1962). According to Piaget (1962) this behaviour is one of the first signs of representational thinking, and is manifest in children's language and pretend play.

Pretend play (or 'symbolic play', Bornstein & Tamis-LeMonda, 1995; Fiese, 1990; Lang et al., 2009) is defined as the intentional projecting of a counterfactual situation onto an actual one for the purpose of fun rather than for survival (Lillard, 1993a, 1993b). Three main forms of pretend play have been identified (Baron-Cohen, 1987; Leslie, 1987; Lewis, et al., 2000): (1) object substitution (e.g., representing a block as a dog), (2) reference to an absent object (e.g., eating cereal from a bowl which does not have any cereal inside), and (3) attribution of symbolic properties (e.g., pretending that a teddy bear is happy). It has been suggested that when children act symbolically in these ways, they are expressing an understanding that an object can have two levels of representation (DeLoache, 1995; DeLoache & Burns, 1994). First, an object has a function for which it was designed, for example, a cardboard box is an object that can be manipulated to put objects inside of it. Second this 'standard' function of the object can be ignored when in a pretence context and *any* object can be utilised to represent *anything* the child desires; the properties of the object they are engaging with (e.g., its shape or what it looks like) do not dictate the possibilities of what the child may use that object for in a pretense scenario (Saussure, 1969).

Symbolic understanding is also important for speech development (Bialystok, 2000). While the relation between the signifier and signified is not constrained in pretend play (in principle anything could 'stand in' for anything else), speech is constrained by the formal linguistic conventions established by the cultural environment. For example, to learn how to represent a fluffy animal with a tail through speech, a child must learn the specific arbitrary symbolic relation between the animal and the symbol itself (e.g., dog), through an understanding that symbolic meaning is contained in the speech that they hear.

Theorists have argued that the emergence of pretend play and speech are the result of an underlying capacity to represent symbolically. Piaget (1962) argued that pretend play was an early indicator (along with deferred imitation) of the transition to the preoperational stage (Gallagher & Reid, 1981). Thus, in order to represent symbolically children have to be able to remove themselves from their sensorimotor perceptions and consider objects that are not immediately perceptible. Other researchers have suggested that the development of symbol production abilities results from underlying social-cognitive advancements that enable children to interpret the communicative intentions of others (Liszkowski, 2011; Tomasello, 1999). For example, previous research has found relations between children's ability to engage others in triadic interactions and their subsequent abilities in pretend play (Leslie, 1987; Rutherford, et al., 2007) and word learning (Charman, 2003; Tomasello & Farrar, 1986).

These perspectives on symbol formation in children are domain-general, in the sense that one emerging cognitive capacity influences the concurrent development of children's use of symbols irrespective of the medium (Goswami, 1998; O'Toole & Chiat, 2006). In previous research this has led to the hypothesis that children's abilities in pretend play should be closely matched to their development in speech. McCune (1995) found that children's first word combinations coincided with their first attempts to combine play acts, while Ungerer and Sigman (1984) found that children who participated in pretend play at 13 months had higher speech scores at 22 months than those who did not (see also Charman, et al., 2000; Lewis, et al., 2000; Lyytinen, et al., 1999). Further evidence for a link between pretend play and speech comes from research on children with autism and Down syndrome (Jarrold, 2003; Kasari, Freeman, & Paparella, 2006; Kasari, et al., 2008; O'Toole & Chiat, 2006; Ungerer & Sigman, 1981). O'Toole and Chiat (2006) for example found that pretend play and language scores were correlated when age was controlled for in a sample of children with Down syndrome, while Kasari et al. (2008) found that children with autism who were given an intervention that involved attempts to involve them in pretend play showed significant improvements in their post-intervention language scores.

The research described above provides evidence to support the view that the symbolic abilities shown by children are indicative of a common underlying representational ability (Piaget, 1962; Werner & Kaplan, 1963). However, there are two main limitations to this body of research. First, these studies only investigated the relations between speech and pretend play in the first two years. Beyond this age, children show increasing competence with both pretend play and speech, using them to create increasingly complex pretence scenarios (Goncu, 1993; Goncu & Kessel, 1988; Howe & Bruno, 2010; Howe, et al., 2005). The relations between these two abilities beyond their emergence are still unclear. Second, by investigating the link between pretend play and *speech* in the first two years, the previous studies have neglected a second communicative modality (gesture), which has been identified as being closely linked to speech production in adults (Kendon, 2004; Kita & Ozyurek, 2003; McNeill, 1992, 2005). According to McNeill (1992), gestures can be split into four main categories: beats, deictic gestures, conventional and iconic gestures. Iconic gestures form some sort of resemblance to what is being spoken about (e.g., providing information about the speed of a descent), and thus it has been argued that iconic gestures are symbolic because they are “analysable as paired signifiers and signifieds” (McNeill, 1985, p. 352). The gesture represents the speaker’s memory of the event or object being depicted (however see Hostetter & Alibali, 2008; Kita & Davies, 2009; Kita & Ozyurek, 2003 for alternative accounts). These gestures begin to be produced at approximately the same time that children begin to produce pretense acts and multiword speech. Any research then that aims to analyse the potential for speech and pretend play to be explained by an underlying core symbolic representational ability should also consider children’s iconic gesture production.

Child, Theakston and Pika (Submitted) attempted to address this issue by assessing the abilities of children aged between 3;2 years and 3;4 years in pretend play, speech development, gesture, and non-verbal reasoning. The main aims of the study were to determine whether the concurrent relations observed between speech and pretend play at the emergence of these behaviours in the second year could also be observed in the later preschool years, and to extend this line of enquiry to consider the gestural modality of language. They found that children’s symbolic abilities in speech, gesture, and pretend play were all related, even when children’s non-verbal reasoning abilities were taken into account. These findings suggest that the relations between pretend play, speech and gestures observed in younger children (Lewis, et al., 2000; Lyytinen, et al., 1999; McCune, 1995) were also present in an older sample of children. At first glance this would seem to provide support for the theoretical perspective that all three abilities share the same underlying cognitive capacity. However, by three years of age there are a number of possible influences on children’s symbolic production. For speech, children have to learn a range of complex syntactic constructions and the pragmatics that govern choice of referring expression, both of which are associated with the language children are exposed to (Diessel, 2004; Matthews, Lieven, & Tomasello, 2007). For pretend play, children have to combine play schemes without violating the 'rules' of the current pretence scenario (Wyman, et al., 2009a, 2009b). The possibility remains that other cognitive influences may affect children's developmental progress in these domains beyond the initial emergence of these abilities.

One possible interpretation of the Child et al. findings is that children's skills in these symbolic areas, although related at 3 years of age, are about to diverge, and hence will become disassociated as different cognitive demands take hold on each means of symbolic expression (Charman, et al., 2000; Dixon & Shore, 1993; Karmiloff-Smith, 1992). The aim of the present study was to shed further light on the *concurrent* relations found between different domains of symbolic ability by observing the changes in these relations *longitudinally*, in the same sample of children reported on in Child et al. (Submitted), up to a year after initial testing. A longitudinal method has the advantage of being able to determine the stability of the measures across time, as well as determine causal relations between them (Card & Little, 2007; Rutherford, et al., 2007).

We investigated two research questions:

(1) Are the concurrent correlations between children's abilities in pretend play, speech, and iconic gesture production found at 3;3 years replicated at 3;9 and 4;3 years of age? We predicted that if the same underlying symbolic capacity maintains its influence over development between 3-4 years, we would find a similar pattern of *concurrent* correlations at ages 3;9 and 4;3 to those found at age 3;3.

(2) Do symbolic abilities at earlier ages have a significant relation to symbolic abilities at later ages? Evidence of concurrent relations would suggest that the relations observed in children in at 3;3 years are maintained throughout the fourth year. However, we would also expect to find a particular pattern of predictive relations between the three symbolic abilities across developmental time. First, as the measures are expected

to show stability in terms of individual differences (Bretherton & Bates, 1984; Card & Little, 2007), we would expect to find longitudinal correlations and predictive relations between children's abilities on a given measure at 3;3 years and their subsequent abilities on that same measure at 3;9 and 4;3 years. For example, measures of children's speech at 3;3 years should correlate significantly with these same measures at 3;9 and 4;3 years. Second, if there is a mutually shared symbolic ability underlying children's performance in all three modes of symbolic expression, the *other* symbolic measures at the earlier testing phases should be reliable predictors of a given ability over and above the influence of the *equivalent* measure at that same earlier time point. For example, measures of children's speech at 3;9 years should be significantly predicted not just by their speech score at 3;3 years, but also by their abilities in pretend play and iconic gesture production at 3;3 years. Alternatively, there may be a changing relation between these measures across developmental time. For example in school-age children, pretend play success has been attributed to the ability of children to negotiate roles and maintain play themes with play partners (Farver, 1992; Goncu, et al., 2002; Howe, et al., 2005; Howes, et al., 1989). This changing relation may reveal itself in the predictive patterns shown between 3;3 and 3;9 years, compared to 3;9 and 4;3 years.

5.2. Method

5.2.1. Participants and recruitment

The children who took part in the current longitudinal study were recruited from the same sample of 49 children who participated in the first phase of testing at between 3;3 years of age (see Child et al. (Submitted) for full details). The caregivers were recruited by using the University of Manchester Max Planck Child Study Centre database, via letters distributed through local nurseries, through posters placed in and visits to local play centres, and via an advertisement in a local parents' magazine. The children were monolingual and had a typical developmental history, as determined by a short screening questionnaire administered to caregivers when they expressed an interest in participating. 70% of caregivers were educated to at least degree level, 79% were employed at the time of initial testing.

47 caregiver-child dyads were retained for the second phase of the study (21 girls; 26 boys) and were tested approximately six months after the initial testing date (three weeks either side of the six-month date). The children ranged in age between 3;8 and 3;10 years of age (Mean = 3;9).

46 caregiver-child dyads were retained for the third and final testing phase (21 girls; 25 boys) and all were tested within three weeks either side of the date twelve months after the initial testing date. The children ranged in age between 4;2 and 4;4 years (Mean = 4;3).

5.2.2. Materials

As for the first testing phase, the second and third testing phases of the longitudinal study used three standardised tests to assess each child's current level of development. These were the Test of Pretend Play (ToPP, Lewis & Boucher, 1997), the Clinical Evaluation of Language Fundamentals- Preschool 'quick test' (CELF, Wiig, et al., 2000) and Raven's Coloured Progressive Matrices (hereby referred to as Raven's, Raven, 2004). In addition to the standardised tests, we used a Picture Description task designed to elicit gestures. Further details of these tasks can be found in Child et al. (Submitted) and a summary of each task is given below.

For the ToPP, children were given the structured version of the test, which is designed to identify children's ability in three forms of pretend play identified in the literature (Baron-Cohen, 1987; Leslie, 1987; Lewis, et al., 2000); object substitution, property attribution and reference to absent objects.

The CELF consists of two subtests. One assesses children's receptive speech ability, while the other assesses children's expressive speech ability. Combining the two standardised scores together gives a third overall standardised language measure.

Raven's consists of thirty six trials. For each trial the child is presented with a picture which has a piece missing from it. The child's task is to choose the correct piece (from an array of six) that completes the picture.

The picture description task consisted of five geometric shapes presented in a random order to the child. The child's task was to describe each picture, so that their caregiver could draw it on a piece of paper.

5.2.3. Procedure

Children were tested either at their homes or at the laboratory at the University of Manchester, determined by the preference expressed by the caregiver at the recruitment stage. Data collection for all of the phases was performed at the same location (phase 2 - 13 laboratory, 34 home; phase 3 - 13 laboratory, 33 home). Home testing took place in the main living space of the home which was cleared of distractions. The order of administration of the tasks was the same at each developmental point, with the picture description task first, followed by the CELF, Raven's and finally the ToPP. This was to ensure maximum comparability between the scores for each test, as children were likely to have similar levels of concentration for each task across testing phases. As the testing took around two hours in total, children were regularly asked if they would like a break. If the child was showing signs of fatigue, testing was stopped and then continued no more than two weeks after the date the testing phase began. This occurred four times during the second testing phase and twice in the final testing phase.

For the standardised instruments, the specific instructions were closely adhered to. During these tests each child sat on age appropriate seating and caregivers were able to observe the testing taking place but were asked not to provide any instruction.

For the picture description task children sat on age appropriate seating, opposite their caregiver who was handed a piece of paper and pen. A video-camera was placed so that all participants in the task could be seen. The experimenter sat next to the child and introduced the game to them as a “describing game”. The experimenter then gave the child the practice trial card. After the child had made an attempt to describe the picture to their caregiver, the caregiver was asked to show what they had drawn to the child. The experimenter then asked if anything more needed to be done to make the picture look the same as the card. If the child answered in the affirmative, they were encouraged to tell their caregiver more about the picture. If they responded negatively, then the practice trial was completed and the test trial pictures were introduced individually. The same trial termination criterion (i.e., the child’s satisfaction with the picture drawn by the caregiver) was used for the test trials.

5.2.4. Coding

The standardised tests were scored according to the criteria in their respective manuals. In the gesture elicitation task, all speech produced by the child, the caregiver and the experimenter was transcribed. All gestures produced by the child and the caregiver were coded according to the gesture categories outlined by McNeill (1992, 1998). Iconic gestures could take two main forms. ‘Airborne’ gestures were when the child performed an iconic gesture in the space in front of their body, while ‘finger draw’ iconic gestures comprised a hand movement which depicted a property of the picture being described but on the piece of paper the caregiver was holding. Hand movements that were not communicative (e.g., manipulation of objects) were not classified as gestures (see Table 5.1 for gesture categories). To be classed as communicative, there had to be an attempt by the child to transfer meaning to another person (either the experimenter or the caregiver).

5.2.5. Reliability

In order to analyse intercoder reliability of the gesture categories for each of the testing phases, 11% of the videos from each of the three testing phases were coded by a second coder, who was blind to the aims and questions of the study. Overall agreement was good for both phase 2 (Cohen's *kappa* = .82; 84% agreement) and phase 3 (Cohen's *kappa* = .82; 87% agreement), similar to the levels of agreement established for phase 1 (Child, et al., Submitted). The percentage agreement for initial identification of gestures was 90% across all three testing phases.

5.3. Results

5.3.1. Screening

To verify that any differences found were not due to differences in testing location (home versus laboratory), each of the standardised and gesture measures were screened for differences between testing locations. There were no differences found for either the standardised measures or the gesture measures during testing phases 2 or 3 (Mann Whitney- U; all $p > .05$), thus the data from both locations was combined for subsequent analysis.

It was also necessary to screen the utterances produced during the picture description task to make sure that children were not showing differences between the phases for their general 'talkativeness'. There was a marginally significant difference in the number of utterances children produced during the picture description task between testing phases ($F(2,82) = 2.56$, $p = .083$). Children in the first phase of the study spoke a mean of 53.66 utterances during the picture description task (SD = 27.87), while children in the second and third phases spoke a mean of 56.74 (SD = 23.04) and 49.07

Table 5.1: Example of each gesture type coded for in picture description task

Gesture type	Example
Beat	Child lifts then lowers hand when saying "yes"
Conventional	Child sticks up one finger after being asked "how many lines?"
Deictic	Child points and says "put a triangle on mummy"
Iconic (airborne)	Child sweeps hand in front of them indicating the shape of a picture
Iconic (finger draw)	Child uses finger to draw shape on paper
Finger traces	Child follows lines of picture on the stimulus card with finger

(SD = 15.25) utterances respectively. This indicates that over the course of the study, children did not show any systematic change in their 'talkativeness' during the picture description task. A similar pattern was found with regards to caregiver's total utterances during the task. The number of utterances the caregivers produced across the three testing phases differed (Kendall's $W = .125$, $p = .005$), with caregivers during phase 3 (M = 48.05, SD = 20.45) producing fewer utterances than in either phase 1 (M = 61.76, SD = 31.82) or phase 2 (M = 61.62, SD = 25.47).

Finally, as the picture description task was collaborative in nature, it was necessary to screen for changes in caregiver's behaviours across the three testing phases. There were no significant differences found across the three phases on the proportion of iconic gestures produced by the caregivers ($F(2,72) = .776$, $p = .453$), the number of iconic gestures produced *per utterance* (Kendall's $W = .01$, df = 2, $p = .799$), or the proportion of utterances that were questions directed at the child ($F(2,82) = .685$, $p = .507$). There was also no significant correlation found between the proportion of iconic gestures produced by the caregiver and child at phase 1 ($r = .10$, $p = .51$), phase 2 ($r = -.08$, $p = .62$) or phase 3 ($r = .19$, $p = .23$). Taken together, these results suggest that caregivers were performing their roles similarly across the three phases, and that there was no significant relation between children's and caregivers' iconic gesture production during the picture description task.

We now turn to the analyses that directly relate to the research questions outlined above.

5.3.2. Research question 1: Are the concurrent correlations at testing phase 1(3;3) replicated at phases 2 (3;9) and 3 (4;3)?

The first step of the analysis addressed whether the concurrent relations found between symbolic measures at 3;3 years are replicated in the same sample of children six and twelve months later. Table 5.2 gives the within-phase partial correlations between measures for the second and third testing phases. These measures were controlled for non-verbal abilities as measured by Raven's.

For children at 3;9 years (phase 2), the partial correlations between the standardised speech measures (CELF receptive, CELF expressive and CELF total) and the pretend play measure (ToPP) were significant. In addition, the correlations between the speech measures and the gesture measure (proportion of iconic gestures) were significant. This contrasts with the phase 1 data, where the relation between iconic gesture production and the *receptive* CELF measure was not significant. The partial correlation between ToPP and proportion of iconic gestures, while marginally significant at 3;3 (phase 1) is not significant at 3;9 (phase 2).

For testing at 4;3 years (phase 3) a similar pattern of results to 3;9 (phase 2) was found. Partial correlations between the CELF measures and ToPP measures were significant, replicating the results at 3;3 and 3;9 years. The correlations between the CELF measures and the iconic gesture measure were also significant at 4;3 years, replicating the correlations found six months earlier at 3;9 years. However, the correlation between the ToPP measure and the iconic gesture measure, while only marginally significant at phase 1 (3;3) and non-significant at phase 2 (3;9), is now significant at phase 3 (4;3).

Table 5.2: Within-phase partial correlations, controlling for non-verbal scores, for second (3;9) and third (4;3) testing phases (* = significant, $p < .05$)

Measure 1	Measure 2	Phase 2 *r*	Phase 2 *p*	Phase 3 *r*	Phase 3 *p*
Receptive CELF	Expressive CELF	.610*	<.001	.733*	<.001
Receptive CELF	Total CELF	.785*	<.001	.829*	<.001
Receptive CELF	ToPP	.374*	.012	.523*	<.001
Receptive CELF	Prop iconic	.314*	.043	.586*	<.001
Receptive CELF	Raven's	.220	.137	.276	.063
Expressive CELF	Total CELF	.892*	<.001	.947*	<.001
Expressive CELF	ToPP	.401*	.008	.507*	.001
Expressive CELF	Prop iconic	.304*	.050	.407*	.007
Expressive CELF	Raven's	.434*	.003	.305*	.042
Total CELF	ToPP	.545*	<.001	.574*	<.001
Total CELF	Prop iconic	.343*	.026	.519*	<.001
Total CELF	Raven's	.390*	.007	.294*	.050
ToPP	Prop iconic	.146	.370	.441*	.040
ToPP	Raven's	.373*	.012	.300*	.050
Raven's	Prop iconic	.193	.216	.252	.990

Note: Correlations involving Raven’s were standard correlations

In summary, a similar pattern of concurrent relations was found at 3;9 years (phase 2) and 4;3 years (phase 3) compared to the initial phase at 3;3 years. For all three phases, speech abilities were significantly correlated with pretend play abilities. There was also a consistent relation at all three phases between children’s production of iconic gestures and their speech scores. However, the final relation between pretend play and iconic gesture production was less consistent across the three testing phases.

