Effect of Language Background on Metalinguistic Awareness and Theory of Mind

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Author's Declaration

I declare that this thesis is a presentation of my original work that has not been submitted for any other degree or award. All additional sources of contribution have been acknowledged accordingly. The work was completed under the supervision of Dr. Martin Doherty and conducted at the University of Stirling, United Kingdom.

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Abstract

Research has shown that theory of mind tends to develop in typically-developing children at about the age of 4 years. However, language appears to play a great role in this, particularly as deaf children, particularly those born to hearing parents, display extreme delays in theory of mind development, while bilinguals have been found to develop at a somewhat faster rate than monolinguals. Additionally, effects of culture on theory of mind development remain somewhat unclear, as there have been mixed results in past research. Theory of mind has also been correlated with metalinguistic ability and executive functioning skills, leading to multiple hypotheses regarding what drives theory of mind development.

The aim of this doctoral thesis was to examine the relationships between theory of mind, metalinguistic awareness, and executive functioning, as well as to evaluate how language and culture play a role in these relationships. Four studies were conducted in an attempt to seek answers to six research questions surrounding this aim. Study1 evaluated theory of mind, metalinguistic awareness, and executive functioning among hearing nursery children in Central Scotland. Study 2 was aimed at evaluating these same skills among deaf children in the U.S. and U.K., as well as developing a scaling of theory of mind abilities among deaf children. Study 3 assessed these skills among deaf Ghanaian children, as well as evaluating theory of mind abilities among a group of hearing Ghanaian children. Finally, Study 4 compared monolingual and bilingual children on theory of mind, metalinguistic awareness, and executive functioning. Results show that there is a strong link between theory of mind and metalinguistic awareness among hearing children that is not explained by executive functioning skills. This relationship was not apparent among deaf children, who struggle more with theory of mind than metalinguistic awareness. The deaf children in Ghana were delayed

compared to their Western peers; hearing Ghanaian children were delayed compared to their Western peers as well, but only slightly. Bilingual children and monolingual children performed similarly on false belief and set-shifting tasks; however, monolingual children outperformed bilinguals on metalinguistic awareness and inhibition tasks, possibly due to low verbal mental age among the monolinguals. Results of the four studies suggest that language does play a part in the relationship between theory of mind and metalinguistic awareness. Due to limited data, cultural effects remain unclear. It is proposed that deaf children's struggle with theory of mind stems from their difficulty with abstract concepts.

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This thesis is dedicated to the memory of my grandfathers

John Pearson

and

José Rosas

While I am saddened that each of you passed before I was able to complete this journey, I hope that knowing I had embarked on it made you proud.

Publications Arising from this Thesis

Pearson, D. K., & Doherty, M. J. (2010). Issues of representation: Developmental patterns of theory of mind, metalinguistic awareness, and executive functioning. Poster presented at British Psychological Society Developmental Section, London. September, 2010.

Pearson, D. K. (2012). Development of theory of mind, metalinguistic awareness, and executive functioning in nursery children. Talk presented at Scottish Federation of University Women Research Presentation Day, Glasgow, Scotland. April, 2012.

Pearson, D. K. (2012). Theory of mind development in Ghanaian children. Talk presented at Stirling Graduate Research School Postgraduate Research Conference 2012, Stirling, Scotland. May, 2012.

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Chapter One

Introduction

Scientists have long been interested in the process of early childhood development, with systematic studies of infant behaviour spanning back to the early to mid-19th century (Shonkoff & Phillips, 2000). The importance of early life experiences has been of increasing interest given the media attention regarding the malleability of the developing brain (Shonkoff & Phillips, 2000). Early learning is essential for preparing for formal education, resulting in long term effects not only for the children as they grow into adulthood, but also on a larger scale in terms of social well-being and a well-prepared workforce (Ball, 1994). Given the importance of development of vital skills in early childhood, understanding what experiences and backgrounds lead to effectual development, or alternatively, delayed development, is crucial to ensure children are given the best chances to succeed.

Theory of mind, metalinguistic awareness, and executive functioning are key cognitive and social skills that typically show significant development by around 4 to 5 years of age (Carlson & Moses, 2001; Doherty & Perner, 1998). There is some evidence, however, that children who lack critical early life experiences, such as language input, develop some skills at a delayed rate in comparison to the majority of children (Peterson & Siegal, 1995; Wood, Wood, Griffiths, & Howarth, 1986). The purpose of this thesis was to investigate how early life language and cultural background interplay with the development of these skills in the hopes that early interventions may be designed to support children that are at-risk for delays.