The following analysis extends our understanding of the relations between symbolic skills found within the testing phases by addressing whether the measures taken at earlier phases significantly predict later symbolic performance.

5.3.3. Research question 2: Do symbolic abilities at earlier phases predict abilities at later phases?

There are two main parts to this research question. First, it needs to be deduced (a) whether children show any changes in their performance across testing phases (e.g., between receptive CELF score at phases 1, 2 and 3) to establish the stability of the measures over time, and (b) whether children's performance on each individual measure remains consistent in terms of their performance relative to other children. In other words, do children who score highly at 3;3 years also score highly on the same measure at 3;9 years and at 4;3 years?

Second, we need to establish whether the abilities shown at earlier phases *taken together* (speech, pretend play, proportion iconic gestures and Raven's) are a significant predictor of *specific* symbolic abilities, above and beyond the predictive relation shown between the *same* specific measure across phases.

Stability of specific measures across phases:

First we examined the standardised tests for differences between testing phases (see Table 5.3 for means and standard deviations for the measures). As the CELF scores were standardised in relation to age, there should not be any significant changes between the initial testing phase (3;3 years) and the second (3;9 years) and third (4;3 years) testing phases. For all three of the CELF measures there was a significant difference between the initial and second testing phase (receptive CELF; $F(2,90) = 8.40$, $p = .002$, expressive CELF; $F(2,88) = 8.80$, $p = .001$, total CELF; $F(2,88) = 15.17$, $p < .001$), with children scoring significantly higher at 3;9 years (phase 2) than at 3;3 (phase 1). This suggests a practice effect for the CELF measures. However, there were no significant differences in CELF scores between testing phases 2 and 3 (receptive CELF; $t = -1.04$, $df = 45$, $p = .306$, expressive CELF; $t = .00$, $df = 44$, $p = 1.00$, total CELF; $t = -.61$, $df = 44$, $p = .548$).

Table 5.3: Means, standard deviations and between-phase correlations of measures

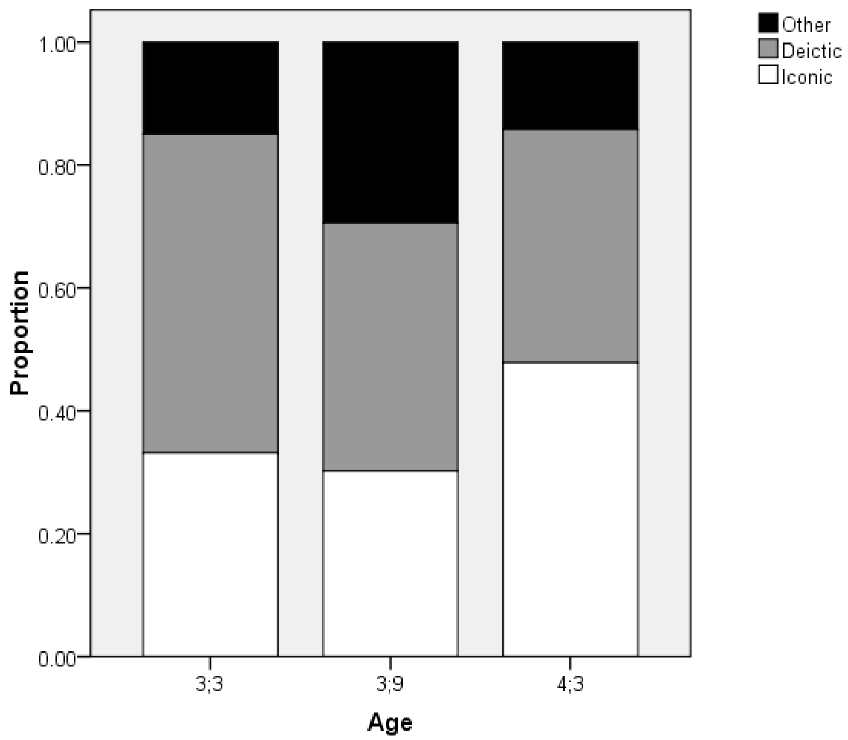
	Phase 1 (3;3)		Correlation (phase 1 and 2)		Phase 2 (3;9)		Correlation (phase 2 and 3)		Phase 3 (4;3)		Correlation (phase 1 and 3)	
Measure	M	SD	*r*	*p*	M	SD	*r*	*p*	M	SD	*r*	*p*
CELF receptive	10.57	3.11	.549*	<.001	11.83	2.43	.766*	<.001	11.55	2.04	.707*	<.001
CELF expressive	10.18	2.62	.710*	<.001	11.15	2.48	.809*	<.001	11.14	2.71	.688*	<.001
CELF total	20.39	5.19	.683*	<.001	22.77	4.46	.902*	<.001	22.69	4.43	.738*	<.001
ToPP	17.73	4.84	.560*	<.001	21.00	3.83	.799*	<.001	23.31	3.73	.553*	<.001
Prop iconic	.33	.24	.013	.935	.30	.17	.563*	<.001	.48	.23	.272	0.074
Raven's	11.02	3.18	.560*	<.001	13.68	3.3	.613*	<.001	15.83	3.04	.277	0.062

As the ToPP score and Raven's were not standardised by age, we expected that their raw scores would significantly increase across time. This was found to be the case for both ToPP (Kendall's $W = .49$, $df = 2$, $p < .001$) and for Raven's (Kendall's $W = .59$, $df = 2$, $p < .001$).

There was a significant difference between phases in the proportion of iconic gestures produced (Kendall's $W = .17$, $df = 2$, $p = .001$). There was no significant difference between 3;3 and 3;9 years (Wilcoxon, $z = -.54$, $p = .587$; phase 1 M = .33, SD = .24, phase 2 M = .30, SD = .17), but there was a significant difference between 3;9 and 4;3 years, with the children producing a higher proportion of iconic gestures at 4;3 than at 3;9 (Wilcoxon, $z = -4.67$, $p < .001$, phase 3 M = .49, SD = .23) and 3;3 (Wilcoxon, $z = -2.99$, $p = .003$, see Figure 5.4). This suggests a general increase in children's *iconic* gesture production as a function of their *total* gesture production over time in the picture description task. In terms of the types of iconic gestures children produced (either 'airborne' or 'finger draws' on a piece of paper), 52% (254) were airborne at 3;9 years (phase 2), with 48% (236) finger draws. At 4;3 years (phase 3), 55% (370) of iconic gestures were 'airborne', with 45% (301) 'finger draws'. These proportions did not differ significantly across the three testing phases ($F(1.65, 61.11) = .865$, $p = .408$).

We also briefly examined the kinds of non-iconic gestures the children produced, to cast light on how symbolic gestures fitted into their overall gesture lexicons. There was a gradual reduction in the proportion of deictic gestures that children produced across the testing phases (phase 1, 53%, SD = 20%; phase, 2 40%, SD = 17%; phase 3, 38%, SD = 18%). A repeated-measures ANOVA found this change to be significant $F(2,82) = 10.08$, $p < .001$, with pairwise comparisons finding a significant difference between phases 1 and the two later phases (both $p < .05$) but no difference between phases 2 and 3 ($p = 1.00$). There was also a difference between testing phases in the proportion of gestures that were *finger traces* on the picture card (phase 1, 12%, SD = 12%; phase 2, 29%, SD = 15%, dropping back to 11%, SD = 13% at phase 3). These differences were significant

Figure 5.4: Proportion of total gestures by gesture type



(Kendall's *W*, for non-normally distributed data = .424, *df* = 2, *p* < .001), with children in the second phase (3;9) performing a significantly greater proportion of finger traces than observed at 3;3 and 4;3. The significance of these gesture types will be addressed in the discussion.

We then analysed whether children's performance on each of the measures of symbolic abilities was stable across time. Table 5.3 shows the between phase correlations. The correlations between the three CELF measures at all of the testing phases remained strong and consistent. This is also the case for the ToPP measure. For Raven's, phase 1 scores are strongly correlated with phase 2 scores and phase 2 scores with phase 3 scores. However, the correlation between phase 1 and phase 3 scores is only marginally significant. For the proportion of iconic gestures measure, there is no correlation found between phases 1 and 2, or 1 and 3, but there is a significant correlation between phases 2 and 3.

This pattern of results transfers into predictive relations between phases (see Table 5.5). For the three CELF measures, children's performance at phase 1 was predictive of their abilities on the same subtest at phases 2 and 3. The same pattern of results was found for the ToPP and Raven's. Scores at phases 2 and 3 were significantly predicted by ToPP and Raven's scores at phase 1 respectively. For proportion of iconic gestures, there was no predictive relation found between phases 1 and 2 or phases 1 and 3, but there was a predictive relation between phases 2 and 3.

Table 5.5: Between-phase regressions for each measure (* = significantly loaded)

	Phases					
	1 and 2		2 and 3		1 and 3	
Measure	R^2	Beta	R^2	Beta	R^2	Beta
CELF receptive	.302*	.549	.587*	.766	.499*	.707
CELF expressive	.504*	.710	.791*	.890	.446*	.668
CELF total	.467*	.683	.814*	.902	.545*	.738
ToPP	.313*	.560	.712*	.844	.443*	.665
Prop Iconic	.000	-.016	.365*	.604	.077	.277
Raven's	.319*	.564	.493*	.702	.144*	.379

Multiple regression analyses:

For the second part of this research question, the simple linear regressions reported in the first analysis were extended to include the additional measures from the earlier phases. For example, for the first analysis we determined that the children's phase 2 total CELF scores were predicted by their phase 1 total CELF scores. For this secondary analysis, phase 2 total CELF scores was again the outcome (predicted) variable, with phase 1 total CELF score included as a predictor variable *with the addition* of the ToPP, Raven's and proportion of iconic gesture measures from phase 1 as further predictor variables. Table 5.6 shows the multiple regressions predicting the phase 2 and 3 measures. For the phase 3 outcome measures this includes separate regressions with predictor variables from phases 1 and 2 respectively, while for phase 2 outcome measures, predictor variables from phase 1 were included.

Table 5.6: Multiple regressions predicting outcome measures with significantly loaded variables

Predictors (Phase 1)			Predictors (Phase 2)			Predictors (Phase 1)	
Outcome variable (phase 2)	Multiple regression R^2	Significantly loaded variables	Outcome variable (phase 3)	Multiple regression R^2	Significantly loaded variables	Multiple regression R^2	Significantly loaded variables
CELF (total)	.523*	CELF (total) (< .001) ToPP (.069)	CELF (total)	.823*	CELF (total) (< .001)	.601*	CELF (total) (< .001)
ToPP	.503*	ToPP (.024) Prop iconic (.015) Raven's (.065)	ToPP	.779*	ToPP (< .001) CELF (total) (.010)	.566*	ToPP (.003) CELF (total) (.021) Raven's (.031)
Raven's	.448*	Raven's (< .001) CELF (total) (.072)	Raven's	.545*	Raven's (< .001)	.310*	Raven's (.013) CELF (total) (.049)
Prop Iconic	.033	None	Prop Iconic	.498*	Prop Iconic (.001)	.327*	CELF (total) (.010)

For all of the phase 2 outcome variables (e.g., total CELF score), the total variance explained when all phase 1 measures were placed in the regression model (e.g., total CELF, ToPP, Raven's and proportion of iconic gestures) was higher than when only the *equivalent* phase 1 measure was included (see appendix 5 for effect sizes). For example when total CELF score at phase 2 was the outcome variable, the total CELF score at phase 1 explained 46% of the variance. However when ToPP, Raven's and proportion of iconic gestures were included as additional predictors, the variance explained rose to 52%, with the phase 1 total CELF score loading significantly, and ToPP marginally significantly. The additional variables that significantly predicted the phase 2 ToPP score were the phase 1 proportion of iconic gestures and Raven's, but not the CELF. None of the phase 1 variables had any predictive relation to the proportion of iconic gestures produced in phase 2 (see Table 5.5).

When using the phase 2 measures to predict the phase 3 scores, again the variance explained by the multiple regressions is higher than for the simple regressions. However, apart from the ToPP score (where total CELF was a significant predictor), none of the other additional variables were significant predictors for any measure.

The zero order and part correlations for each of the predictor variables at phase 2 (Table 5.7) indicate how the variance is partitioned for each of the regression models predicting each outcome variable at phase 3. Although there are relatively high zero-order correlations between the measures of different symbolic abilities across time (e.g., ToPP at phase 2 and CELF at phase 3), the unique variance accounted for by other symbolic abilities is small, meaning that the high zero order correlations are due to shared variance with the equivalent measure in phase 2. This suggests that the equivalent phase 2 measures are making the largest *unique* contribution to the phase 3 outcome regression models.

Table 5.7: Zero order and part correlations for phase 3 regression analysis (predictor variables phase 2 measures)

Outcome Variable (phase 3)	CELF (total)		ToPP		Proportion Iconic		Raven's	
	Zero order	Part	Zero order	Part	Zero order	Part	Zero order	Part
CELF (total)	.905	.690	.482	-.022	.334	.002	.413	.060
ToPP	.696	.220	.808	.483	.369	.117	.481	.126
Prop Iconic	.481	.120	.375	.101	.601	.441	.422	.193
Raven's	.415	.080	.356	.053	.254	.063	.721	.580

Finally, phase 1 measures were used to predict phase 3 measures. For all of the phase 3 outcome variables the total variance explained when all phase 1 measures were placed in the regression model was higher than when only the *equivalent* phase 1 measure was included. When ToPP score at phase 3 was the outcome variable, the ToPP score at phase 1 explained 44% of the variance. However when all the measures were included as predictors, the variance explained rose to 57% (see appendix 5). Phase 3 CELF scores were predicted only by phase 2 CELF scores. Phase 3 ToPP scores were significantly predicted by phase 1 ToPP, total CELF and Raven's scores. For the proportion of iconic gestures (phase 3), the phase 1 total CELF score was a significant predictor, but there was no predictive relation between proportion of iconic gestures at phases 1 and 3.

To summarise, there seem to be stable relations between early (3;3 years) scores and the later *equivalent* scores (at 3;9 and 4;3 years) in the standardised tests measuring children's pretend play, language and non-verbal abilities. However, for the gesture measure (proportion of iconic gestures), this stability across phases is not as strong, with a significant relation only found between phases 2 and 3. Children across the phases seem to be increasing their iconic gesture production during the picture description task relative to their total gesture use.

When these simple relations were extended to include all the measures at the earlier testing phases, we found that there was a difference in the relations over time. When phase 2 measures were predicted by phase 1 measures, a number of non-equivalent measures significantly loaded onto the regression models (e.g., phase 1 pretend play score made a marginally significant contribution to phase 2 speech score). However, when phase 3 was the outcome variable, only speech scores appeared to have any consistent predictive effect on non-equivalent measures, specifically on the pretend play measure.

5.4. Discussion

The aim of the present study was to assess the potential for a longitudinal relation between three domains which have all been linked to an underlying ability to represent symbolically; speech, iconic gesture production and pretend play. Previous research that has sought relations between language and pretend play has not previously considered iconic gesture production, and has generally focused on relations at the emergence of these abilities (Bates, et al., 1979; Capirci, et al., 1996; Lyytinen, et al., 1999; McCune, 1995; Nicolich, 1977; Ozcaliskan & Goldin-Meadow, 2005b). According to these accounts, pretend play and language develop in an orderly fashion, with transitions in play being coupled with comparative advancements in language (McCune-Nicolich, 1981; McCune, 1995; O'Toole & Chiat, 2006; Piaget, 1962), and are based on an underlying capacity to represent symbolically. The present study investigated the potential influence that a domain-general symbolic ability may have in a sample of preschool children, who had already achieved a relatively high level of competence with symbols in a number of media (Callaghan, 1999; DeLoache, 1995, 2000; Ganea, et al., 2009). The present study also extended previous research that had sought relations between pretend play and speech to include iconic gestures, which have been identified as playing a crucial role in preschool children's communicative attempts (Iverson, et al., 1994; Kidd & Holler, 2009; McNeill, 2005; Nicoladis, 2002). This was achieved by giving preschool children between the ages of three and four a battery of tasks designed to tap into their respective abilities in speech, gesture production, pretend play and non-verbal ability.

We made two main predictions based on the notion that all three preschool symbolic abilities rely on an underlying representational capacity. The first was that there would be significant and consistent *concurrent* relations between children's abilities in speech, pretend play, and iconic gesture production, when controlling for their general non-verbal abilities. This extended previous research that had established pairwise correlations between (1) a measure of pretend play and speech, (2) speech with iconic gesture production and (3) a third marginally significant correlation between pretend play and symbolic gesture production (Child, et al., Submitted). The second prediction was that concurrent relations would also extend longitudinally. If a general capacity to represent symbols underlies these three abilities in preschool children, we expected to find that early symbolic abilities in all three of these domains would make a significant predictive contribution to later abilities in *any one* of these domains.

In confirmation of the first prediction, we found a consistent concurrent relation between the pretend play and the speech measures at all three testing phases. There was also a significant relation at all phases between the measures of speech and iconic gesture. This finding is in line with previous work that has found a relation between preschool children's advancements in speech and their iconic gesture production (Mayberry & Nicoladis, 2000; Nicoladis, 2002; Nicoladis, et al., 1999). However, there was an inconsistent relation between the pretend play and iconic gesture measures, with the only significant relation observed at phase 3, although there was also a marginally significant relation at phase 1. This is surprising given that previous research suggests that children's comprehension of gestural symbols and symbols with objects are part of the same 'representational continuum' (Andren, 2010; Bigham & Bourchier-Sutton, 2007; Tomasello, et al., 1999). One possibility for the lack of a relation between these measures at phase 2 is the high correlation found between Raven's and ToPP. As Raven's was the control measure for the partial correlations, this may have acted to mask the relation between proportion of iconic gestures and ToPP. A second possibility for this inconsistent concurrent relation is the relative instability of the iconic gesture measure in comparison with the standardised measures across phases (see below).

Taken together then, there appears to be at least *some* concurrent relation between all three measures of symbolic representation. We then investigated whether there were also predictive relations between these abilities over time. First, we expected to find significant correlations and predictive relations between children's early symbolic abilities and the same *equivalent* abilities at later ages. This was found to be the case for speech and pretend play, but not for iconic gesture production. It is unclear why this is the case, as the children did not show any great differences in their spoken behaviour or engagement with the gesture task. However, at phase 2 there was a significant increase in the number of *finger traces* that the children produced. We speculate that this sudden rise may have been due to children reaching a transitional stage between performing non-symbolic deictic gestures, to performing fully 'distanced' iconic gestures by phase 3 (Andren, 2010; Werner & Kaplan, 1963). Andren (2010) suggests that finger trace gestures are linked to children's private experience with drawing. These are initially learned socially via interactions with caregivers and over time become increasingly flexible, in that they can be performed without accompaniment with objects (i.e., paper). The significant change in finger traces between the three phases in the present study may be indicative of a change in how flexible children are in using their hands as a symbolic medium. By the middle of the third year children may understand the communicative usefulness of iconic gestures but may not have full competence in expressing this knowledge and so resort to using tracing gestures. By the fourth year, they may have achieved increased flexibility with iconic gestures, which reveals itself in the present study as (1) an increase in proportion of iconic gestures produced and (2) a gradual increase in 'airborne' iconic gestures relative to 'iconic finger draws'. This developmental change in how children chose to express their symbolic knowledge may have resulted in the apparent instability of the iconic gesture measure.