Theory of Mind

The introduction of the phrase ‘theory of mind’ by Premack and Woodruff in 1978 stimulated a wealth of research into whether young children have a theory of mind, and how and when it develops. Simply put, theory of mind is the ability to impute mental states, such as beliefs, feelings, desires, and intentions, to oneself and others. The term is now widely used to represent how children come to understand the mind and mental states, with belief considered by many to be of primary focus. A full understanding of beliefs implies that one can understand that beliefs are not always true, and can indeed sometimes be false. It is this reasoning that has led to the development of what some consider the litmus test for assessing theory of mind – the false belief task. This task has been extensively used in research involving both typically developed and atypically developing children, with general acceptance of the fact that typically-developing children begin to consistently demonstrate success on the task at around 4 years of age.

Some researchers have argued that the false belief task only measures *explicit* theory of mind, and that implicit false belief reasoning develops in infancy, rather than around 4 years of age (e.g., Neumann, Thoermer, & Sodian, 2008; Onishi & Baillargeon, 2005; Southgate, Senju, & Csibra, 2007). Onishi and Baillargeon (2005), using a violation-of-expectation task (one in which the protagonist looks for the object in the correct location, rather than a location he or she falsely believed it to be) found that 15-month-old infants looked significantly longer at a scene that violates expectation. Using eye-tracking, Southgate et al. (2007) found that most 25-month-old children correctly anticipate where the protagonist with a false belief will search for an object, while Nuemann et al. (2008) fold similar results among 18-month-olds. Other studies have suggested false belief understanding among children as young as 7 months of age (Kovács, Teglas, & Endress, 2010).

Additionally, while studying a group of criminal offenders with psychopathic tendenceies, Shamay-Tsoory, Harari, Aharaon-Peretz, and Levkovits (2010) created a model of theory of mind that includes two components: "(1) affective ToM encompassing inferences about emotions (i.e., "hot" aspects) and (2) cognitive ToM encompassing inferences about knowledge and beliefs (i.e., "cold" aspects of ToM)" (Vetter, Altgassen, Phillips, Mahy, & Kliegel, 2013, p. 115). Cognitive theory of mind is a prerequisite for developing affective theory of mind (Shamay-Tsoory et al., 2010), supported by the fact that evidence suggests cognitive theory of mind develops prior to development of affective theory of mind (Ruffman & Keenan, 1996, as cited in Vetter et al., 2013). This is in line with the fact that children must gain a basic understanding of others' beliefs prior to being able to appreciate that beliefs guide others' emotions (Vetter et al., 2013).

However, despite the growing interest in implicit measures of false belief understanding and the current debate about their relationship to explicit later abilities, as well as growing interest in the second tier "affective" theory of mind, this thesis is concerned with explicitly demonstrated understanding through the standard false belief task, the validity of which has been shown through meta-analysis (Wellman, Cross, & Watson, 2001).

False belief reasoning is typically assessed with two commonly used tasks: the *unexpected transfer task* and the *unexpected contents task*. The unexpected transfer task is also sometimes referred to as the unexpected location task, the transfer task, the Maxi task, and the Sally-Ann task. In this task, a character (acted out in pictures or with dolls) places an object in one location, and the object is moved while the character is absent. Children are then asked where the character will look for the object upon his or her return – the original location or where the object is currently located. Typically children are also asked control questions, such as where the object was originally placed (memory question) and where the object is currently (reality question) (Doherty, 2009).

The unexpected contents task is also referred to as the contents task, Smarties task, or deceptive box task. In the task, the child is shown a box or a container that contains something other than the presumable contents. A classic version of the task involves showing the child a Smarties chocolate tube that is actually filled with pencils, rather than Smarties. Children are asked what they think is in the container and then shown what is actually inside. After being shown what is inside, children are asked what they originally thought was inside the container (own belief question) and what someone else who has not been shown the contents will think is inside upon first viewing the container (other belief question). Hogrefe, Wimmer, and Perner (1986) originated this type of task (Doherty, 2009).

Theory of mind and executive functioning. Executive functioning, or the set of skills related to impulse control, attention, and working memory, has been repeatedly shown to correlate with performance on the false belief task. The nature of the relationship between executive functioning and theory of mind abilities, namely, the role executive functioning has in the explicit indication of a theory of mind, has been debated (e.g., Carlson & Moses, 2001; Hughes, 1998; Perner, Lang, & Kloo, 2002; Sabbagh, Xu, Carlson, Moses, & Lee, 2006). Several theories have been posed to explain the relationship, although evidence is still somewhat weak for definitively differentiating between them. One theory for this link that grew in popularity in the 1990s was that false belief tasks place strong executive demands on the child. The arguments were made that the false belief task does not solely depend on the ability to understand another's false beliefs, but also required sufficient working memory, the ability to switch between the child's and another's perspective of a situation, and inhibition of the true nature of the situation. If this was indeed the case, one would expect that lowering the executive demands of false belief tasks would result in an increase in performance.

The primary executive functioning skills are inhibition, working memory, and set-shifting. Inhibition is formally defined as the ability to deliberately inhibit a strong, automatic response (Miyake et al., 2000). The classic Stroop task (Stroop, 1935) and subsequent Stroop-like tasks (e.g., Day/Night Stroop-like Task; Gerstadt, Hong, & Diamond, 1994) are designed to elicit such strong automatic responses and therefore are often used to test inhibitory skills. Working memory, according to Baddeley (1992), refers to “a brain system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning” (p. 1). Simply put, working memory involves the ability to hold and mentally manipulate information relevant to a task. A task typically used to assess working memory is the backwards digit span task. Set-shifting involves the ability to shift between two sets of rules, with a commonly used task for assessing set-shifting abilities being the Dimensional Change Card Sort (DCCS; Frye, Zelazo, & Palfai, 1995). While these tasks are largely aimed at assessing one aspect of executive functioning at a time, there is undoubtedly some overlap, given that “executive functions are correlated, but separable” (Friedman et al., 2008). This results in some ambiguity in terms of interpreting task performance results; Miyake et al. (2000) highlights this fact by reporting that the Wisconson Card Sorting Task (upon which the DCCS was based) “has been suggested by different researchers as a measure of ‘mental set shifting,’ ‘inhibition,’ ‘flexibility,’ ‘problem solving,’ and ‘categorization,’ just to name a few” (p. 53).

Despite this somewhat vagueness, performance on theory of mind tasks and a variety of executive functioning tasks have been found to correlate beyond age.

Carlson and Moses (2001) evaluated children's inhibitory control and theory of mind abilities by using a battery of tasks. Children were given tasks aimed at assessing both inhibitory control and theory of mind. The PPVT-R (Dunn & Dunn, 1981) was also administered to each child as a measure of verbal ability. The theory of mind battery included an unexpected transfer task, an unexpected contents task, a deceptive pointing task, and an appearance-reality task. Two mental state control tasks, designed to mirror two of the theory of mind tests but less any reference to mental states, were also conducted. The inhibitory control battery included ten tasks, including two Stroop-like tasks - the Day/Night task designed by Gerstadt et al. (1994) and a similar Grass/Snow task - a spatial conflict task, the DCCS, a Simon-says like task called the Bear/Dragon task, and several other tasks measuring inhibition.

Carlson and Moses (2001) found that the unexpected contents, unexpected transfer, deceptive pointing, and appearance-reality tasks all correlated moderately ($.36 \leq r \leq .58$). These significant correlations persisted when controlling for age, gender, and verbal ability, although they were reduced to low-to-moderate correlations ($.18 \leq r \leq .35$). Four-year-olds generally outperformed three-year-olds on both theory of mind measures and on inhibitory control measures. As the ten inhibitory control measures were moderately intercorrelated ($\alpha = .76$, average item-total $r(92) = .47$), a composite score was calculated. After partialling out the effects of age, gender, and verbal ability were partialled out, the majority of the inhibitory control measures correlated with the theory of mind battery, and all theory of mind measures correlated with the inhibitory control battery. The two battery scores were significantly, moderately correlated, $r = .41$, $p < .001$. These batteries remained related when also controlling for other extraneous factors: family size and performance on mental state control, motor sequencing, and pretend action tasks.

Despite the interrelatedness of inhibitory control and theory of mind batteries, the fact that some individual measures, such as the deception task and the two false belief measures, did not correlate indicates that these remain two separate, although apparently related, abilities. While Carlson and Moses's (2001) findings suggest that developing inhibitory control facilitates and is possibly necessary for theory of mind to fully develop, they support the notion that it is not the sole factor involved in this development.