Second, we predicted that if abilities in speech, pretend play, and gesture were related on the basis of a shared symbolic capacity, then *all* these abilities would make a significant contribution to the variance explained for each individual ability later in development. Thus, although we expected a predictive and stable relation between children's performance in any given mode of symbolic representation across development, we also expected the other symbolic abilities to have an additional predictive effect. Overall, this was not found to be the case. First, children's speech scores at phases 1 and 2 predicted their later pretend play scores at phase 3, but the reverse effect was not consistently found. This implies a specific direction of effect; that children's early speech ability predicts their later abilities in pretend play even when they have achieved a level of competence with symbols in these domains. By age three, pretend play is increasingly social in nature (Farver, 1992; Garvey, 1990; Garvey & Kramer, 1989; Nielsen & Christie, 2008) and involves the successful coordination and maintenance of themes and roles (Goncu & Kessel, 1988; Howes & Tonyan, 1999; Howes, et al., 1989; Wyman, et al., 2009a, 2009b). We speculate that children's general speech ability helps them in this process, by boosting their potential to negotiate pretense acts with peers. Howe et al. (2005) found for example that siblings, who used linguistic strategies to extend their pretense and to create shared meanings, performed pretense actions more frequently than children who did not build on the established play theme (see also Farver, 1992). Thus, speech may not be related to children's pretend play on the basis of an underlying symbolic ability by this age (McCune, 1995; Piaget, 1962; Werner & Kaplan, 1963), but instead may shape how children structure their symbolic representation through pretend play, which in turn influences the overall opportunities children have for effectively advancing their pretense activity.

Second, the concurrent relations found between iconic gesture production and children's speech abilities do not appear to convert into consistent predictive relations. This contrasts with previous research on children at the earliest stages of speech which found a facilitative effect of symbolic gestures on later vocabulary development (Goodwyn, et al., 2000; Rowe & Goldin-Meadow, 2009b). It is more likely then that the significant increase in children's iconic gesture production observed across the three phases is 'symptomatic' of children's increasing linguistic competence. From around two years old, children come to expect a verbal label for objects (Capone & McGregor, 2004; Namy & Waxman, 1998) and their iconic gesture production plays an supplementary role to the speech they produce (Alibali, et al., 2009). Ozcaliskan and Goldin-Meadow (2011) suggest that preschool children increase their gesture production in line with their increasing knowledge of these gestures' communicative potential. Indeed, this does appear to be reflected in the increase in children's production of iconic gestures relative to other gestures across the phases (Vallotton, 2010).

However, an issue with the present study is that although the picture description task was collaborative in the sense that children had to interact with their caregiver to achieve the goal of drawing the picture, this task cannot tease apart the potential social factors which may influence children's production of iconic gestures in the preschool years. We found that children's iconic gesture production was correlated with their *individual* abilities in speech production and was not related to parental gesture production, although caregiver input was controlled. Thus, future research needs to assess which social factors influence the formation of iconic gestures during spontaneous descriptions of objects or events. For example, do children utilise the iconic gestures of caregivers as a way to facilitate descriptions of objects (Acredolo & Goodwyn, 1985, 1988; Caselli, 1990)? This research question is currently being addressed in ongoing work using the same sample of children from the present study. Also, as the speech measure in the present study was global in nature, future research is required to determine which specific aspects of speech are critical for advancements in these domains. For pretend play this may involve children's pragmatic knowledge, while iconic gesture production may be linked to children's overall syntactic complexity including use of verbs and adverbs (Nicoladis, et al., 1999).

In addition, the apparent predictive effect in the present study needs to be established in a naturalistic setting. We anticipate that children with higher abilities in speech will be more likely to respond positively to their caregiver's or siblings' attempts to establish a pretense scenario (Howe & Bruno, 2010). This in turn leads to children obtaining a better understanding of the potential for objects to be used as symbolic tools (Rakoczy, 2006, 2008; Rakoczy & Tomasello, 2006).

In conclusion, it appears that the three symbolic behaviours of interest here are not solely influenced by a shared ability to represent symbolically by the time children reach the middle of their fourth year. It is more likely that once a general symbolic competence is achieved, advancements in these three domains ‘branch’ and are influenced by extraneous factors (Charman, et al., 2000; Dixon & Shore, 1993). However, the findings of the present study suggest that speech remains a mediating factor for the symbolic domains of pretend play and iconic gesture use, but that there is a changing relationship between them.

Chapter 6: Empirical Paper Three

The previous two papers sought evidence for concurrent and longitudinal relations between three domains of symbol formation which are prominent in children's preschool behaviours (pretend play, speech and iconic gestures). In summary, there was a triad of relations found concurrently between these abilities, with significant associations observed even when non-verbal intelligence was controlled for. The longitudinal relations were found to be less consistent. There was evidence for a predictive relation between children's early speech scores and their later abilities in pretend play. However, this predictive effect was not mutual. There was also an overall increase in children's iconic gesture production as a function of their *overall* gesture production over developmental time. This consistently correlated with speech measures, suggesting that there is a tight link between iconic gesture production and children's spoken language capacities (see also Mayberry & Nicoladis, 2000; Nicoladis, et al., 1999). In the words of Ozcaliskan and Goldin-Meadow (2011) "iconic gestures may emerge as an outcome of related spoken language achievements, rather than being a precursor to such abilities" (p. 172).

It is important to note that the previous two studies focused on children's symbolic representational abilities in these three domains in during tasks that were controlled in terms of experimenter and caregiver. For the ToPP, the pretend play demonstrated to the child was highly structured, so that caregiver or experimenter input did not distort the stability of the measure. For the picture description task (where the gesture measure was derived), there was some collaboration involved, as the child had to inform a naive caregiver as to what a picture looked like. However, caregivers were restricted in the type of questions they could ask so that the onus remained on the child to provide full descriptions.

There remains the possibility (that will be examined in the following paper) that preschool children's iconic gesture production is influenced, not just by their personal inferences about objects and events, but by how more capable interlocutors represent these events through gesture. No research thus far has investigated whether preschool children socially learn iconic gestures through interactive routines, and whether this affects their subsequent description of the objects or events (see section 1.6.2.2).

There is a body of research that suggests that children from around the age of 10 months are able to map an iconic gesture onto objects, in a similar way to their early labelling via speech (Acredolo & Goodwyn, 1985, 1988; Caselli, 1990; Iverson, et al., 1994; Namy, et al., 2000; Namy & Waxman, 1998). However, these gestures do not appear to be spontaneously produced, but are instead tightly linked to the social context which the child is in. The form and meaning of these gestures appears to be ‘agreed’ upon by members of the interaction (Iverson, et al., 1994). Caselli (1990) noted that there were three criteria for these early iconic gestures: they (1) are used with the intention to communicate, (2) refer to an external object or event, and (3) are conventional. The conventional, socially established nature of these early gestural labels is of particular importance in gesture research. *Conventional* gestures (also termed *emblems* (Ekman & Friesen, 1969) or *quotable gestures* (Kendon, 1992) are often categorised separately from iconic gestures as (1) they do not need speech to inform the recipient of what is being represented through the gesture (McNeill, 2000) and (2) they are established by general agreement across the culture or subculture (e.g., Pika, et al., 2009). In the case of children’s earliest iconic gestures, as they are *in place* of speech and part of a socially established routine with an adult, it is unclear how they relate to, or whether they are qualitatively the same as the iconic gestures produced by older children (observed in the present study) and by adults (McNeill, 1992, 2005). Indeed, Liszkowski (2008, 2010) argues that the reproduction of these early iconic gestures by children does not indicate that children understand their symbolic nature (see section 1.6.2.2 for discussion).

By around the age of two years children begin to prefer the vocal modality to the gestural in terms of their labelling behaviours (Capone & McGregor, 2004; Namy & Waxman, 1998). Children by 26 months also seems to prefer iconic gestures over arbitrary ones, possibly because children are becoming more skilled at comprehending the similarity between the gesture and what it represents (Bates, et al., 1979; Namy, et al., 2004). These iconic gestures are no longer separated from speech. Beyond the age of two, children begin to use iconic gestures to supplement their longer linguistic constructions (McNeill, 1985, 1992). These gestures are classed as symbolic by McNeill (1985) because the gesture is paired exclusively with that which it represents (Saussure, 1969).

The first aim of the following paper was to investigate how children incorporate gestures into their communication about objects. The second aim was to establish whether the specific *imagistic* properties of gesture input from adults have an effect on whether children will use those gestures to refer to a novel object. There are two competing possibilities which may influence children's incorporation of gestures they see into their own descriptions of objects. First, it may be the case that children's uptake of gestures is determined by their individual inferences about the 'usefulness' or 'rationality' of the demonstrated gesture (Gergely, et al., 2002; Koenig & Harris, 2005; Schwier, et al., 2006). Children's incorporation of gestures into their own gestural lexicon may be related to how communicatively effective the gesture is regarded to achieve the aim of telling an interlocutor about an object. Second, the imagistic properties of the iconic gestures themselves (i.e., what aspect of the object they represent) may influence children's representation of the object (Cook & Tanenhaus, 2009; Hostetter & Alibali, 2010). Previous research on adults (see section 1.6.2.2) suggests that they are more likely to produce iconic gestures when asked to represent imagery that is based in *action* rather than *features* (Feyereisen & Havard, 1999; Hostetter & Alibali, 2010; Hostetter & Skirving, 2011; Pine, et al., 2010). It is a possibility then that children who observe gestures that depict the movement of the object, may glean this information from the gestures (Goldin-Meadow, 2003; Goldin-Meadow & Beilock, 2010; Singer & Goldin-Meadow, 2005) which in turn influences how they use gestures to represent the object in their subsequent descriptions.

The following paper attempts to compare these competing accounts by asking children to describe four novel objects to their caregiver, who cannot see the objects. The main experimental manipulation is the type of gesture that accompanies each object when it is introduced to the child (either a gesture that depicts the object's movement, a physical feature, or no gesture at all).

This paper is submitted for publication and is co-authored by Simon Child, Anna Theakston and Simone Pika.

Paper three: The use of symbolic gestures in preschool children: Conventional routines or individual inferences?

6.1. Introduction

"The growth of children's gestures [...] provide some of the best evidence that in performing gestures the hands are, in fact, symbols with meanings in their own rights" (McNeill, 1992).

Everyday communication consists of two main modalities, gestures and speech, which are semantically, pragmatically and temporally linked to each other (McNeill, 1992). Although there is no universally agreed definition of speech, many theorists would agree that speech consists of linguistic symbols, which are individually learned and based on shared social conventions (Pika, 2008a; Tomasello, 1999). Gestures can be either highly iconic and are spontaneously produced (McNeill, 1992) or highly conventional across groups and cultures (Eibl-Eibesfeldt, 1972; Ekman & Friesen, 1969). Together, speech and gesture form a dynamic and highly sophisticated communicative system, which is unique to humans (Pika, et al., 2005).

Although the extent to which co-speech gestures function as primarily communicative aids (Bavelas & Chovil, 2000; Clark, 1996; Kendon, 2004), cognitive aids (Butterworth & Hadar, 1989), or both (Bavelas, 1994; Özyürek, 2002) is a source of debate, relatively little is known about the acquisition of gestures in humans (Bates, et al., 1979; Lock, 1978). Early research on the communicative development of children showed that gestures and speech emerge and develop together (Bates, et al., 1979; Riseborough, 1982). The earliest gestures emerge around the age of 9-12 months, when children start to denote concrete objects and situations by typically either vocalising *or* gesturing (McNeill, 1992). These gestures (also called protogestures by some authors e.g., McNeill, 1992) can be classified into three distinct types: *ritualisations, deictics*, and *symbolic* gestures (Acredolo & Goodwyn, 1988; Bates, et al., 1979; Pika, 2008a).

Ritualisations are behaviours in which the signaller uses an effective behaviour to request an action. For instance, children often use a stylised *arm-raise* to be picked up. It has been suggested that the underlying learning mechanism is most likely an individual learning mechanism called “conventionalisation” (Bates, et al., 1979; Mead, 1910, 1934; Vygotsky, 1978) or “ontogenetic ritualization” (Tomasello & Call, 1997). In this process, a communicative gesture is created by two individuals shaping each other’s behaviour in repeated instances of an interaction.

The second type of gesture found in children’s early repertoires, *deictics*, are designed to direct the recipient’s attention to outside entities. Prototypes are *showing* (e.g., holding up an object to the recipient) and *pointing* (with an index finger or the whole hand). Concerning learning, researchers reported that *pointing* at first emerges in a non-communicative fashion, to orient children’s own attention to objects and events (Bates, et al., 1975; Carpenter, Nagell, & Tomasello, 1998). Similarly, Werner and Kaplan (1963) proposed that children go through a stage of *pointing-for-self* before *pointing-for-others* (see also Moore & D'Entremont, 2001). The communicative and referential function of pointing is thus clearly socially learned (Cochet & Vauclair, 2010; Goldfield, 1990), with social learning being defined as “a group of learning mechanisms in which observation of other individuals facilitates or enables the acquisition of a novel behaviour” (Call, 1999, p. 317). Four main social learning phenomena are discriminated: (1) mimicking (reproduction of sensorimotor acts); (2) local and stimulus enhancement (in the former the adult focuses the attention of the child to a single location while in the latter case the child’s attention is focused to stimuli of a specific quality); (3) emulation (reproduction of changes of state in the environment that others have produced); and (4) imitation (for an overview see Carpenter & Call, 2002).

The third type, *symbolic* gestures (Acredolo & Goodwyn, 1988; Namy & Waxman, 1998) (referred to by others as "iconic", "pictographic" or "representational" gestures Iverson, et al., 1994; McNeill, 1992; Poggi, 2002) consist mainly of whole-body enactments to depict actions and objects. These gestures are cognitively different from the symbolic (iconic and metaphoric) gestures used by adults, because they provide symbolic labels *in place* of speech, rather than *coupled with* speech (Namy, et al., 2000). They are either associated with a referent metonymically (the gesture refers to an element or attribute of something to mean the thing itself, (e.g., putting a finger to the nose and raising it for “elephant”) or on the basis of their mutual iconic relation to each other (e.g., flapping one's arms to represent a bird's wings, Acredolo & Goodwyn, 1988; Pizzuto & Volterra, 2000). Concerning the underlying learning process involved, Acredolo and Goodwyn (1988; see also Caselli, 1990) proposed that infants acquire their first symbolic gestures in social interactions (gestural or motor routines) with their caregivers, that are either performed deliberately (e.g., caregivers accompany the Itsy-Bitsy Spider song with a finger gesture depicting a spider crawling motion) or unwittingly (e.g., sniffing a flower). The underlying social learning process thus probably changes over time: First gestures might be acquired via mimicking from caregivers, while an understanding of the caregivers’ intentions when producing these gestures may only emerge later in development (imitation). However, since the form and meaning of these earliest gestures seem to be the result of a particular agreement established in the context of child-adult interaction, Caselli (1990) suggested they are better classified as *conventional* gestures. Following the definition of McNeill (1992), the form and meaning of conventional gestures are established by the conventions of specific communities and/or groups. This implies standards of form that must be met if the gestures are to be recognised and thus involves low levels of individual differences within the community/group.

Around the age of 20 months, the verbal system is becoming the preferred channel of communication, resulting in a proportionate decline in the production of gesture relative to speech (Iverson, et al., 1994). Children start to combine words into more complex speech streams and, instead of using words and gestures interchangeably, begin to use gesture to supplement the content of the speech itself (Alibali, et al., 2009). Children at around the end of the second year, eventually come to prefer iconic gestures over more arbitrary gestural symbols (Namy, et al., 2004).

Concerning older preschool children, virtually nothing is known about how children increase their gestural lexicon. Insight however may come from research on symbolic representational abilities, pretence, and embodied cognition. Liben and Downs (1992) for instance showed that young children mainly rely on their own inferences about the best way to represent actions and objects and incorrectly fuse aspects of the symbol and referent. For instance, when presented with coloured maps and landmarks, children thought that a road shown in red on the map meant that if you went to that road, it would actually be red. Furthermore, Hostetter and colleagues (Hostetter & Alibali, 2008, 2010; Hostetter & Skirving, 2011) argued that gestures emerge from the perceptual and motor simulations that underlie embodied language and mental imagery (e.g., Barsalou, 1999). This so-called gesture-as-simulated-action (GSA) framework suggests that gestures are produced on the basis of speakers 'replaying' the visualisation of the object through activation of relevant areas of the visual and motor cortex. This in turn then leads to activation beyond a *gesture threshold*, resulting in the production of a gesture (Hostetter & Alibali, 2008).

The present study was designed to enable a better understanding of how children's gestural development progresses and how they increase their gestural lexicon. Specifically, we aimed to address the following two research questions:

(1) Which gestures do preschool children spontaneously use to represent novel objects and which features of objects do they preferentially encode in their gestures?

(2) Are these gestures based on conventional routines or due to children's own inferences about the best way to represent objects?

To investigate these questions, we used an object description task consisting of three different scenarios. In each scenario, we presented four different new objects to preschool children and either introduced these objects by (1) using speech only, or by accompanying the verbal introductions with (2) *movement* gestures, or (3) *physical feature* gestures.

To address question one, we analysed the gestures children were producing spontaneously in the speech-only scenario (scenario 1) with regards to (a) kind of gestures used, and (b) features of objects depicted.

Concerning our second research question, we had two predictions: First, if children mainly rely on previously learned *conventional* gestures, we predicted a high degree of gestural concordance in the speech-only condition. In addition, we assumed that children, if relying on conventional gestural routines, would be very likely to match the gestures observed in condition (2) and (3). Alternatively, if children at this age are already relying on a more flexible gestural lexicon, and are productively matching gestures to what they perceive to be salient aspects of the objects, we expected to find a high degree of gestural variety in addition to idiosyncratic gestures.

6.2. Methods

6.2.1. Participants

Participants were 42 monolingual English-speaking children (18 girls, 24 boys) aged between 44 and 46 months (mean: 45 months 14 days). They were recruited from a sample participating in a longitudinal study of symbolic development (Child, et al., Submitted). All the children had typical language development (as determined by their performance on the CELF-preschool test (Wiig, et al., 2000). An additional four children were not included in the sample because of fussiness before completion of testing.

6.2.2. Materials

In order to study the acquisition of gestures, we used a game box and a total of 20 objects, varying in feature and shape. Four of the objects were designated *target* objects and the remaining sixteen functioned as *filler* objects (see Table 6.1).

6.2.2.1. The game box

The tasks took place around a large cardboard box that was placed between the child and the caregiver (39 cm x 28 cm x 26 cm). The box was coloured red to make it attractive and engaging for the children. Extending from one side of the box was a large cardboard flap (32 cm x 26 cm), which was designed to impede the view of the adult. On the other side of the box was another cardboard flap (32 cm x 9 cm). This flap was designed to discourage the child from looking around the box to the adult's side, while at the same time not impeding the view of the child towards the adult and vice versa. At each end of the box was a square hole (10 cm x 10 cm), to pass objects from one side of the box to the other. The main purpose of the box was to provide a restricted visual space between the experimenter and the caregiver, so that the caregiver was unable to see (a) the target object and (b) the experimenter's gesture. An additional purpose of the box was to provide a motivating and engaging game for the children. Once the children had described an object successfully, the caregivers pushed the object through the hole in the box towards them.

6.2.2.2. Objects

The four target objects were a *spiky ball*, a *stretch toy*, a *string ball* and a *sway triangle* (these names were not revealed to the children at any stage). The target objects were selected on the basis of them having both a distinctive appearance and a distinctive movement from which the demonstrated gestures were derived (see Table 6.1). These objects had been tested in a pilot-study and had been chosen based on their likely novelty to children and the fact that they could not be fully disambiguated from 'filler' objects (see below) with one word. For example, while children may have known the word "ball" for the *spiky ball*, the children had to provide extra information to disambiguate the target

Table 6.1: Target object and filler objects

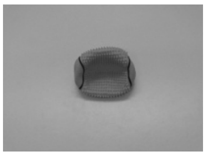
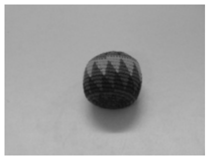
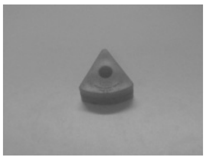
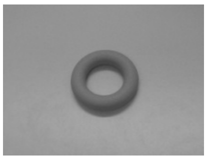
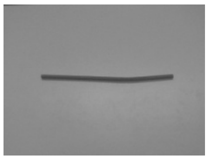
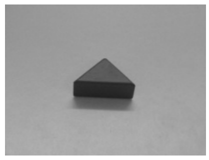
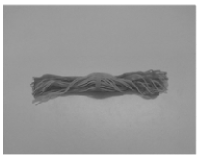
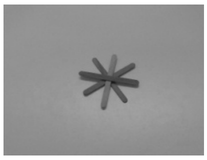
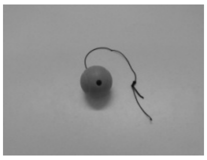
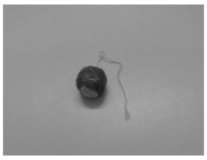
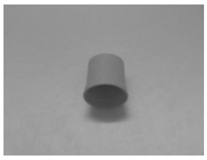
Target Object	Movement (FO1)	Physical Feature (FO2)	Colour (FO3)	Shape (FO4)
Spiky Ball				
				
Sway Triangle				
				
Stretch Toy				
				
String Ball				
				

Table 6.1 shows the target objects, children had been asked to describe and four filler objects for each target object. FO1 is matched to the target object on the basis of its similar action when a small force is applied to it. FO2 is matched to the target object on the basis of the physical property that is depicted through the demonstrated physical feature gesture (e.g., the spikes of spiky ball). FO3 is the same colour as the target object, while FO4 is the same approximate shape of the target object.

object from the other balls in the total array of objects.

In addition to each target object, we had four ‘filler’ objects (FO), which each matched a certain aspect of the target object (see Table 6.1). FO1 for instance was matched on the basis of having a similar potential movement to the target object, so for the *string ball*, FO1 bobbed up and down in a similar fashion. FO2 was matched on the basis of a distinct physical characteristic, so for the *sway triangle* FO2 had a hole through the middle.

The remaining two filler objects were chosen on the basis of matching the colour (FO3) and the basic shape (FO4) of the target object.

6.2.3. Experimental procedure

Testing took place either in our lab at the University of Manchester or at the children's homes, depending on the caregiver's preference. At the lab, children were made to feel as comfortable as possible in their surroundings. At the children's homes, testing took place in a quiet room, away from potential distractions. Before testing, the caregivers were informed about the aims of the study and what the task involved. The children were then asked if they wanted to play a describing game.

Once the children were comfortable, they were asked to sit on a chair opposite their caregiver, with a small table between them. The experimenter sat on the left side of the child placing himself in-between the child and a bag of objects, which were placed on the far side of the experimenter. The experimenter introduced the game box to the child and placed it on the table, with the front end of the box facing the caretaker. The child was then given the opportunity to explore the box and to get used to its appearance and position (see Figure 6.2).

Once the child appeared ready to begin, the experimenter introduced the game by saying: *"Now we are going to play a describing game. I am going to show you some toys that your mum/dad can't see. The aim of the game is to describe the toy to your mum/dad so that they can pick the right one from lots of other toys and, then send it back to you through the box."*

6.2.3.1. Experimental tasks

Each task consisted of a total of five trials, - one warm-up trial and four test trials. *Warm-up trial*: The aim of the warm-up trial was to familiarise children with the introduction of the objects and the procedures of the task. The child was introduced to an

Figure 6.2: Schematic set up of object description task and video still

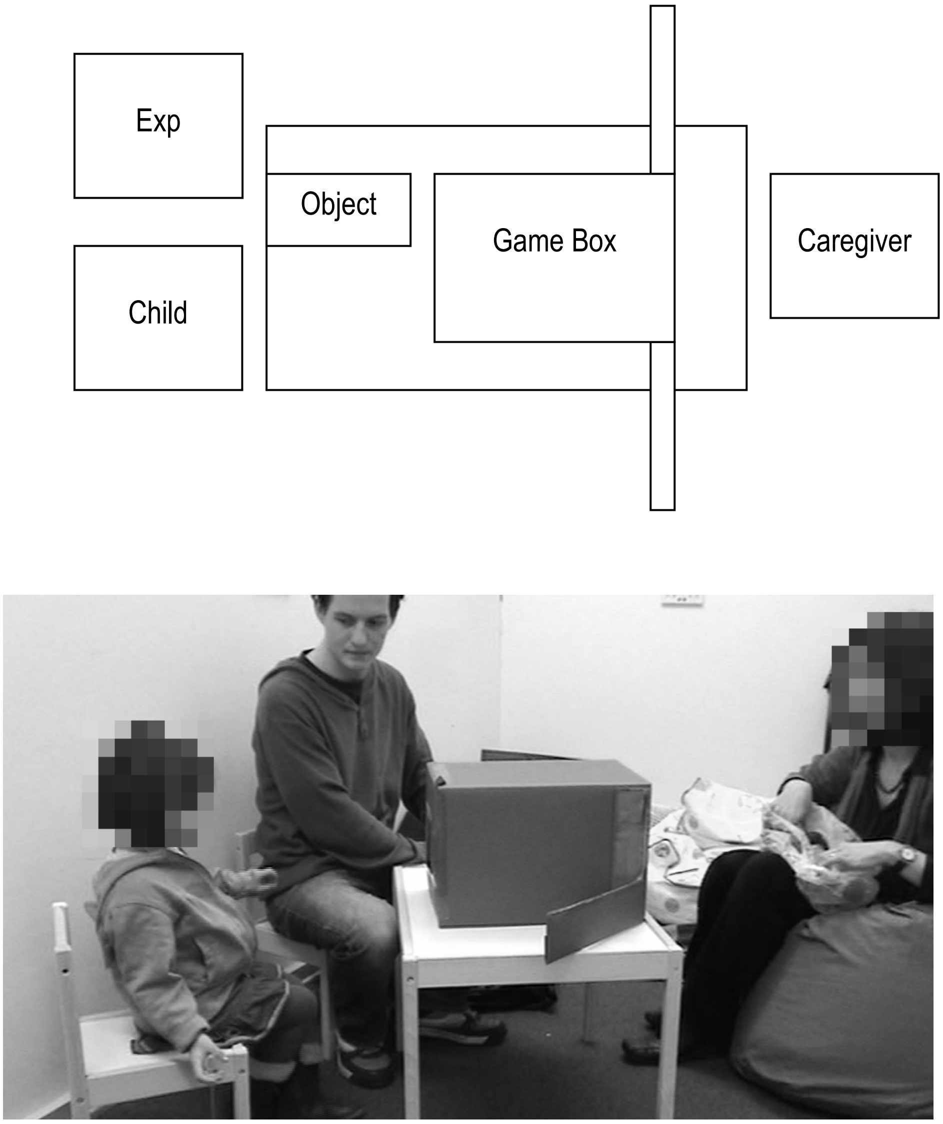


Figure 6.2 shows the location of participants during the object description task.

object (a small toy car) and given the opportunity to hold the object. The experimenter then said: *"This is an interesting toy isn't it?"* Once the child had explored the toy, the experimenter took the object and placed it into a bag with some filler objects. The toy was placed in the bag so that the child could not see any of the filler objects. The bag was shaken and passed around to the caregiver. The experimenter then asked the child to describe the toy to his/her caregiver so that the caregiver could choose the correct one to send back to the child through the game box. If the child appeared reluctant, the experimenter encouraged the child by asking: *"Is there anything you can tell your mum/dad about the toy you've just played with?"*

Once the child had made an attempt to describe the toy to his/her caregiver, the experimenter asked the caregiver to choose which object they thought it was. If the caregiver was unsure of the correct object, the experimenter asked the child: *"Is there anything else you can tell your mum/dad about the object?"* Once the caregiver was certain of the correct object, they were asked to show the object to the child for confirmation. If the correct toy was chosen, the experimenter asked the caregiver to place the object in the hole at his/her end of the box, which allowed the child to pick the toy up from his/her end of the box. Then the test trials started.

Test trials: Each test trial consisted of three subsequent steps:

Step 1: The experimenter introduced one of the four target objects to the child. The order of the presented objects per task was randomised. On presentation of the first target object, the experimenter placed the object behind the flap of the game box, outside of the caregiver's view but in full sight of the child. The experimenter then said: *"Look at this toy!"* to draw the child's attention to the object. Depending on the test condition (described below), the experimenter proceeded to communicate about the target object by using distinct statements (see Table 6.3) with or without accompanying gestures (see Table 6.4).

The gestures were performed directly above the target object to ensure that the child could see each gesture. The child was then given an opportunity to play with the object to explore its properties. Once the child had finished playing with the toy, the experimenter placed the target object into a bag with the four related filler objects, shook them and placed them on the caregiver's side of the box. All the filler objects were situated out of sight of the child. The experimenter then prompted the child to describe the object to the caregiver by saying either: (i) *"Can you tell your mum/ dad what that toy looked like or what it moved like?"* or (ii) *"Can you tell your mum/ dad what that toy moved like or what*

Table 6.3: Sentences used by condition

MD Condition	PF Condition
"Look at this toy, look at how it **moves**"	"Look at this toy. See what it **looks** like"
"It **moves** in a funny way doesn't it?"	"It **looks** quite funny doesn't it?"
"Look at what you **can do** to this toy"	"Look at what this toy **looks** like"
"It can **move** about in a fun way"	"It is quite a fun **looking** toy"
"Look at what it **can do**"	"This toy **looks** like a lot of fun"

Table 6.3 shows the different sentences used in a randomised order in the MD and PF Conditions. Words in bold emphasise the movement or physical features of the presented objects.

Table 6.4: Gestures demonstrated to children in demonstration conditions

Object	Description	
	Movement Gestures	*Physical Feature* Gestures
Spiky Ball	Hand in 'C' shape, bringing the thumb to the fingers to represent squeezing action.	Pointed finger moving up and down to represent spikes.
Sway Triangle	Flat hand facing upwards rocking side to side, pivoting on the wrist to represent rocking action.	Pointed finger creating a circle to represent the hole.
Stretch Toy	Two closed fists moving away then back towards each other, to represent stretch movement.	Fingers interlock to represent multiple 'legs' of the toy.
String Ball	One closed fist remains still, while other hand moves up and down to represent 'bouncing' action	Fingers and wrist on one hand touches the respective part on the other hand, creating a ball shape

Table 6.4 shows the gestures that were demonstrated to children in the MD Condition and the PF Conditions for each object.

it looked like?" These phrases were chosen in a pseudo-random manner, with two of the objects being accompanied by phrase (i) and two by phrase (ii).

Step 2: The child was then asked to describe the target object to the caregiver.

Step 3: Once the child had made an attempt to describe the target object, the caregiver was asked to choose an object out of the selection of five objects if they were able to do so based on the information the child had provided (one target object and four 'filler' objects), which best matched the child's description. If the caregiver selected the target object, the child was given positive verbal feedback by the experimenter and the caregiver was asked to place the toy into the game box, for the child to collect. The experimenter then asked the child for the object, took the bag of filler objects from the caregiver, put the object into the bag and placed it back into a second larger bag where all the toys were kept on the left side of the experimenter. If, after the child's initial description, the caregiver was still unsure as to the correct object, the caregiver could ask further questions to try to clarify (see caregiver instructions below). If the child seemed unsure how to respond, the experimenter asked the child if there was anything else she/he could say about the object. If the child answered in the negative, the experimenter asked the caregiver to choose which object they thought might best fit the child's description. The object was then held up so that the child could see it. If the caregiver was correct, the child was praised and asked to collect the toy from the caregiver, through the game box. If incorrect, the experimenter asked the child to tell his/her caregiver anything else she/he could about the object, until the caregiver chose the target object.

6.2.3.2. Caregiver instructions

The caregivers had been instructed before the beginning of the test trials that they should not select which object they thought the child was describing until they were certain of their choice. They were also instructed that they could ask for more information from their child, but must not ask specific questions (e.g., "Is the toy blue?"). These guidelines were given to provide a context, which encouraged the children to give full descriptions of the objects that had been presented to them.

6.2.3.3. Experimental conditions

Children were randomly placed into one of three experimental conditions: The Speech only Condition (SO) – 12 children, the Movement Demonstration Condition (MD) – 13 children, and the Physical Feature Demonstration Condition (PF) – 17 children. The main manipulation of these three conditions was whether or not gestures were used to accompany speech (SO Condition) and the type of representative gesture utilised by the experimenter while introducing the four target objects (MD and PF Condition).

SO Condition

In the SO Condition, the experimenter only used spoken language (four statements, see Table 6.3) to introduce the four target objects. Two statements were intended to draw the child's attention to the movement of the object (as per the MD Condition, see below) and two statements were intended to draw the child's attention to the physical feature of the object (as per the PF Condition, see below). During each trial, the sentences were used in a randomised order.

MD Condition and PF Condition

In these two conditions, the experimenter introduced each target object, by drawing the attention of the child to the object (a) verbally (four different statements/trial, see Table 6.3) and (b) gesturally (four repetitions of the same gesture/trial, see Table 6.4). In the MD Condition, the child's attention was drawn verbally to the movement of the object (e.g., *"It moves in a funny way doesn't it?"*), while in the PF Condition, the accompanying speech referred to physical features of the target object (e.g., *"See what it looks like!"*).

Concerning gestures, in the MD Condition the experimenter depicted a characteristic movement of the object, when a small amount of force was applied to it. For example, for the sway triangle the experimenter's hand swayed from side to side to represent the rocking of the triangle if pushed. In contrast, in the PF Condition, the experimenter used gestures that highlighted a physical characteristic of the object. For example the gesture accompanying the introduction of the *spiky ball* consisted of an up and down movement in an inverted 'V', performed with a pointing index finger to represent the spikes.

6.2.4. Data collection

Each task was videotaped using a Sony HDD DCR-SR75E digital camera. The camera was placed on a tripod, which was one metre in height and was placed so that the child, caregiver, and experimenter were visible throughout testing.

6.2.5. Coding

Since the focus of the study concerns symbolic gestures, only these gestures were coded. For the SO Condition, gestures were classified under the same criteria as 'same as demonstrated-movement', 'same as demonstrated-feature' or 'other- movement' or 'other physical feature'. All of the children's symbolic gestures produced when describing the objects were coded using these criteria.

For the two demonstration conditions (MD Condition and PF Condition), children's symbolic gestures were coded for whether they were 'same as demonstrated' or 'other-movement' or 'other physical feature'. For the MD Condition a gesture was classed as 'same as demonstrated' (i.e., reproduction of the previously modelled *movement* gesture) if the gesture had the same trajectory of movement as the demonstrated *movement* gesture. Hand shape did not have to be the same. For example, to be classed as 'same as demonstrated' for the *sway triangle* the child had to rock their hand side to side pivoting on the wrist. For the PF Condition a gesture was classed as 'same as demonstrated' if the gesture had the same hand shape as the demonstrated *physical feature* gesture. The movement of the hands whilst in this shape did not have to be the same. For example, for the *string ball* the child had to cup their hands to form a ball shape.

In order to test inter-coder reliability of these gesture classifications, 24% of the videos were coded by a second coder, blind to the aims and questions of the study. We found that overall agreement was good (87% agreement, Fleiss, 1981), with a Cohen's kappa of 0.714.

6.3. Results

To investigate how pre-school children represent new objects through gestural means in communicative interactions and whether these are based on conventional routines or due to children's own inferences, we carried out several analyses.

First, we examined whether gender or experimental condition influenced the children's overall gesture use.

6.3.1. Gestural performance across gender

To rule out differences in gesture performance due to gender, we compared the total number of symbolic gestures produced by boys and girls, and did not find a significant difference (Mann Whitney U-test; U = 189.5, z = - .88, *p* = .50; boys mean = 4.08, SD = 2.41, girls mean = 5.00, SD = 3.48). We thus collapsed the data across gender.

6.3.2. Overall symbolic gesture production

To establish whether experimental condition may have influenced overall gesture use, we compared the total number of symbolic gestures produced by children in relation to the three experimental conditions. There was no significant difference between conditions (Kruskal-Wallis Test; $X^2(2,42) = 3.61$, $p = .16$). Children performed a mean of 4.17 gestures (SD = 2.92) in the SO Condition, a mean of 5.62 gestures (SD = 3.01) in the MD Condition, and a mean of 3.82 gestures (SD = 2.66) in the PF Condition.

6.3.3. Spontaneous gesture production (SO Condition)

To investigate our first research question, namely which gestures were already in the children's gestural lexicons and if children preferentially depicted distinct features of objects, we analysed the gestures and gesture types spontaneously produced by children in the SO Condition (see Table 6.5).

Overall, gestures depicting physical features of objects were more frequently used than gestures depicting movements of objects, accounting for 75% (M = 3.00, SD = 2.05) of gestures produced by the children in the SO Condition. Of these *physical feature* gestures, 36% (M = 1.00, SD = 1.13) matched the gestures demonstrated in the PF Condition. The *physical feature* gestures were spread evenly across the objects (spiky ball, M = .67, SD = .65; sway triangle, M = .83, SD = .84; stretch toy, M = .75, SD = .97; string

Table 6.5: Examples of original gestures for each target object

Target Object	Demonstrated Movement	Demonstrated physical feature	Other Movement	Other physical feature
Spiky Ball	0	5	Enacting action of bouncing a ball (1)	Covering self in 'spikes' (1) Both hands circling (1) Putting fists together for 'spikes' (1)
Sway Triangle	1	4		Drawing triangle in air with finger (3) Forming triangle with hands together (2)
Stretch Toy	1	1	Drinking action (1) Twist wrist (1) Hand up and down (1)	Moving hand away from body once (4) Both/one hand circling (2) Closing fist (1)
String Ball	5	1		Moving hand across to represent 'string' (4) Circling hand for 'round' (1)

Table 6.5 shows the number of children in the SO Condition (out of 12) that produced the demonstrated movement or the demonstrated physical feature gestures. The table also gives information about the other gestures produced by children in the SO Condition (amount of children who produced these gestures at least once is given in brackets).

ball, M = .75, SD = .97). *Movement* gestures accounted for 25% (M = 1.17, SD = 1.19) of the total gestures children produced in the SO Condition. Of these gestures, 63% (M = .75, SD = .97) matched the gestures demonstrated in the MD Condition. There again appeared to be a similar number of *movement* gestures produced by children in the SO Condition across the objects (spiky ball, M = .17, SD = .58; stretch toy, M = .33, SD = .49; string ball, M = .58, SD = .90) apart from the sway triangle, which elicited few *movement* gestures (M = .08, SD = .29).

The spontaneous production of distinct *movement* and *physical feature* gestures indicated that these gesture types are already known to children of this age. To determine whether children were more likely to spontaneously produce either the demonstrated *movement* or *physical feature* gestures, we compared the total number of demonstrated *movement* gestures with the total number of demonstrated *physical feature* gestures[35], but did not find a significant difference (Wilcoxon-test, z = - .749, p = .45).

To address our second research question, namely the degree to which children's gestures might be considered to be *conventional*, we carried out two main analyses: First, we examined the variety of spontaneous gestural performance between children in the SO Condition. Second, we examined whether previous observation of distinct gestures in connection with distinct objects had an influence on children's subsequent gestural performance using the same objects.

6.3.4. Gestural concordances

We found that for each object, there was at least one particular type of gesture that was produced by multiple children (by 4 or 5 of the 12 children, see Table 6.5). For example, for the *stretch toy*, one third of the children represented the strings of the toy by moving their hand away from their body and holding it there. In addition, we identified a number of idiosyncratic *movement* and *physical feature* gestures that were characteristic for a single child only. Overall, children had a tendency to use more *physical feature* gestures than *movement* gestures.