Perner, Lang, and Kloo (2002) followed up Carlson and Moses's (2001) study by further examining the relationship between theory of mind and self-control. They found that performance on the dimensional change card sort task (DCCS) correlated well with performance on both the usual false-belief unexpected transfer task and a false-belief "explanation" task. The explanation task involves a story of twins, based on the procedure used by Robinson and Mitchell (1995). Perner, Lang, and Kloo presented four versions of the twin scenario in which children ultimately have to answer why one of the twins mistakenly looks in the wrong location for something (the twin holds a false belief about the location). A go-nogo task was included as a measure of inhibition. The researchers found that performance on the DCCS correlated strongly with both the unexpected transfer task and the explanation task (*r*s = .65). Performance on the go-nogo task only reduced correlations by .02 at most, showing that the relationships between performance on the belief tasks and the DCCS were not due to the ability to inhibit strong response tendencies. Also, as the explanation version of the false belief task is described as minimizing executive function demands that the typical version places on the child, yet is correlated to the same extent as the typical task, this further suggests that inhibition is not the key to developing theory of mind understanding.

Perner, Lang, and Kloo (2002) reviewed four of the prominent theories as to why executive function and theory of mind tasks correlate, as well as how their data fit in with these theories. The first theory, that "children gain better self-control with a better understanding of their mind" (Perner, 1991; Wimmer, 1989; both as cited by Perner, Lang, & Kloo, 2002), while not completely disputed by Perner, Lang, and Kloo's results, was not supported in terms of executive inhibition specifically. Perner, Lang, and Kloo (2002) suggest that "the present finding that performance on the go-nogo task was not substantially related to the link between false-belief understanding and card sorting speaks against this particular application of the more general idea that a better understanding of the mind leads to better self-control" (p. 764).

Perner, Lang, and Kloo (2002) did not argue against the argument made by Ozonoff, Pennington, and Rogers (1991) that theory of mind and executive functioning abilities arise from the same brain region, and as such are similarly impaired among children on the autism spectrum and go through normal development through maturation for typically developing children. However, Perner, Lang, and Kloo's findings did not help to distinguish the plausibility of the theory. Contrastingly, Perner, Lang, and Kloo's findings did appear to support the proposition made by Frye, Zelazo, and Palfai (1995) that the ability to reason with embedded conditionals (e.g., if, if, then) accounts for the developmental correlation between theory of mind and inhibition tasks. Perner, Lang, and Kloo stated that the fact that the go-nogo task was easier than the DCCS for children in their study supported that theory; however, Perner, Lang, and Kloo still found the theory problematic for reasons as highlighted in other studies (e.g., Frye, Zelazo, Brooks, & Samuels, 1996; Perner & Lang, 1999).

Finally, Perner, Lang, and Kloo (2002) discussed a theory put forth by Russell (1996, 1997, as cited in Perner, Lang, & Kloo, 2002) that the ability to monitor one's actions and act at will are requirements for the development of a ‘pretheoretical’ form of self-awareness, and that it is this self-awareness that is necessary for individuals to fully grasp mental concepts (p. 764). Perner, Lang, and Kloo contended that their findings did not rule out this theory, as they did not rule out the other theories discussed, but that they did provide strong support against the argument that the relationship between performance on theory of mind tasks and executive functioning tasks arises merely due to problems with inhibition.

Sabbagh, Xu, Carlson, Moses, and Lee (2006) expanded on the inquiry into the relationship between executive functioning and theory of mind by including culture as an additional factor. Sabbagh et al. assessed whether the relationship found between theory of mind and executive function was also found among Chinese preschoolers. They tested a sample of 109 Chinese preschoolers and a sample of 107 U.S. preschoolers on a battery of theory of mind and executive functioning tasks, the same as those used by Carlson and Moses (2001). While they found that the Chinese children outperformed their American counterparts on the executive functioning tasks, they did not see a similar difference on the theory of mind tasks. However, despite this difference in performance trends between children from the two countries, theory of mind and executive functioning were once again found to correlate significantly and positively, even after controlling for age, sex, and verbal ability. This relationship was evident for both the U.S. and the Chinese sample, suggesting that the relationship between executive functioning and theory of mind is robust across the two cultures.