To analyse the degree of gestural concordance between children's spontaneous gesture production, we applied Cohen's Kappa statistics to determine agreement or

[35] The children in the SO Condition were not shown any gestures by the experimenter. These analyses are based on the gestures that would have been coded as demonstrated *movement* or *physical feature gestures* if they were performed by children in the MD and PF Conditions respectively.

disagreement between individuals gesture for each object (Pika, Liebal, & Tomasello, 2003; Tomasello et al., 1997). To calculate the values for each individual, we used a matrix method whereby each individual received an average score in its agreement with each other individual based on a comparison of all performed gestures. These scores were then averaged across individuals to obtain a group variable. The within group kappa (M = .170, SD = .31) showed a very low degree of concordance (Altmann, 1991), and thus a high degree of variety in children's spontaneous gesture production (see appendix 6 for full kappa table).

6.3.5. Influence of demonstration of gestures

6.3.5.1. Overall gesture production

The analysis of spontaneous produced gestures had shown that the demonstrated *movement* and *physical feature* gestures were already in the children's gestural lexicons. To further address the question whether children at this age still mainly rely on previously learned *conventional* gestures, we compared whether the use of distinct gestures had an influence on children's subsequent gestural performance. To do so, we calculated proportions of children's symbolic gestures by dividing the number of demonstrated gestures by the total number of symbolic gestures produced by a given child. The analysis showed that children in the MD Condition used a significantly higher proportion of demonstrated *movement* gestures (M = .41, SD = .27) compared to the SO Condition (M = .18, SD = .23; Mann-Whitney U-test, U = 35, $z = -2.37$, $p = .018$). There was no significant difference in gestural performance between children in the PF and the SO Conditions (Mann-Whitney U-test, U = 81, $z = -.99$, $p = .32$). However there was a tendency for children in the PF Condition (M = .17, SD = .26) to perform the demonstrated *physical feature* gesture less often than children in the SO Condition (M = .28, SD = .32).

6.3.5.2. First gestures used

Overall, the results showed that children tended to match *movement* gestures they had previously observed, but not *physical feature* gestures. To investigate this finding in more detail, we analysed children's first gesture use, since first gestures produced in a communicative act have been identified as children's most 'spontaneous' communicative reaction (Huang & Charman, 2005). As there were four objects shown to each child during the test trials, children could score a maximum of four for their 'total first gestures'. An initial analysis established that children in each of the three conditions used at least one gesture for the same number of objects ($X^2(2,42) = 2.52$, $p = .28$; MD condition, M = 3.00, SD = .81; PF Condition, M = 2.41, SD = 1.12; SO Condition, M = 2.58, SD = 1.00).

A subsequent analysis showed that for children in the MD Condition, a significantly higher proportion of their first gestures matched the demonstrated gestures than for children in the SO Condition (MD Condition: M = .43, SD = .33; SO Condition: M = .13, SD = .21; MWU-test = 36, $z = - 2.39$, $p = .022$). There was no significant difference in the proportion of first gestures that matched the demonstrated gestures between children in the PF and SO Conditions (PF Condition: M = .15, SD = .26; SO Condition: mean = .32, SD = .37; MWU -test = 76, $z = - 1.29$, $p = .26$).

6.4. Discussion

The present study aimed to shed light on how children's gestural development progresses and how they increase their gestural lexicon. Specifically, we had two main questions: First we wanted to know how preschool children spontaneously use symbolic gestures to represent novel objects and which features of objects they preferentially depict. Second, we investigated if these gestures are still based on and/or originate from conventional play routines or are due to children's own inferences about the best way to represent objects.

In our first task, we investigated children's spontaneous gesture production while referring to novel objects in a communicative interaction. The results showed that pre-school children aged 44-46 months spontaneously combined verbal explanations of objects with symbolic gestures, and, in the absence of any gestural input, had a preference to depict physical features of objects rather than movements of objects. These gestures were highly coordinated with the speech of the children during their descriptions, instead of *in place* of speech which had previously been described for younger children (Acredolo & Goodwyn, 1985, 1988).

Furthermore, we found that although some gestures types in combination with distinct objects showed a higher production frequency than others, overall children showed a high degree of individual variability in their spontaneous gestural performance including the use of idiosyncratic gestures. These gestures often focused on one particular feature of the objects that was of interest to the child (e.g., a string of the ‘stretch toy’) or related to the object as a whole (e.g., forming a triangle for the ‘sway triangle’).

In our second task, we manipulated the gestural input of children to investigate if the use of distinct gesture types by an experimenter in combination with speech and distinct objects had an influence on the subsequent gestural behaviour of children. Quite surprisingly, we found that children showed a preference to match *movement* gestures in a subsequent communicative interaction including the same objects but not *physical feature* gestures.

Overall, our findings thus do not support the hypothesis that children aged 44-46 months of age still mainly rely on conventional gestural routines learned in previous play interactions with their caretakers (for children aged 20 months see, Acredolo & Goodwyn, 1988; Goodwyn & Acredolo, 1993). On the contrary, our results provide convincing evidence that preschool children already have a relatively flexible gestural lexicon, and make their own inferences about the best way how to represent objects on the basis of their salient properties.

However, quite surprisingly, we also could show that some gesture types observed in a communicative interaction and *with* a distinct object influence the subsequent gestural behaviour of children differently than others. There may be three possible explanations: First, children may be incorporating the *movement gestures* into their own gesture lexicon on the basis of their inferences about the usefulness of the demonstrated gesture as a communicative strategy for providing information about the object. Previous research has shown that children are able to infer about the appropriateness of means in order to achieve an end (Carpenter, Akhtar, et al., 1998; Gergely, et al., 2002; Koenig & Harris, 2005; Schwier, et al., 2006). One possible explanation is that children perceive *movement* gestures to be more communicatively useful (rational) than *physical feature* gestures. If this is the case, then we would have expected to find that children in the SO Condition would have shown a higher frequency of spontaneously produced *movement* gestures than "less useful" *physical feature* gestures. However, this was not the case with children producing both gesture types equally often.

A second explanation is that children's incorporation of gestures into their gesture lexicon may have been influenced by the imagistic properties of the gesture itself. In the present study the act of the adult depicting motor actions through symbolic gestures may change children's own representation of the object, leading them to simulate this aspect of the object when asked to describe it. Previous research has shown that children glean information in adult's gestures in distinct learning contexts (e.g., Goldin-Meadow, 2003; Singer & Goldin-Meadow, 2005). In addition, research on adult speakers has shown that more gestures are produced if the object or event being spoken about evokes high levels of *motor* imagery compared to *visual* imagery (Cook & Tanenhaus, 2009; Feyereisen & Havard, 1999; Pine, et al., 2010). According to the GSA perspective (Hostetter & Alibali, 2008, 2010; Hostetter & Skirving, 2011), gestures are produced when speakers "simulate actions in the interest of speaking" (Hostetter & Alibali, 2010, p. 245). Alibali et al. (2000) suggested that gestures assist in the process of 'breaking down' perceptual and motor knowledge into a verbal form. The expressive possibilities of gesture to represent spatial information are numerous (Alibali, et al., 2009; Emmorey & Casey, 2001; Kendon, 2004) and in children in particular, rate and type of symbolic gestures has been linked to their attempts to represent complex spatial events (Alibali, et al., 2009; Kidd & Holler, 2009).

The GSA framework contends that speakers are more likely to produce gestures that simulate actions compared to gestures that simulate visual properties. This is because the motor imagery created when simulating these actions is more likely to reach the gesture threshold, as this imagery is closely tied to the actions of the body (Hostetter & Alibali, 2008). Indeed, motor imagery is more closely linked to neural motor activation in the brain (e.g., Wexler, Kosslyn, & Berthoz, 1998). Visual properties of objects on the other hand are less directly linked to bodily action. Imagery involving visual features of objects (e.g., size or shape) need to be 'converted' on the basis of how these features affect the affordances of the object (i.e., how it can be held).

In our second task then the demonstrated *movement* gestures may have acted to change children's thinking about the object by changing the imagistic properties of their representation. As the demonstrated *physical feature* gestures were more likely to be matched with children's initial representation of the object (as shown in the SO Condition), this type of demonstrated gesture may have been redundant in the context of this task. Therefore, the conflicting imagistic information provided by the *movement* gestures may have acted to alter children's representation, which subsequently changed how they used gestures to communicate about the object.

However a third, leaner explanation cannot currently be ruled out. It may not be the gesture *per se* that changed children's imagistic representation of the object, but the gesture may have made children more aware of the potential affordances of the object, specifically the way it can move (Bird, Brindley, Leighton, & Heyes, 2007). This in turn may have led children individually to create their own symbolic gestures to represent that object. Although in the current study, the children appeared to interact with the objects in similar ways irrespective of experimental condition, future research could address these competing accounts by manipulating children's access to the object after the experimenter has presented the object (and gestures) to them. If the same pattern of results is found in children who were given access to the object, compared to those that were *not* given access to the object, it would suggest the 'rich' interpretation that the gesture itself is altering children's representation of the object (Cook & Tanenhaus, 2009; Goldin-Meadow, 2003; Singer & Goldin-Meadow, 2005). However, if there is a higher number of reproduced gestures in the 'object accessed' condition, it would suggest a 'lean' interpretation that the symbolic gestures are making children aware of the affordances of the object, but that the children are using their own representation of the object as a basis for their symbolic gestures.

Overall, the present study extends previous work that has implied a role of adult input in children's use of symbolic gestures from around ten months of age (Acredolo & Goodwyn, 1988; Goldin-Meadow, et al., 2007; Iverson, et al., 1999) by expanding the scope of research to three year old children who are just beginning to use symbolic co-speech gestures in everyday interactions (Nicoladis, et al., 1999). Furthermore, our findings provide the first evidence that children at the age of three years make use of relatively flexible gestural lexicons and glean information from gestures and utilise them as a representational resource.

Chapter 7: General Discussion

The present thesis had two main aims. First I analysed the potential for concurrent and longitudinal relations between preschool children's abilities in speech, pretend play and gesture production in a sample of children where a level of competence had already been obtained. No previous research had sought evidence for concurrent and predictive associations between these symbolic domains beyond the second year. Second, this thesis considered children's gesture production in the preschool years in two ways; (a) by exploring its potential concurrent and longitudinal links to speech, and (b) determining if and how children utilise the gestures they observe into their own representations of objects.

This discussion section is divided into a number of subsections. For each of the research questions introduced in chapter three of this thesis, there is a short summary of the main results, followed by a subsection where these findings are discussed in relation to previous research literature. Next, potential methodological limitations will be discussed and finally potential future research directions that have emerged from the findings of the present thesis will be introduced.

7.1. Research question 1: Are there associations between linguistic ability and the development of pretend play in children between 3 and 4 years of age?

7.1.1. Summary of findings

Previous research had only addressed the relation between pretend play and speech at its *emergence* (Lyytinen, et al., 1999; McCune, 1995; Ungerer & Sigman, 1984). These studies had focused primarily on children between the ages of 12 and 24 months, when sensorimotor actions on objects give way in favour of symbolic representations (Piaget, 1962). Beyond this age, although the consensus is that pretend play is a tool for language development (Andresen, 2005; Bergen, 2002; Yawkey, 1983), no studies have investigated whether these relations, persist beyond their initial ontogenesis (Dixon & Shore, 1993).

The abilities expressed by children before two years in their pretend play and speech have been argued to be indicative of an underlying cognitive capacity to understand and produce symbols. In the words of McCune-Nicolich (1981) both skills “develop in response to general progress in the semiotic function” (p. 786). Theories differ with regards to *how* children arrive at this developmental point at around the second year. Some researchers for instance suggest development of symbolic abilities is due to children’s individual adaptations to their environment (e.g., Piaget, 1954, 1962). Others argue that symbol use in the domains studied here reflects children’s understanding of the social nature of symbols, and is linked to an underlying knowledge of the intentions of others (Tomasello, 2008; Tomasello & Rakoczy, 2003; Vygotsky, 1978). These theories emphasise a significant relation between children’s early pretend play behaviour and speech acts.

To summarise the results of the first two papers, there were consistent concurrent relations between pretend play and speech, even when controlling for general non-verbal ability. Indeed, these correlations appeared to strengthen over developmental time. Longitudinally, while speech was a predictor of pretend play scores at later phases, pretend play abilities were not a reliable predictor of later speech scores.

7.1.2. Implications of findings

The predictive direction observed in the present thesis appears to conflict with evidence that suggests that pretend play is a catalyst for children’s social and language skills (Kasari, et al., 2008; Tamis-LeMonda & Bornstein, 1994; Ungerer & Sigman, 1984). This evidence is mainly based on play interventions for children with developmental disorders or delays (Kasari, et al., 2006; Kasari, et al., 2008; O'Connor & Stagnitti, 2011; Reddy, Files-Hall, & Schaefer, 2005). However, it is difficult to tease apart the respective influences of the pretend play intervention from the additional linguistic input this type of intervention is likely to be coupled with. For example, O’Connor and Stagnitti (2011) involved children in four play themes which were led by the therapist. It is unclear in these studies then whether it was the symbolic representation through pretend play *or* the added linguistic interaction with the caregiver that facilitated later pretense in children.

In the present studies, the results suggest that for children aged between three and four years of age, abilities in speech are a significant predictor of their subsequent pretense capacities, as measured by a standardised measure of pretend play. On the other hand, pretend play itself does not reliably predict subsequent speech abilities. The question here is how can this predictive direction be explained? Pretend play may be governed by children's pragmatic understanding, their establishment and maintenance of play themes and their use of speech to engage their peers in pretend play scenarios (Garvey & Kramer, 1989; Goncu, 1993; Goncu & Kessel, 1988; Tykkylainen & Laakso, 2010; Vygotsky, 1978; Vygotsky & Luria, 1994). Sachs (1980) suggested that child-adult play schemes boost children's knowledge of components of speech, for example turn taking (see also Bruner, 1975b) and increasing narrative skills (Garvey, 1990). Garvey and Kramer (1989) for example found that when engaging in pretend play with a partner, children produced significantly more future (e.g., "will") and modal (e.g., "may") verb forms compared to instances when they were not engaged in pretend play. They argued that children in the preschool years begin to use language in order to structure and negotiate play roles with partners. It is also a possibility that pretend play and speech are related in terms of their "organisational complexity" (Lewis, 2003, p. 392). Pretend play becomes more complex as themes are introduced (Garvey, 1990) and specific roles are determined and maintained by children (Skolnick & Bloom, 2006; Weisberg & Bloom, 2009; Wyman, et al., 2009b). For example, Weisberg and Bloom (2009) observed that three to four year old children chose not to 'merge' two pretense scenarios into one when they were initially established separately. This suggests that children apply constraints on their pretend play behaviour, linked to the prior establishment of separate pretend 'worlds' (Leslie, 1987; Nichols & Stich, 2000). In speech, children are able to produce more complex syntactic constructions, which are reflected by increased MLU and a developing awareness of pragmatics (Diessel, 2004; Matthews, et al., 2007).

Language then may be the mediator for how children use a general cognitive ability for symbolic representation to introduce and evolve multiple play schemes. Children also use the pretense acts of adults "as a foundation or catalyst for the generation of their own new actions" (Nielsen & Christie, 2008, p. 157). To use Vygotsky's terminology, pretend play becomes 'intrapsychological'. At around age three children may use language to serve a mediating role, with the aim of engaging peers, to structure and negotiate roles, and to maintain themes (Farver, 1992; Garvey, 1990; Goncu & Kessel, 1988; Howe & Bruno, 2010; Howe, et al., 2005; Howes, 1985; Howes, et al., 1989). This use of language in turn leads to children obtaining a better understanding of the potential for objects to be used as symbolic tools (Rakoczy, 2006, 2008; Rakoczy & Tomasello, 2006). Howe et al. (2005) for instance found that the strategies that dyads (consisting of two children) used in order to build on or maintain established pretend play acts were positively associated with pretend play frequency. Importantly, dyads that performed play acts frequently[36] did not differ from dyads that did not perform play acts frequently on the number of play schemes *introduced*, suggesting no difference in their abilities to represent symbolically in the first instance. Where they did differ was on the linguistic strategies to *maintain* and *elaborate* on this pretense.

An issue raised in the present thesis is that the predictive relation between speech and pretend play was not entirely consistent, as phase 1 speech ability did not make a significant contribution to the variance explained in phase 2. It is unclear as to why this may be the case, given the predictive relations found between phase 1 and phase 3. One possibility is that this may be due to the unusually strong relation between the proportion of iconic gesture measure and ToPP scores at this age (relative to the other regression

[36] The Howe et al. (2005) study did not define the frequency categories used in the study.

analyses), which acted to partition off the predictive contribution of the total CELF measure.

7.2. Research question 2: How does children's iconic gesture use relate to their linguistic abilities?

7.2.1. Summary of findings

Previous research has suggested that the production of gestures in children is closely related to their speech at the ontogenesis of language development, particularly at the one to two word stage (section 2.3.1). Few studies have investigated the relation between children's iconic gesture production and their speech abilities during the fourth year. One of the aims of the present thesis was to assess the potential for children's symbolic gesture production (as measured by the proportion of iconic gestures) to (1) increase over developmental time and (2) be related concurrently to children's linguistic abilities.

First, across the three testing phases, there was an increase in children's iconic gesture production (as a proportion of their total gesture use) between phases 2 (3;9) and 3 (4;3), but not between phases 1 (3;3) and 2. By just over four years old, iconic gestures accounted for 49% of total gestures produced. Second, there were indeed strong and consistent concurrent associations found between children's iconic gesture production and their speech scores. This correlation showed signs of increasing over time, suggesting a greater level of integration between speech and iconic gesture production. Related to this was the second finding that only 18% of iconic gestures produced in the first testing phase were not accompanied by speech. Many of these 'speech free' gestures may have been an artefact of the picture description task, as children could potentially have used their fingers to 'draw' on the paper for their caregiver's benefit. Indeed when children were asked to describe novel objects (see paper three) only 11% of gestures produced had no vocal accompaniment, compared to 17% at the during the gesture elicitation task at the same testing phase.

7.2.3. Implications of findings

The first finding here ties in with the approximate timing of the gesture ‘explosion’ posited by McNeill (2005). McNeill (2005) suggests that while children’s gestures begin to synchronise with speech by the end of the one-word period (Capirci, et al., 1996; Goldin-Meadow & Butcher, 2003), in the main gestures at this age serve a complementary rather than a co-expressive function to convey “different meanings in a different mode” (McNeill, 2005, p. 182). By the ages of three and four, gestures become more integrated into the linguistic output of the child, as the imagery that children are able to process becomes more complex. However, in the present study the iconic gestures that children produced in the earlier test phases were not trivial, accounting for 1 in 3 of gestures produced during the task. This is broadly in line with other research that has identified increases in children’s iconic gesture production at around 26 months (Ozcaliskan & Goldin-Meadow, 2011; Zlatev & Andren, 2009). Zlatev and Andren (2009) suggest that the ability to combine iconic gestures with speech is the endpoint of a developmental process, which involves three stages. The first stage (at around 14-20 months) involves children being able to coordinate their early conventional signs triadically. The second transition at approximately 20-26 months is where single words and gestures become increasingly integrated. This involves the child understanding the conventionality of a symbol (i.e., there is a correct way to represent a dog through speech). They suggest that this knowledge is expressed as a sudden increase in headnods and a peak in the production of deictic gestures. The final stage beyond 26 months involves the production of multi-word utterances and flexible speech-gesture combinations, and was displayed in their study by an increase in gestures that included an iconic component, and an increase in the number of deictic and conventional gestures that were combined with speech (see also Ozcaliskan and Goldin-Meadow, 2011, for related findings).

The increase in children's iconic gesture production relative to their overall gesture production is in line with the view that beyond two years of age children become increasingly adept at using non-verbal, mechanical symbols (Mayberry & Nicoladis, 2000). Vallotton (2010) suggested that as iconic gestures increase in frequency, this leads in turn to a reduction of deictic gestures, possibly as children grasp the potential of the symbolic medium as a communicative tool, or gain a greater understanding of the iconicity of gesture (Namy, et al., 2004; Ozcaliskan & Goldin-Meadow, 2011). This was evident in the present longitudinal study, as there was a significant reduction in the proportion of total gestures that were deictic gestures across the time points (53% at phase 1; 38% at phase 3). It may be that in the context of the task, children realised the added communicative benefit of producing an iconic gesture relative to a deictic one, which only gives location information in this task.

The second finding suggests that it is likely that the relation with speech is dependent on children's ongoing spoken abilities. Iconic gesture production is a 'symptom' of children's ongoing development in syntactic understanding. The suggestion I make here is that the concurrent associations found between children's iconic gesture production and global measures of speech are not indicative of an underlying ability to represent symbolically, but rather are 'led' by children's individual advancements in speech (Nicoladis, et al., 1999; Ozcaliskan & Goldin-Meadow, 2011). Nicoladis et al. (1999) argued that children's iconic gesture production is linked to their initial attempts to flesh out details of visual images "associated with actions, locations, shapes and so forth" (p. 524). Indeed two lines of research appear to support this view. First, research has found that more iconic gestures appear to be produced in conditions where there is more visual imagery (e.g., Feyereisen & Havard, 1999; Pine, et al., 2010). Second, research has also suggested that gestures are closely tied at the clausal level to the speaker's relevant speech segment (e.g., McNeill, 1992; Ozyurek, 2010). Nicoladis et al. (1999) suggested that while children gain representational mastery, and thus begin to use predicate structures, they use iconic gesture to "express aspects of complex concepts that cannot be expressed in speech" (p. 524). Children may use iconic gestures to express a complex representation, using an expressive medium that is not limited by the potentially cumbersome nature of children's early speech (Guidetti & Nicoladis, 2008). This view is supported by research that has found age-related changes in how children utilise gestures to express meaning to an interlocutor (Alibali, et al., 2009; Kidd & Holler, 2009). They suggest, in line with Kendon (2004), that children may adjust their gesture production as a direct result of the linguistic resources they have available to them, or to compensate for difficulties with words.

However, if this were the case, it would have been found in the present study that children would have used *less* iconic gestures to express the same pictures over time, as they became more advanced in the spoken domain (Stefanini, et al., 2009; Stefanini, et al., 2008). This was not found (see also Nicoladis, 2002), and even adults in the Alibali et al. (2009) study gestured significantly more than children overall (see also Colletta, et al., 2010). Children also appeared not to use gestures in place of speech during the gesture elicitation task. The low percentage of iconic gestures that were produced without speech by children in the present sample is in line with previous work that argues that iconic gestures produced by children are *not* a compensatory strategy for poor linguistic abilities. Nicoladis (2002) suggested that although iconic gestures may serve a facilitatory role in adults' lexical retrieval (Frick-Horbury & Guttentag, 1998; Rauscher, et al., 1996), this is only the case when the adults sampled are fully competent speakers. The production of iconic gestures in adult speakers seems robust, even when they are speaking a different language (Gullberg, et al., 2008). For speakers that have weakened linguistic abilities, Nicoladis (2002) argued that they are more likely to compensate with conventionalised or deictic gestures, as these gestures can be understood without context provided by speech (Goldin- Meadow & Morford, 1985; McNeill, 2000). She found that only a fifth of the iconic gestures produced by children in her sample were as a result of word finding difficulty. However, there was a trend for iconic gestures to act in a facilitatory role in the older children of her sample, suggesting that gestures may serve an increasing function in lexical retrieval over developmental time (Pine, Bird, & Kirk, 2007).

Interestingly, it does not appear that children's iconic gesture production at earlier phases has any relation to their *later* spoken abilities. This contrasts with previous research on younger children that had established a longitudinal relation between gesture production and later linguistic outcomes (Goodwyn, et al., 2000; Ingersoll & Lalonde, 2010; Rowe & Goldin-Meadow, 2009b) (see section 7.6.4.2 for related research directions based on this notion).

In summary, there is evidence in the present thesis that children's iconic gesture production is related to their advances in the spoken domain. This has been attributed to children's attempts at longer, more complex syntactic constructions (Nicoladis, 2002; Nicoladis, et al., 1999) and their increased knowledge in this symbolic domain from around 26 months onwards (Namy, et al., 2004; Ozcaliskan & Goldin-Meadow, 2011). Indeed, children by this age may have a dawning understanding of the potential of iconic gestures as a communicative medium and hence use this type of gesture more readily over time, when tasked with describing objects or events.

7.3. Research question 3: To what extent are the three symbolic representational capacities of spoken language, gestural communication, and pretend play related between 3 and 4 years of age?

7.3.1. Summary of findings

The first two research questions sought relations between children's symbolic representational abilities in pairs of domains: pretend play and speech, and speech and iconic gestures. The present thesis is the first attempt to consider the development of all three of these symbolic domains together. It was hypothesised that if an underlying representational ability accounted for the development of symbolic capacities in children, then two main lines of evidence would be observed. First, there would be a concurrent relation between the measure of iconic gesture production and the measure of pretend play at all three testing phases, after controlling for general non-verbal abilities. This is in addition to the observed pairwise correlations found between speech and pretend play, and speech and iconic gesture production (see sections 7.1-7.2). Overall evidence for this final relation was lacking, with a marginally significant association found at phase 1 (3;3 years), a non-significant relation at phase 2 (3;9 years) and a significant relation at phase 3 (4;3 years). Overall this suggests that there is no consistent relation between these measures.

The second line of evidence revolves around the contribution that the symbolic skills at earlier testing phases make to these skills at later testing phases. If a general capacity to represent symbolically underlies all three of these abilities in preschool children, all three measures of symbolic skills would have made a significant contribution to later measures. Alternatively, it may be the case that only the *equivalent* skill makes a significant contribution to later development (e.g., speech at phase 1 predicts speech at phase 2). Taken together, the results of the first and second papers suggest that by the later preschool years, there is no longer any consistent predictive cross-domain effect of earlier symbolic skills on later abilities. Although there was a significant effect of the *equivalent* abilities found (e.g., pretend play ability at phase 1 predicted pretend play ability at phase 2) suggesting a *within-domain* relation, few cross-domain variables showed any predictive value.

7.3.2. Implications of findings

The results of the first two papers suggest that for preschool children, the relations between measures of symbolic ability cannot be explained by a general underlying capacity to represent symbolically as had traditionally been identified in younger children (Piaget, 1962; Werner & Kaplan, 1963). Previous research implying this possibility comes from Charman et al. (2000) who found concurrent associations between pretend play and expressive language at 20 months of age, but pretend play at 20 months did not associate significantly with either receptive or expressive language at 44 months. They suggest that these symbolic domains may share an underlying representational ability up until approximately 20 months, which "diverges and becomes more separate" (p.492) as development occurs in the second and third years of life. In this sense, a domain-general capacity to represent symbolically (which is itself emergent from underlying cognitive advancements, for example an understanding of others as intentional beings) using either pretend play, speech or iconic gestures gradually gives way to more independent abilities (Karmiloff-Smith, 1992, 1998, 2007, 2009). For example, it has been argued by Karmiloff-Smith (1998) that speech emerges from systems concerned with auditory, social and symbolic stimuli. This results in specific advancements in children's later linguistic accomplishments in, for example, grammar or phonology. It is possible then that there may be a changing relation between speech and the other symbolic domains as different influences take hold on their subsequent development. In the preschool children observed in the present study, this revealed itself as lack of consistent predictive relations between symbolic measures between the testing phases. O'Toole and Chiat (2006) found in a sample of children with Down syndrome that concurrent pretend play and language correlations became weaker as children reached the multi-word stage, compared to earlier ages. Similarly, Namy and Waxman (1998) found that children at around 18 months of age gave an equal status to symbols presented in vocal and manual modalities, but by 26 months, children strongly preferred the vocal modality only. They interpret these findings as evidence that at 18 months, children have an 'all round' capacity for symbol learning, but by 26 months this becomes increasingly specialised as their environmental input changes around the end of the second year. The findings in the present thesis are broadly in line with the perspective that separates symbolic abilities across the fourth year, as cognitive and social demands take hold on effective representation. In the O'Toole and

Chiat (2006) study, mutual relations between pretend play and speech were lost at the stage where children were attempting multi-word utterances. They suggest that by this age, children's speech abilities have become domain-specific, as children are exposed to increased multi-word input from their caregivers. This gradual modularisation of language is also reflected in the consistent concurrent relations between iconic gesture production and speech measures, coupled with the inconsistent relations between iconic gesture production and pretend play. As 'language' encompasses both speech and gesture (e.g., McNeill, 1992), it is reasonable to suggest that speech 'paces' iconic gesture production. The inconsistent concurrent relation between iconic gesture production and pretend play reveals that their development beyond three years of age is not on the basis of a shared symbolic capacity. Additionally as iconic gesture production does not have any established role in negotiating or mediating pretend play (unlike speech), this may explain the apparent lack of a predictive relation between iconic gesture production and pretend play outcomes.

However, it appears from the results of the present thesis that the relation between speech and the other domains of pretend play and iconic gestures is not completely lost. The suggestion here is that speech mediates the other two symbolic abilities (pretend play and iconic gesture production), albeit in different ways. By around the age of three, children have developed a sophisticated conceptual understanding of symbols using a variety of media including scale models (DeLoache, 2000; DeLoache, Miller, & Rosengren, 1997), analogue symbols (Bialystok, 2000) and pictures (Allen, Bloom, & Hodgson, 2010; Callaghan, 1999; Ganea, et al., 2009; Preissler & Carey, 2004). They are also able to comprehend the *intentions* of others to represent symbolically (Bloom & Markson, 1998; DeLoache, 1995, 2002b; Ganea, et al., 2009; Rakoczy, 2006, 2008; Tomasello & Barton, 1994) and have a flexible understanding of the relation between the signifier and the signified (Allen, et al., 2010; Callaghan, 1999; Namy & Waxman, 2005)[37]. Speech then

[37] Children do not appear to achieve competence with symbols in all domains by this age. Myers and Liben (2008) found that five to six year old children have difficulty understanding cartographic symbols, when the symbol bears some iconic resemblance to the item being represented. Sharon and Deloache (2003) suggest that this may be due to children not being able to inhibit the iconic representation in favour of an symbolic

may not be related to children's other symbolic representational abilities on the basis of a mutual underlying representational system, but instead may sculpt how children structure their symbolic representation in these domains separately.

7.4. Research Question 4: How do children incorporate symbolic gestures into their own gesture repertoire?

7.4.1. Summary of findings

There were a number of lines of evidence that suggested that children may utilise the iconic gestures produced by adults. First, research has shown, that iconic gesture production is not merely an internal process but can also be interpersonal in nature, and influenced by social context (e.g., Alibali, et al., 2001; Bavelas, et al., 2002). Second, preschool children appear to learn potential ways to act symbolically (with objects) through reproducing the pretend play actions of an adult (Rakoczy, et al., 2005a, 2005b; Striano, et al., 2001). Third, children can use the information contained in gestures to help them solve difficult cognitive tasks (Goldin-Meadow & Singer, 2003; Singer & Goldin-Meadow, 2005) and can integrate information contained in gestures (Goldin-Meadow, 2006a; Kelly, 2001; M. Morford & Goldin-Meadow, 1992). Fourth, children appear capable from around the age of 10 months of socially learning symbolic gestures to represent objects and items of interest (Acredolo & Goodwyn, 1985, 1988)[38]. These socially learned gestures are given an equal status to speech symbols (Acredolo & Goodwyn, 1985, 1988). They are also likely to be conventional in nature, because the meaning of the gesture is mutually agreed between the child and adult, and this meaning can be communicated without necessity of speech (Caselli, 1990; Namy & Waxman, 1998). At around the end of the second year, children begin to combine iconic gestures within

one. Huttenlocher, Vasilyeva, Newcombe and Duffy (2008) found that children's ability to do 'scaling tasks' emerge later than object-to-object correspondence tasks, suggesting a step by step change in children's symbolic flexibility.

[38] Although see Liszkowski (2008) for criticism of the view on the basis of these gestures symbolic status.

more complex speech streams, and use iconic gestures to supplement speech, rather than instead of speech (Capone & McGregor, 2004).

In the third paper, I investigated the possibility that children aged between 44 and 46 months would use the iconic gestures shown to them by an experimenter as a strategy (in addition to their speech) to tell their caregiver about novel objects. The main manipulation of the study was the iconic gesture (or not, in the case of the SO Condition) that accompanied the initial presentation of the object to each child. Children were given the same opportunities to handle each of the objects in all three conditions and were shown the objects for approximately the same amount of time.

In summary, it was found that compared to a control group that received no gestural input from the experimenter, children who were shown iconic gestures that depicted a potential *movement* of the object were more likely to produce this gesture. On the other hand, children who were shown a gesture that depicted a *physical feature* of the object did not produce these gestures any more often than those in the control condition[39].

7.4.2. Implications of findings

The third paper in this thesis suggests that children learn iconic gestures from observing the gestures of adults, in the sense that children incorporate these gestures into their gestural lexicons. Interestingly, the properties of the gestures themselves appeared to play a significant role in their subsequent uptake. This has not been previously observed in studies with younger children. This did not appear to be an inference by the child about the 'usefulness' of the gesture as a strategy for achieving the aim of telling the caregiver about the object. The question here is why were children more likely to reproduce the iconic gestures of an adult when they depicted the *movement* of an object compared to the *physical feature* of the same object? Namy, Vallas and Knight-Schwarz (2008) suggest that

[39] We do not take these findings to be a result of children taking more notice of the demonstrated movement gestures on the basis of their dynamic nature, because even the physical feature gestures had an element of movement in their presentation. For example, the physical feature gesture for the *sway triangle* involved the circling of a pointed finger to represent the hole.

young children may not imitate the gestures of an adult directly, but infer individually about objects from how adults interact with them. They found that the gesture rates of 16-22 month old children were related not to the amount of *empty handed* gestures that their parents produced (which would have suggested an imitative effect), but to the number of *actions with objects* the caregivers performed. It may be the case then, that children's representations of the object are being influenced by their relative experiences with it, in terms of manual interaction with the object and what they see others do with it.

The view that symbol formation is borne out of early sensorimotor and perceptual experience has gathered momentum in recent years (see Wilson, 2002). Traditional theories of symbol use have regarded them as having an arbitrary relation to what they represent (Namy & Waxman, 2005; Peirce, 1955; Saussure, 1969) and that perceptual representations have no relation to their formation (see Barsalou, 1999 for discussion). According to Anderson (2005), this view is attributed to the early distinction made by Decartes between the body and the mind. Theorists in the *embodied cognition* tradition reject this notion, instead suggesting that the "mind must be understood in the context of its relationship to a physical body that interacts with the world" (Wilson, 2002, p. 625).

According to the embodied cognition perspective, symbol use is not an abstract understanding of signified-signifier relations; that representation is independent of perceptual input (Zerwas, 2007) but is instead the ability to *simulate* perceptual and sensorimotor sensations (Barsalou, 1999; Gibbs, 2005; Glenberg, Havas, Becker, & Rinck, 2005; Glenberg & Kaschak, 2002; Zerwas, 2007). For example, if one was to imagine holding a cup, the biological systems involved in cup holding (e.g., the fingers) would react as if they were involved in the act of holding. A series of studies by Glenberg and colleagues (Glenberg, et al., 2005; Glenberg & Kaschak, 2002; Havas, Glenberg, Gutowski, Lucarelli, & Davidson, 2009) has found that language processing is faster when the movement of the participant to respond to the appropriateness of a sentence (i.e., the direction the hands need to move) is matched to the action involved in the sentence. For example, for the sentence “you gave Andy the pizza”, processing rates were faster when the movement to respond was directed *away* from the body compared to towards the body (Glenberg & Kaschak, 2002). In this sense, the symbols used in speech are grounded by evoking the perceptual affordances of the objects and events (Barsalou, 1999; Stanfield & Zwaan, 2001) including shape, size, motion and colour (see Connell, 2007; Connell & Lynott, 2009).

Concerning gesture, Hostetter and Alibali (2008, 2010) argue that they are produced from simulations of perception and action (called the ‘gestures as simulated action’ (GSA) framework, see section 1.6.2.2). Hostetter and Alibali (2008, 2010) claim that the activation of neural areas that are involved in the simulation and planning of physical actions are directly linked to gesture production. This has been supported by research that has found that children and adults produced more iconic gestures in response to questions that evoked high levels of motor imagery compared to visual imagery (Beilock & Goldin- Meadow, 2010; Feyereisen & Havard, 1999; Pine, et al., 2010).

If gestures are grounded in the simulation of actions, as suggested by the GSA framework, then this may account for the increased uptake of demonstrated movement gestures relative to physical feature gestures observed in the third paper. Recent research by Cook and Tanenhaus (2009) found that (1) speakers’ gesture production when explaining a task to an observer was influenced by their previous experience with the objects involved in the task (either holding it or solving the same task on a computer), and (2) observers’ subsequent strategies to solve the same task were influenced by the gestures they observed. They argue that speakers’ perceptual and motor experiences directly influence the gestures they later produce, and that observers glean this information, which affects their performance on a similar task. Recent research has also shown that *producing* gestures may alter children’s thinking about a task either when encouraged or trained to do so (Broaders, Cook, Mitchell, & Goldin-Meadow, 2007; Cook, et al., 2008; Goldin-Meadow & Beilock, 2010).

The third paper in the present thesis is the first study to find that children incorporate the iconic gestures they observe into their own representations of objects. This in turn affects how they use gesture to represent the object. In the words of Goldin-Meadow and Beilock (2010), "actions reflected in gestures influence thought" (p. 669). This supplements previous research that has found the reverse effect, that children's 'thinking' about an event changes how they use gestures to represent it. Alibali et al. (2000) asked five year old children to either *describe* or *explain* a conservation task to an experimenter. The reasoning behind this manipulation was that while both tasks would involve inclusion of the same lexical items, they differed in terms of *complexity*[40], and thus contrasted in terms of the information that needed to be packaged. They found differences in the number of representational gestures children produced, with significantly more in the *explanation* condition compared to the *description* condition. This implies that children's production of iconic gestures is influenced by their 'thinking' about the task. I speculate here that the production of movement iconic gestures by the experimenter may have acted to change children's initial representation of the object, by adjusting the children's perceptive experience with it. As this representation had been altered to encode the potential movements of the object, this resulted in iconic gestures that highlighted the movement of the object (Hostetter & Alibali, 2008, 2010; Hostetter & Skirving, 2011).

However, while the GSA framework is able to explain the results of the third paper, this perspective must be met with caution on the basis of the findings from the first two papers. First, even though the stimuli that the children had to describe for their caregivers did not involve high levels of dynamic action (as they were pictures), children still showed significant numbers of gestures that depicted iconic aspects of the pictures. According to the GSA framework, it would be unlikely that these pictures would activate pre-motor action states, as they are not involved in movement. Second, although the pictures presented to the children were the same across the three testing phases, measures of the

[40] By 'complexity', Alibali et al. (2000) reason that in the *explanation* task children had to consider multiple perceptual dimensions to solve the task, while in the *description* task this was not required for task success.

proportion of iconic gestures increased over developmental time. The GSA framework, given that the desire of the child to communicate, and their belief about the usefulness of gestures were approximately equal across tasks[41], would predict that iconic gesture production would be similar across phases. This is not the case, suggesting, in line with a number of researchers, that iconic gestures are shaped by the communicative potential that the speaker has at her disposal (Kendon, 2004; Kita & Ozyurek, 2003, 2007; Kita, et al., 2007; Mayberry & Nicoladis, 2000; Nicoladis, et al., 1999; Nicoladis, et al., 2007).

It is also surprising that children in the SO Condition produced more gestures that depicted features of the object rather than movements spontaneously. If gestures are linked to action, as suggested by the GSA framework, then it may have been more likely that children would have produced more gestures depicting movement. However, it is possible that in the present study, children did not encode the movements of the objects naturally, instead opting to focus on the multitude of physical properties of each object.