Theory of mind and metalinguistic awareness. Doherty and Perner (1998) argued that metalinguistic tasks and the false belief task are both “based on a common conceptual understanding that one and the same state of affairs can be conceived in different ways” (p. 303). Indeed, the ability to hold more than one representation of events in mind at one moment is a crucial aspect of being able to pass the false belief task. The child must be able to hold not only his or her own (true) representation of the situation, but also the (false) representation being held by the character in the task in mind. As such, it involves metarepresentation, the ability to differentiate between representations. Metarepresentation is also a critical component of metalinguistic awareness, given that metalinguistic awareness involves the understanding that language is representational.

The link between theory of mind development and metalinguistic awareness development was shown in Doherty and Perner's 1998 paper and followed up by several others (e.g., Doherty, 2000; Farrar & Ashwell, 2012; Farrar, Ashwell, & Maag, 2005). Doherty and Perner (1998) tested a group of preschool-aged children on a traditional unexpected transfer false belief task and a metalinguistic task involving synonyms. The metalinguistic task was administered in two versions – the judgment version, in which children had to monitor the use of an appropriate synonym for an object by another person, and the production version, in which children had to produce the synonyms themselves. The researchers found that the traditional false belief task correlated strongly (rs $\geq .60$) with both versions of the synonym task, even when accounting for verbal mental ability and performance on a control task. Doherty and Perner suggested that these findings support the existence of an underlying mechanism involving representations that drives the development of both theory of mind and metalinguistic awareness. They argued that, while strongly and specifically related, metalinguistic awareness and explicit false belief understanding are not the same thing; however, they argued that "both are based on a common conceptual basis" (p. 298), providing evidence for a metarepresentation theory.

Doherty (2000) sought to follow up the finding that understanding of synonymy was related to false belief understanding by expanding the concept to homonymy. Doherty found that performance on a homonym task was strongly and significantly associated with performance on the synonym task. Additionally, performance on both the synonym and homonym tasks were significantly related to performance on the typical unexpected transfer task to at least a moderate degree, even after partialling out verbal mental age and age ($.35 \leq r$s $\leq .66$). Doherty once again argued these findings were in support of an underlying metarepresentation development, although he acknowledged that, while not as supported, a one-to-one mapping or mutual exclusivity bias account could not be entirely ruled out without additional investigation.

Farrar, Ashwell, and Maag (2005) also examined the relationship between metalinguistic awareness and theory of mind development, albeit by examining phonological awareness rather than homonymy and synonymy. Phonological awareness represents one aspect of metalinguistic awareness, as it "refers to an awareness of the sound structure of language" (Farrar et al., 2005, p. 158). In their longitudinal study, Farrar et al. examined the relationship between phonological awareness and early language development and the relationship between phonological awareness and theory of mind. They examined whether language ability at 2 years of age predicted children's abilities on two phonological awareness tasks, one involving rhyming and the other involving deleting a syllable from a two-syllable word, at 4 years of age. They found that this was indeed the case, that early language ability was significantly, positively related (rs $\geq .49$) to phonological awareness performance; this relationship remained (rs $\geq .45$) when controlling for their performance on the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1981, as cited in Farrar et al., 2005). Additionally, performance on the phonological awareness task was significantly and positively related (rs $\geq .64$) to performance on measures of theory of mind. The relationships between the rhyming phonological awareness task and theory of mind tasks remained when controlling for performance on the PPVT and age (rs $\geq .57$).

While Farrar et al. (2005) indicate that "both tasks may require the child to focus on conflicting or different representations of a situation" (p. 169), as consistent with the metrapresentation theory, they also state that "executive functioning ability may underlie this relationship between ToM and phonological awareness, rather then [*sic*] conflicting representations per se" (p. 169). That is, Farrar et al. argued that developing executive functioning may be the underlying cause for the relationships found between theory of mind and metalinguistic awareness abilities, rather than a developing metarepresentational understanding.