7.5. Limitations

7.5.1. Characteristics of the sample

The first general limitation of the present thesis concerns the sample sizes on which statistical analyses were performed. Although attrition rates were low throughout the longitudinal element of the present thesis (papers one and two), the analyses (correlations and multiple regressions) were based on relatively small sample sizes; 49 children at testing phase 1, 47 at testing phase 2, and 46 at testing phase 3. The possibility remains that a high amount of sampling error may be inherent in the analyses. According to Friedman (1982, Table 1), to leave only a 20% possibility of Type II error (incorrect rejection of the null hypothesis) for an r value of .30[42], the sample size would have to be 82 people. For the

[41] It is a possibility that children's motivation for the gesture elicitation task may reduce across testing and that the shared knowledge of the objects may change between communicative partners. However, this would typically result in a *reduction* of iconic gestures as participants would share common ground (Holler & Stevens, 2007; Holler & Wilkin, 2009).

[42] This is determined by J. Cohen (1988) as a medium effect size.

present correlational study, the power is .50, indicating that there is a 50% chance of agreeing with the null hypothesis incorrectly.

A second related issue is that the between-phase regression analyses had four predictor variables and just over 40 subjects included in the models. According to Tabachnick and Fidell (1996, 2001), having an inappropriate case to variable ratio means that although the models will be significant, they will be meaningless. Some researchers suggest that a case to variable ratio of 10:1 is acceptable in multiple regression analyses (Halinski & Feldt, 1970; Sawyer, 1982; Tabachnick & Fidell, 1996). However, Tabachnick and Fidell (2001) claim that a more conservative approach would be to multiply the number of predictors in the model by eight and then add this number to 50, to get the minimum number of subjects[43]. In the present longitudinal study, this would mean a minimum of 74 children, which is obviously higher than the number collected. However, as R^2 is not calculated using the number of subjects, it may be more appropriate to calculate the power of the regression models *post-hoc*[44], by using an online power calculator, where observed effect size, number of predictor variables (4), level of significance ($\leq .05$) and sample size were inputted (www.danielsoper.com/statcalc; see Table 7.1).

Not all of the power calculations are above the 0.8 standard for adequacy (J. Cohen, 1988). The low post-hoc power calculations are mostly found when the additional variables added to the initial simple regressions added little to the total variance explained by the model, which resulted in small effect sizes. This suggests then that caution is appropriate when interpreting these results.

A second issue with the present sample is that it consisted of a particular socio-economic group. 70% of the caregivers recruited at the initial phase of testing were educated to at least degree level, with 79% of them in full or part-time employment. As

[43] Although see Green (1991) for criticism of this formula.
[44] While the prospective use of power analysis has been widely accepted, the post-hoc method is controversial. For instance, Thomas (1997) argues that calculating statistical power using observed effect sizes overestimates ‘true’ power.

Table 7.1: Post-hoc power calculations for between-phase hierarchical regression analyses (effect size (f^2) in brackets)

	IV's		
	Phase 1	Phase 1	Phase 2
Predicted Variable	Phase 2	Phase 3	Phase 3
CELF total	.293 (.104)	.291 (.103)	.088 (.022)
ToPP	.915 (.458)	.911 (.459)	.957 (.570)
Proportion Iconic	.893 (.407)	.806 (.345)	.677 (.271)
Raven's	.508 (.182)	.467 (.168)	.168 (.057)

seen in Table 3.3, caregivers also tended to be older. Indeed the sample of children did appear to perform higher than what would be expected of a truly representative sample of children (see Table 5.3). Thus, any conclusions must be made with appropriate caution.

7.5.2. Stability of iconic gesture measure

Another issue for the longitudinal study is that the iconic gesture measure (proportion iconic gestures) did not maintain stability throughout the testing phases. While there was a significant correlation between testing phases 2 (3;9) and 3 (4;3), there was no correlation found between testing phases 1 (3;3) and 2, suggesting that between these phases, children’s overall distribution of gesture production was inconsistent, even when performing the same task. The main differences observed in children’s gesture production in the gesture elicitation task apart from children’s iconic gesture production was the production of deictic gestures and finger traces. As described in paper two it may be that changes in production of these gestures influenced the iconic gesture measure used in the present studies. There was a significant reduction in the proportion of gestures produced that were deictic, suggesting that children were adopting a different strategy to solve the task of explaining the pictures to their caregiver (Vallotton, 2010). This reduction of deictic gestures relative to iconics itself may not explain children’s inconsistent use of iconic gestures. However, it may be that these finger traces were an intermediate stage between children's deictic gestures and their iconic gestures, as indicated by the developmental change in production of these gestures across the three phases. By the age of four (phase 3), children have become highly flexible in their use of iconic gestures, and so no longer require the support of the picture itself to represent the shapes. This dynamic change in how children express symbolically through gestures may offer some explanation for the inconsistent relations found between the first two phases.

7.5.3. Pretend play measure

The ToPP used in the present study is a useful measure of children's symbolic representational capacities both using objects and their own bodies (Lewis, Boucher, & Astell, 1992; Lewis, et al., 2000). In the ToPP, children who were able to represent multiple objects concurrently, and who were also able to create an original pretense scenario scored more highly than children who merely imitated the actions of the administrator. This emphasis on *creative* pretend play is appropriate because it involves the child using their conceptual knowledge (of for example making food) and adapting this concept to the objects that are available to them. However, there are a number of issues with using a standardised instrument to measure children's symbolic representation using objects that I address here.

First, it is never certain whether the 'creative' pretense that the child is producing during the short time period of administration is truly creative, or is simply an imitation of a pretense scenario that they had performed previously. Second, according to some researchers (Charman & Baron-Cohen, 1997; Wyman, et al., 2009b), specifically instructing children to perform pretense actions (e.g., by asking them to make a teddy drive a car) results in the children making a 'best guess' about the appropriate action, rather than actually representing symbolically (P. L. Harris, et al., 1994). This indeed may be a problem for the ToPP, as it involves an instructional component, and scoring is based on children performing the same actions as the administrator. Jarrold (2003) suggested that this direct instruction to pretend may result in children making ‘intelligent guesses’ about what the administrator expects of them and thus may be performing actions that are scored as pretense but the child themselves shows no intention to pretend (e.g., through looks or smiles, Randell & Nielsen, 2006).

Another issue is that there is little consideration for the vocal or behavioural accompaniments that signify pretense in the ToPP. There is general agreement that children may use behavioural manner cues to assist in their recognition in pretense (D. Cohen, 1987; Piaget, 1962). Piaget (1962) noted that children’s laughter was an effective signal to identify pretend play episodes during observations of his children, while Lillard and Witherington (2004) found that parents performed significantly more social behaviours during pretend acts compared to acts that were similar but had no pretense element (pretending to feed vs. actually feeding their child). They found that in the pretend condition, parents were more likely to smile, to mention the word “pretend” and to look at the child compared to the real condition. This type of behaviour has also been reported in children’s social behaviours when performing pretense acts compared to functional acts (McCune, 1995; Nicolich, 1977; Randell & Nielsen, 2006), suggesting that social behaviours are a crucial component of pretense behaviour.

This research emphasises two possible limitations for the ToPP as a measure of children’s pretend play. First, the social behaviours of the administrator while performing the pretend acts are not controlled, meaning that children may be exposed to different ‘pretense recognition’ behaviours across administrations of the test. Second, the scoring of the ToPP does not take the social behaviours of the children into account when they perform the actions, as it is in part focused on the re-enactment of the action that has been shown to the child. It is a possibility then that the ToPP may overestimate children’s pretend play capacities. However, during the creative element of the ToPP, the administrator only scores the act as symbolic pretend play when they are certain that the child is using the object (or their body) to represent something other than itself. For pretend play, this may involve adding noises or vocal descriptions of the target act. It is reasonable to suggest that the administrators may be implicitly aware of children's social behaviours as they make their scoring decisions.

7.5.4. Artefacts of the interaction

A third limitation to the data collected relates to the third paper in the present thesis. It is unclear whether the children's production of iconic gestures was influenced by the activation of motor simulations after *observing* the experimenter demonstrate the gestures or whether they are simulating from their experience of *handling* the object. Across all conditions children got the opportunity to explore the object before they were asked to describe it to their caregiver. It is possible that children in the movement demonstration condition were not incorporating the iconic gesture they received into their own representation of the object, but were instead using the gesture as a guide to make their own inferences about the potential movement affordances of the object (Namy, et al., 2008). To test for this possibility, I analysed whether the children across the three conditions manipulated the novel objects differently when they had the opportunity to investigate them themselves. As the movement gestures for each object were linked to a particular manipulation of the object, these specific manipulations were analysed for differences within conditions (see appendix 7). Overall, there was no difference between conditions for any of the four novel objects in terms of these object manipulations, suggesting that in this study the demonstrated movement gestures did not merely act to make children aware of the movement affordances of the object.

Future research could assess these two accounts further by manipulating children's access to the objects post-demonstration. Under the 'rich' interpretation, a similar pattern of results should be found in children who post-demonstration are able to access the object, and those who are not. This is because in both conditions they are observing the iconic gesture which, in this account, changes their representation of the object. Under the 'lean' interpretation of the present findings, it is the subsequent handling of the object that is important, as children need to manipulate the object to make their individual inference about the movement affordance of the object. Therefore children that do not have access to the object post-demonstration would perform significantly fewer of the demonstrated movement gestures compared to those who have access to the object. According to Zerwas (2007), it is *actions with objects* that facilitate in the "decoupling and re-coupling of the links between motor and visual perception" (p.80). Zerwas (2007) found that 28 month old children were more adept at matching substitute toys (i.e., toys that did not look like their referent) to referent objects when they had direct motor input (by being asked to imitate the actions) compared to if they did not have this input. An empirical investigation of children's iconic gesture use, when the actions on objects are manipulated may enlighten this issue.

7.6. Future research directions

7.6.1. Analysis of observational data

In the second empirical paper it was found that children tend to use more iconic gestures over developmental time (Mayberry & Nicoladis, 2000; Nicoladis, 2002; Nicoladis, et al., 1999; Ozcaliskan & Goldin-Meadow, 2011; Vallotton, 2010). Ozcaliskan and Goldin-Meadow (2011), in line with previous research on children's early iconic gestures (Namy, et al., 2004; Tomasello, et al., 1999), suggest that beyond the second year children begin to understand fully the potential of gestures as a symbolic medium, and thus their iconic gesture production is closely tied to their symbolic abilities in other domains, for example speech. Indeed in the present thesis a consistent concurrent correlation between children's speech scores and their production of iconic gestures during the gesture elicitation task was found, indicating a close relation between the two measures.

However, the present thesis also found that children's gesture production appears to be positively influenced by the gestural input they receive from communicative partners. In the present thesis, this appeared dependent on the imagistic properties of the gesture itself. As discussed in section 1.6.2.2, there is a body of work with children who are just beginning to use symbols as a communicative medium (Acredolo & Goodwyn, 1985, 1988; Goodwyn, et al., 2000; Namy, et al., 2000). These studies suggest that many of the early examples of iconic gesture produced by children at around one year are learned during scripted routines with a caregiver.

Caregivers also sculpt their communicative input to their child on the basis of the child's current developmental level (termed "motherese", Snow, 1972; Snow, 1995). This change in input has been found in the caregiver's use of gestures (Bekken, 1989; Grimminger, Rohlfing, & Stenneken, 2010; Iverson, et al., 1999; Iverson, Longobardi, Spampinato, & Caselli, 2006; Rodrigo et al., 2006). Iverson et al. (1999) found a correlation between the caregiver's verbal and gestural production and the child's gesture production when the children were 16 and 20 months old. They argued that these gestures are conceptually simple, refer to concrete entities and serve to reinforce the message provided in speech (Bekken, 1989; Iverson, et al., 1999; Iverson, et al., 2006).

An issue with this research is that is correlational in nature. Ozcaliskan and Goldin-Meadow (2005a) argue for a particular direction of causality, that the apparent 'matching' of caregiver's gestures to the gestures of their children (in their study this involved the use of supplementary deictic gestures accompanied by one word of speech) was a *response* by the caregiver, as an expert in using speech to represent propositional information, to the child's *own* attempts at creating two word propositional constructions. Caregivers are sensitive to the instability of children's current cognitive state and respond accordingly (Goldin-Meadow, 2003; Goldin-Meadow & Singer, 2003; Ozcaliskan & Goldin-Meadow, 2005a).

However, it is important to determine in future research the role that caregivers play in children's subsequent production of iconic gestures. Ozcaliskan and Goldin-Meadow (2011), in an longitudinal observational study of children between 14 and 34 months old, found that the iconic gestures that children produced was mirrored by the iconic gestures their caregivers produced. This effect was found with both the number of gesture tokens produced by child and caregiver *and* the semantic attributes the gestures contained. This study provides preliminary evidence that this ‘mirroring’ effect is *child led*, not parent led. Specifically, while children in the youngest age groups (14-26 months) produced very few iconic gestures, caregivers were consistently producing iconic gestures in their interactions with these children. If the rate of caregiver’s iconic gestures did indeed influence children’s gesture production, it would have led to children producing more iconic gestures at this age.

In their study Ozcaliskan and Goldin-Meadow (2011) analysed the number of iconic gestures produced by the members of the dyad *across the interaction*. Future research could address the question of whether children’s gesture production is determined by the linguistic ability of the child, or by the gestural environment supplied by the caregiver in a natural interaction. Using the observational data collected during the visits as part of the longitudinal study this question will be investigated by breaking the interaction down into conversational ‘episodes’ (Hoff-Ginsberg, 1987, 1991), where it is possible to analyse in detail the second-to-second changes in caregiver’s and children’s gestural behaviour, dependent on the current topic of conversation.

A second potential question to be addressed using the observational data is whether the behaviours *accompanying* the iconic gestures produced differ between the caregiver and the child? Thus far, the gestural ‘motherese’ literature has focused mainly on the relations between the child and their caregiver’s gestural *rates* using correlational analyses (e.g., Iverson, et al., 1999) or caregivers’ responses to the demands of a collaborative task (Grimminger, et al., 2010; O'Neill, Bard, Linnell, & Fluck, 2005). However, no research has investigated whether the child and the adult differ both in terms of the engagement they show with their interlocutor when *performing* an iconic gesture and their behavioural *responses* to their communicative partner when they observe an iconic gesture. Indeed adults are able to process the gestures of a speaker to glean information about an event (Beattie & Shovelton, 1999a, 1999b), and in the present thesis children appear to use the iconic gestures of adults to sculpt their representations of objects. Adults have been found to fixate more onto iconic gestures compared to other gesture forms (Beattie, Webster, & Ross, 2010) and can use information provided by gestures to determine when a child is on the cusp of understanding a concept (Goldin-Meadow & Singer, 2003). Children on the other hand, while they are able to use gestures to supplement what they say in speech (Alibali & Goldin- Meadow, 1993; Kidd & Holler, 2009; Pine, Lufkin, Kirk, & Messer, 2007), they may have a poorer understanding of the *communicative potential* of their iconic gestures and thus may make fewer attempts to direct their iconic gestures to their caregiver. It is also unclear to what extent children are attentive to the iconic gestures produced by their caregivers in natural interactions. To address this question, the behaviours of the signaller and the recipient of iconic gestures could be coded in terms of their eye gaze when the iconic gesture was performed, the orientation of the body relative to the communicative partner, whether the gestures were directed to the communicative partner and the responses to the signaller from the recipient of the gesture (in terms of their looking behaviour).

7.6.2. Specific analysis of pretend play and speech relations

The present thesis has uncovered two main findings regarding the relation between pretend play and speech across the fourth year of life. First, there were consistent concurrent associations between pretend play and speech abilities. Second, speech made a significant predictive contribution to children's later pretend play scores. This research implies that there is at least some lasting relation between the speech abilities of children and their subsequent pretend play behaviour, as has been suggested by research on children before two years of age (Lewis, et al., 2000; Lyytinen, et al., 1999; McCune, 1995). In the present study, the measures of these skills are global in nature, in the sense that they aim to provide an indication of children's overall abilities in speech and pretend play. The ToPP compartmentalises pretense into four main areas of object substitution, attributing pretend properties to an object, referring to absent entities and coordinating a pretend script of at least three related actions (Baron-Cohen, 1987; Leslie, 1987). The CELF score was determined by children's abilities in recognising linguistic concepts and recalling increasingly complex sentences as part of a story book game.

It would be an interesting area for future research to further investigate these global relations between pretend play and speech by assessing whether *specific* pretend play abilities were determined by specific speech measures. Tamis-LeMonda and Bornstein (1994) found in younger children that symbolic play at 13 months was predictive of children's semantic diversity, i.e., number of semantic concepts (agent, action, possession etc) they expressed in speech at 20 months, but MLU did not. Shore et al. (1984) found that children's MLU was significantly related to their ability to combine pretend schemes. The present thesis has found that concurrent global relations between pretend play and speech persist beyond the third year at a solitary level, but future research needs to take into account the increasingly inter-subjective nature of pretense (Goncu & Kessel, 1988; Howe & Bruno, 2010; Howes, 1985; Howes, et al., 1989). Parten (1932) distinguishes between solitary, parallel and cooperative play (see also Howes & Tonyan, 1999). Lewis et al. (2000) suggests that solitary and shared pretend play require different underlying abilities. Solitary play requires symbolising abilities, for example the understanding that one object can 'stand in' for another (e.g., DeLoache, 1995, 2002b), while shared symbolic play requires making sense of the pretense of others (e.g., P. L. Harris & Kavanaugh, 1993; P. L. Harris, et al., 1994) and coordination of successive pretend schemes (Bateson, 1955; Kavanaugh & Harris, 1999; Wyman, et al., 2009b). The question for future research then is not *if* children's symbolic abilities are related in the preschool years but *how* do they use one form of symbol production (i.e., speech and gestures) to coordinate another form of symbol formation (i.e., shared pretend play).

Pretend play with a partner "requires both that the child manipulate symbolic transformations and communicate the resulting symbolic meaning to a partner" (Howes & Tonyan, 1999, p. 145). Goncu and Kessel (1988) suggested that children do this by making open invitations to partners, by stating pretense plans, by the partner approving of these plans or by offering to changing them (see section 2.2). In standard conversation, speakers use their pragmatic understanding to coordinate meaning successfully between interlocutors (Clark, 1996; Clark & Wilkes-Gibbs, 1986). As children beyond the age of three are gaining pragmatic language skills, these abilities may be directly related to their pretend play success. Rephrasing misunderstood items, staying on a consistent play topic, eye contact and taking turns may all contribute to successful coordination of a pretense scenario. Preliminary evidence from DeKroon, Kyte and Johnson (2002) found that children with language impairment initiated pretend play with a partner less often than typically developing children, although they did actively respond to the initiations of their partner. It may be the case that children with poorer pragmatic language abilities will achieve lower levels of social pretend play compared to children with no such pragmatic difficulties. Pretend play success could be measured by initiation of pretend play schemes, the length of play schemes, proportion of play schemes the child successfully entered into and the number of transformations involved in these schemes.

7.6.3. The role of gesture in the construction of pretend play

An increasing body of research has identified that children's earliest pretend play acts are at least in part social in nature (Fiese, 1990; Garvey, 1990; Haight & Miller, 1993; O'Connell & Bretherton, 1984; Slade, 1987). According to Rakoczy and colleagues (Rakoczy, 2006, 2008; Striano, et al., 2001) pretense by the child begins as a primarily social, interpsychological process and over time becomes individually derived and creative. Children's pretense acts from emergence are 'caregiver led' in the sense that the parent controls both the objects available to the child to play with and offers suggestions and structure to the pretend scheme. Pretend play in children before the third year appears to be facilitated by the caregiver, as long as the caregiver is sensitive to the play scheme currently being performed by the child (Fiese, 1990). Beyond the second year, children do not merely imitate the pretense actions modelled to them by the caregiver (Rakoczy, et al., 2005a, 2005b) but appear capable of using the modelling of the adult as a 'springboard' for the generation of novel pretend acts (Nielsen & Christie, 2008). A question for future research is how does the gestural communication in the caregiver-child play partnership change, as the child presumably attains increasing competence, autonomy and status in the play partnership?

Previous research has found that children use the deictic gestures of caregivers to facilitate their understanding of requests (Kelly, 2001). However, pretend play is typified by the caregiver 'setting the scene' through speech while the hands are occupied by objects. It may be the case then that caregivers use deictic gestures *imperatively* to instruct children to gather objects in readiness for pretense. Over time, as children gain symbolic awareness and increasing status in the play partnership, they may begin using deictic gestures for the same purpose. They may also increase their production of iconic gestures (above and beyond their speech abilities) as they request the caregiver to perform actions in a particular manner. This research could reveal specifically how children become more autonomous and creative in their pretend play production with social partners.

7.6.4. Long-term effects of iconic gesture learning

There are two potential avenues for future research for exploring the longer term influence that the learning of iconic gestures may have on children's communication. The first is an exploration of whether the incorporation of iconic gestures into children's gesture lexicon subsequently affects their construction of sentences. The second involves a study which focuses on the overall benefits of gesture training for caregivers on their children's later developmental outcomes. The following section details these possibilities in turn.

7.6.4.1. Iconic gestures and object descriptions

According to the body of research by Kita and colleagues (Kita, 2000; Kita & Davies, 2009; Kita & Ozyurek, 2003; Ozyurek, Kita, Allen, Furman, & Brown, 2005), gestures are crucial in the process of formulating speech which is compatible with the linguistic possibilities of the language being spoken. Kita (2000) suggested that production of an utterance is a result of a constant interaction between two modes of thinking (spatio-motoric and analytic). In this view spatio-motoric imagery (which is concerned chiefly with actions in relation to body and the environment) is constantly shaped into units which are suitable for speech production (Kita & Ozyurek, 2003). Gestures are involved in this process, as they are influenced by both the linguistic possibilities of speech and the remaining spatio-motoric information that is not contained in speech (Kita & Ozyurek, 2003).

Of course, children compared to adult speakers have fewer linguistic resources at their disposal (Alibali, et al., 2009; Kidd & Holler, 2009). However, the findings of the present thesis suggest that when asked to describe a novel object for which they had no name, children used iconic gestures that depicted movement, when they had previously seen this gesture demonstrated to them. Importantly, these gestures were still incorporated into speech streams. In other words, they were not used by children as *conventional* gestures in McNeill's sense, because they did not appear to replace children's attempts to talk about the novel objects. A question for further research then is whether the learning of these iconic gestures to represent the objects bears any influence on how children speak about the objects. If these iconic gestures that children learn have no influence on the linguistic encoding process, it may be found that the production of these gestures in the 'gesture learned' group may not be as attached to the lexical affiliate (Butterworth &

Beattie, 1978; Morrel-Samuels & Krauss, 1992) as performance of similar iconic gestures in the ‘no gesture learned’ group. This may be because previously learned iconic gestures may be ‘free’ of the demands of the language. Children may be still producing these gestures with speech, as the gestures by themselves are not sufficient to disambiguate the object from others, but these gestures may show different temporal characteristics in their production.

A related line for future research involves separating the specific role of gesture in determining children’s representations of objects. In the third paper it was found that certain types of iconic gesture may act to change children’s thinking about an object or event, so that they focus, for example, more on its movement properties. However, the relation between iconic gestures and children’s subsequent descriptions needs to be separated from speech that matches the gesture in terms of the semantic information it provides. An experimental manipulation where children were either shown an iconic gesture to represent an object (or not) could explore whether iconic gestures *specifically* change children’s thinking about an object. One group of children could be shown a gesture depicting movement of an object with sentences matching the gesture (gesture + speech condition), one group given a gesture depicting movement of the object but no matching sentence (gesture only condition), one group given sentences that highlight the movement of the object but no gesture (sentence only condition), and one group where the movement of the object was neither highlighted in gestures or speech (control condition).

There are three possible findings. If iconic gestures play a significant role in children’s subsequent representation of the object (Goldin-Meadow & Beilock, 2010), it would be expected that *both* the amount of previously demonstrated movement gestures and the number of spoken references to movement would be significantly higher in the *gestures + speech* condition and the *gesture only* condition compared to any of the other groups. If the iconic gestures made no significant contribution to the children’s representation of the object and it was the matching sentences that had an exclusive role, it would be expected that the amount of movement iconic gestures and references to movement produced in the *gesture + speech* and *sentence only* conditions would be higher than the other two conditions. Finally, children may require both the gesture and the matching sentence to change their representations of the object. If this is the case the only difference found would be between the *gesture + speech* condition and the other three conditions.

7.6.4.2. Iconic gestures and later developmental outcomes

Another question that needs to be addressed in future research is whether there are any long-term benefits to the learning of iconic gestures in terms of children's development of language or cognition more generally. Research that has found that 18 month old children's gesture production predicts later vocabulary growth (e.g., Rowe & Goldin-Meadow, 2009a; Rowe & Goldin-Meadow, 2009b), has led to the specific hypothesis that explicitly teaching young children to produce gestures will facilitate overall language development at later ages. Goodwyn et al. (2000) instructed caregivers on ways to promote iconic gestures, by encouraging them to produce a set array of these gestures and by asking them to produce a higher rate of them in day to day interactions with their children (sign training group). This group was compared to a group which received no intervention (control 1), and a group which received training on verbal labelling of objects (control 2). They found that children of parents who received training targeted at gesture production scored higher on overall language scores at 30 months compared to the two control groups. Similarly, Gongora and Farkas (2009) found a significant difference between sign training and a control group on the number of vocal interactions between caregiver and child, and on the number of tactile interactions. Recent work has also identified that teaching children with autism to imitate the iconic gestures of adults has led to improvements in their spontaneous language production (Ingersoll & Lalonde, 2010; Ingersoll, Lewis, & Kroman, 2007). Acredolo and Goodwyn (2000) went further, suggesting that the children in the sign training group in Goodwyn et al. (2000) had a higher IQ score at age eight than children in control group 1, who received no intervention[45].

Alternatively, recent research has suggested that this facilitative effect of gestures should not be limited to iconic gestures only. LeBarton and Goldin-Meadow (2011) found that 18 month old children's vocabulary development was positively influenced by children being instructed to increase their *deictic* gestures towards target pictures. Beyond this age, children's iconic gestures in place of speech may no longer be relevant to children's later speech outcomes, as children come to expect a verbal label for objects (Capone & McGregor, 2004; Namy & Waxman, 1998). Iverson et al. (2008) in their cross cultural analysis of Italian and American children, observed significant differences in the number of iconic gestures that these children produced (Italian's producing more than Americans). This difference did not convert into Italian children reaching the two-word milestone any earlier than American children. They suggest that is it supplementary *deictic* gestures that influence linguistic change, as combining these gestures with a word relies on skills that the child has previously accomplished (e.g., identifying a referent). Iconic gestures are difficult for children to combine with speech as it requires a high level of coordination between vocal and motor activity, along with the ability to retrieve two symbols at once.

As Doherty-Sneddon (2008) and Matchett (2011) note, these perceived benefits to later developmental outcomes has led to a number of applied interventions targeted at typical and atypical populations (e.g., Ingersoll, et al., 2007). Websites including www.tinytalk.co.uk, www.signwithyourbaby.org and www.babysign.org.uk all point to long-term benefits of 'baby sign' training. However, as of yet, the long-term facilitation of cognitive outcomes has not yet been satisfactorily established (Doherty-Sneddon, 2008; Johnston, Durieux-Smith, & Bloom, 2005; Matchett, 2011). Indeed, in the present thesis

[45] Data on control group 2 (verbal training) was not reported.

there was little evidence of children's iconic gesture production having any long-term predictive effect on children's long-term speech or pretend play abilities. In a recent review of 17 studies by Johnston et al. (2005), there were a number of methodological weaknesses noted including no examples of randomised controlled trials, small sample sizes and poor longitudinal follow up. They also concluded that the methods of sign training used in the research studies were qualitatively different from the products and programs commercially available to caregivers. The evidence for a long-term facilitation of language is also mixed. For example the Goodwyn et al. (2000) study found that the overall improvement in language for children in the sign training group was significant up to 30 months, but lost significance by 36 months. It is a possibility that the facilitative effect of iconic gesture training is lost at this age, as the structure of language becomes more focused on combining labels into coherent streams, rather than by labelling (Capirci, et al., 2005; Capone & McGregor, 2004; Namy & Waxman, 1998). The first and second papers of the present thesis highlight the fact that children's iconic gesture production is tightly linked with their *concurrent* abilities in speech and their pretend play.

With the empirical evidence mixed at best, there is a need for research that examines the potential benefits of children receiving increased gestural input in their earliest interactions with their caregivers. An appropriate method of doing so would be to have four conditions. The first group would be a gesture training group, where parents are given specific instructions on how to interact with their children in order to encourage iconic gesture production. This group could be further split in subgroups by using a number of current sign training methods recommended by practitioners. There would then be three control groups. The first control group would receive no training. The second control group would receive verbal label training, similar to the Goodwyn et al. (2000) study. The third control group would be an engagement control group, which would give the caregiver training on how to establish interactions with their children and how to respond to children's attempts at engagement (e.g., their declarative deictic gestures). This final control group would be an attempt to separate whether it is the iconic gesture training *per se* that is having an influence on later developmental outcomes or whether the results found in previous research are based on the increased establishment of joint attentional episodes (Akhtar & Gernsbacher, 2007; Bruner, 1983; Tomasello & Farrar, 1986). The outcome measures could encompass concurrent and longitudinal measures in language and cognition generally. This potential future line of research has important applications for caregivers, as they determine how best to spend their efforts and resources to ensure good developmental outcomes (Doherty-Sneddon, 2008).

7.7. Contributions and conclusions

The present thesis has provided the first attempt to examine the symbolic domains of speech, gestures and pretend play together as part of a longitudinal study. The methods adopted allowed the possibility to challenge the theoretical perspective that had placed these domains as emerging as part of a general underlying capacity with symbols. By incorporating gesture production, this thesis considered for the first time an all encompassing view of language. I conclude that speech has a mediating role for both pretend play and iconic gesture production, but that these relations are likely to be based on different elements of speech.

This thesis has also contributed a novel investigation into how preschool school utilise the iconic gestures they observe into their own representations of objects. Unlike infants who appear to re-enact the gestures they see faithfully as part of interactive routines, I conclude that gestures may act to change how children ‘think’ about objects. This in turn affects the gestural strategies they adopt when asked to describe the object themselves through the gestural modality.

I expect that future research will explore in more detail the role that gestures can play in how children represent events and objects, structure pretend activities and the long-term effects of gesture training on future developmental outcomes.

Appendix 1: Sample parent information sheet

Title of project:
Investigating the development of cognitive symbolic representation and gestural communication

Introduction
Pretend play (for example pretending a box is a spaceship), language and gesture are important indicators of a child's developing of communication abilities. Early childhood is regarded as a crucial period for these skills to develop. The present study aims to explore the development and linkage of communicative skills by focusing on gesture, language and pretend play. We believe that the results of our study will be useful for all those involved with small children as it could provide information about the early indicators of communication abilities in later life
The study will take place over a period of one year and will comprise six different meetings. During the first meeting, we will explain to you the aim of the study and will introduce you to the different tasks. In addition, we will answer all questions you may have concerning the time frame or the tasks. All meetings will preferably take place at our Child Language Laboratory at the University of Manchester or, if that is not feasible, at your home. Each visit could take a couple of hours. Please think carefully about whether you are willing to give up this much of your time.

What will my child be asked to do?
Each visit, your child will be asked to take part in a four different tasks designed to explore their play and communication abilities.

Play task- for this task, your child will be presented with a number of objects (for example a piece of material or a white cube) and encouraged to play with them on their own. After a few minutes, the researcher will introduce a second set of objects for your child to play with. With this new set of toys, the researcher will fully interact and encourage play by showing different ways to play with the objects and by also providing vocal support. This task will take around forty-five minutes to complete and will be videotaped.

Language task- your child will be asked to take part in some exercises that assess a range of language abilities. For instance, one exercise to assess language production will involve asking your child to repeat back small passages of text. Another exercise will assess language comprehension by asking your child to point at pictures that have been described to them by the experimenter. This will take around 20 minutes to complete.

Non-verbal task- for this task, your child will be presented with a grid (2 x 2 or 3 x 3), which shows a number of pictures. One of the pieces of the grid will be missing. Your child will be asked to select which piece out of six options fills in the missing piece on the grid best. This task will take around 20 minutes to complete.

Gesture task- your child will be shown unusual shapes by the researcher (for example a triangle with a line through the middle). Once presented, your child will be asked to describe to the researcher what the shape looks like. Your child will also be shown a short video clip and asked to describe to the researcher what has happened. These tasks together will take approximately twenty minutes to complete and will be videotaped.

Some parent-child pairings will be randomly selected and asked if they would be willing to be observed as they play together, using videotape to film them. We will provide a number of age appropriate toys and videotape how you and your child play with the objects. This will be similar to a typical play scenario at home. We are also performing a second study that you and your child may be asked to participate in. We will give you further information about this study on a separate information sheet. We plan to complete the primary tasks, the natural observation and the second task during the period of two visits. However, if your child is tired during the testing, it may be required to complete the tasks during an additional visit.

Once your child has done all the tasks, and if you consent to your child being tested again around six months later, we will contact you to let you know if your child is required for later testing and make arrangements for the next visits.

Will my child's data be confidential?
The data and videos provided by your child will remain confidential. Only your child's age and gender will be recorded and linked to a unique identification number. If you agree for your child to take part in the follow up study, we will ask you to provide some contact details. If you are happy for your child to participate, we will ask you to fill in a consent form, which will also be linked to your child's identification number. Your child's data will only be accessible to the PhD student and to his supervisors, and will be stored in a locked container. Your child's data will not be passed on or published without their identity first being protected.

Does my child have to take part?
Your child does not have to take part in the study. If you decide to allow your child to take part and then later change your mind, either before the study starts, during it or afterwards you can withdraw your child without giving your reasons, and, if you wish, your child's data can be destroyed. Similarly if before or during the study your child decides that they do not want to take part they can withdraw without giving a reason, and if they wish their data can be given back to them or destroyed.

Where can I obtain further information if I need it?
If you have any questions or would like to know more about the study please contact Simon Child by email (Simon.Child@postgrad.manchester.ac.uk). Alternatively this project is being supervised by Dr Simone Pika (simone.pika@manchester.ac.uk) and Dr Anna Theakston (anna.theakston@manchester.ac.uk).

Appendix 2: Sample consent form

Title of Project: Investigating the development of cognitive symbolic representation and gestural communication.

The participant should complete the following part of this sheet him/herself **please delete** as necessary **and initial**

1. Have you read the Parent Information Sheet?	**YES/NO** Initials:…
2. Have you received enough information about the study?	**YES/NO** Initials:…
3. Do you consent to your child being video taped as detailed in the Parent Information Sheet?	**YES/NO** Initials:…
4. Do you understand that you do not need to take part in the study and if you do enter, you and your child are free to withdraw:- * at any time * without having to give a reason for withdrawing * and without detriment to you or your child?	**YES/NO** Initials:…
5. Do you agree for your child to take part in this study?	**YES/NO** Initials:…

Name of participant: ……………..……**Signed:** .... **Date:** ....

Name of researcher: ………..…… **Signed:** .... **Date:** ....

Do you consent for the videotapes to be retained and used until the study is complete?	**YES/NO** Initials:……
Do you consent for the data obtained from your child to be used for conferences/ publications?	**YES/NO** Initials:……
Do you consent for the videotapes to be retained and used for illustratory purposes in teaching and conferences?	**YES/NO** Initials:……

Name of participant: ……………..……**Signed:** .... **Date:** ....

Appendix 3: Sample parent questionnaire

Name……………………….. Child's name…………………………..

1. Please state your current age (tick where appropriate)

Under 16........ 16-24……. 25-33……. 34-40……. 41 and above…….

2. Please state your level of education (tick where appropriate)

High school (GCSE's, NVQ level 2, O-Levels etc)	.…….
College (A- levels, NVQ level 3 etc)	…….
First Degree (BSc, BA)	……..
Higher degree (MA, PhD etc)	……..
Other qualification (please give details)	………………………...
No qualifications	……..

3. Are you currently employed or in full-time education? (Circle as appropriate) YES/ NO

If yes, please state your current position …………………………………..

Appendix 4: Descriptive statistics for other gesture measures (phase 1)

Gesture Measure	Mean	SD	Range
Number of iconic gestures	8.20	6.92	1-31
Total number of gestures	25.92	17.02	2-71
Words per gesture	6.43	4.11	.55-21.67
Words per iconic gesture	25.53	23.43	.63-133

Appendix 5: Effect sizes for complex regressions compared to simple regressions

	IV's		
	Phase 1	Phase 1	Phase 2
Predicted Variable	Phase 2	Phase 3	Phase 3
CELF total	.104	.103	.022
ToPP	.458	.459	.570
Proportion Iconic	.407	.345	.271
Raven's	.182	.168	.057

Appendix 6: Kappa statistics for agreement between children in the SO Condition

Child ID	1	2	3	4	5	6	7	8	9	10	11	12
1	x	.421	.648	.315	.131	-.028	-.028	-.013	.143	.106	.143	-.043
2	.189	x	.120	.057	.249	-.048	.057	.079	.162	.211	.057	.034
3	1.000	.450	x	.491	.229	-.019	-.019	-.009	-.019	-.475	.236	-.028
4	1.000	.476	1.000	x	.493	-.009	-.009	-.005	-.009	-.023	-.009	-.014
5	.304	1.000	.315	.324	x	-.014	-.014	-.007	.324	.310	-.014	-.020
6	-.028	-.048	-.018	-.009	-.014	x	-.009	-.005	-.009	-.023	-.009	-.014
7	-.028	.476	-.018	-.009	-.014	-.009	x	.498	-.009	.488	-.009	.493
8	-.014	1.000	-.009	-.005	-.007	-.005	1.000	x	-.005	1.000	-.005	1.000
9	.486	1.000	-.018	-.009	.493	-.009	-.009	-.005	x	1.000	-.009	-.014
10	.142	.549	-.475	-.023	.172	-.023	.181	.191	.386	x	-.023	.172
11	.486	.476	.491	-.009	-.014	-.009	-.009	-.005	-.009	-.023	x	-.014
12	-.043	.285	-.028	-.014	-.021	-.014	.324	.329	-.014	.310	-.014	x
Mean	.170											

This appendix shows the kappa calculations for each child in the SO Condition compared to every other child in this condition. Each calculation was based on the total iconic gestures produced by each child for all of the target objects.

Appendix 7: Chi-square analyses for movement based object manipulations

Spiky Ball	Object manipulation- squeeze		
	Yes	No	Total
MD Condition	10	3	13
PF Condition	12	5	17
SO Condition	8	12	12

$\chi^2(2,42) = .332$, $p = .574$

Sway Triangle	Object manipulation- rock		
	Yes	No	Total
MD Condition	9	4	13
PF Condition	11	6	17
SO Condition	6	6	12

$\chi^2(2,42) = .1.074$, $p = .585$

Stretch Toy	Object manipulation- stretch		
	Yes	No	Total
MD Condition	6	7	13
PF Condition	10	7	17
SO Condition	8	4	12

$\chi^2(2,42) = .1.105$, $p = .575$

String Ball	Object manipulation- bounce		
	Yes	No	Total
MD Condition	9	4	13
PF Condition	13	4	17
SO Condition	7	5	12

$\chi^2(2,42) = .1.083$, $p = .582$

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