To follow up their 2005 study, Farrar and Ashwell included measures of executive functioning, primarily inhibition, in their similarly structured 2012 study. Their aim was to tease apart the nature of the relationship between theory of mind and metalinguistic awareness, with particular focus on a representational or perspective shifting hypothesis and an executive functioning hypothesis. The perspective shifting hypothesis arises from Doherty's earlier work (Doherty, 2000; Doherty & Perner, 1998), teamed with follow-up work by Perner, Stummer, Spring, and Doherty (2002) and Kloo and Perner (2005). Perner, Stummer et al. and Kloo and Perner argued that central to children's ability to pass false belief and metalinguistic awareness tasks is their understanding that one thing or one situation can be described differently dependent on perspective. That is, in order to pass these tasks, one must be able to shift flexibly between perspectives, focusing only on the salient perspective for a task or question while consciously disregarding or ignoring the other. The executive functioning hypothesis, on the other hand, suggests that difficulty with metalinguistic awareness and theory of mind arises from still-developing executive functioning. This argument, that the link between metalinguistic awareness and false belief understanding is due to a shared need for inhibitory control, arises from arguments made by Garnham and Garnham (2002, as cited in Farrar & Ashwell, 2012) and Garnham, Brooks, Garnham, & Ostenfeld (2002, as cited in Farrar & Ashwell, 2012).

In an attempt to identify the underlying reasons for the relation between performance on measures of theory of mind and metalinguistic awareness, Farrar and Ashwell (2012) conducted two studies. In Study 1, the authors tested a group of 4-year-olds on a semantic rhyming task, non-semantic rhyming task, the PPVT, four measures of theory of mind, and two measures of executive functioning: the DCCS and a memory for sentences task. The semantic rhyming task included a distractor object in each trial that was semantically related to one of the rhyming (but not semantically related) objects. The non-semantic rhyming task included a distractor object in each trial that was not semantically related to either of the rhyming (and again not semantically linked) objects. Performance on the theory of mind tasks was significantly, positively related to performance on both rhyming tasks, the DCCS, and PPVT, although not with the sentence memory task, when controlling for age. When controlling for PPVT scores, theory of mind performance remained related to rhyming performance on both forms of the rhyming task. The relationships between theory of mind performance and performance on the rhyming tasks remained significant when partialling out the effect of the inhibitory control task, the DCCS, *r*s > .48. This final correlation suggests that the relationship between rhyming and theory of mind did not arise due to issues with inhibitory control.

In Study 2, Farrar and Ashwell (2012) included all of the tasks used in Study 1 and added two tasks: a semantic relations task and the day-night task. The semantic relation task used the same materials as the semantic rhyming task, but instead of indicating items that rhyme, children were to select items that “go together” semantically. This task was also administered on a separate testing day from the rhyming task. The day-night task is a task adapted from one created by Gerstadt, Hong, and Diamond (1994) and is a measure of inhibitory control. Similarly to for Study 1, theory of mind performance was related to both rhyming tasks when controlling for PPVT score, *r*s $\geq .36$. The link between theory of mind and rhyming remained significant after controlling for memory for sentences and a composite inhibitory control measure, *r*s $> .33$. A hierarchical regression in which age and PPVT were entered as control variables, inhibitory control measures and memory for sentences were entered in step 2, and theory of mind performance was entered in step 3, showed that even after accounting for the effects of control and executive functioning variables, theory of mind contributed significantly to predicting rhyming performance.

Farrar and Ashwell (2012) argued that support for the executive functioning hypothesis was limited based on their findings. They found that the measures of inhibitory control they used, the DCCS and the day-night task, did not correlate with the rhyming tasks and in fact did not even correlate with each other. They suggested that the DCCS may actually be assessing perspective or set shifting rather than inhibitory control and suggest future researchers use other measures of inhibitory control than this task. They concluded by stating that their “studies suggest that ToM is related to the emergence of metalinguistic development because it reflects children’s ability to flexibly shift between perspectives” (p. 88), in line with the perspective-shifting hypothesis put forth by Perner, Stummer et al. (2002). Given the results of these studies, it appears that perspective taking and shifting abilities are key to the development of both theory of mind understanding and metalinguistic awareness, above and beyond executive functioning skills.

Theory of mind and culture. Theory of mind has been investigated in populations around the world, although a large percentage of these investigations have been conducted with children in developed countries. Wellman, Cross, and Watson (2001) conducted a meta-analytical study of 178 separate studies including versions of the false belief task. While Wellman et al. (2001) conducted an analysis regarding whether the country of origin influences performance on the task, the countries included aside from the United States, United Kingdom, Canada, and Australia were very limited: Korea, Japan, and Austria. While in more recent years, a rise has been witnessed in studying populations in East Asian countries (e.g., Ahn & Miller, 2012; Barrett et al., 2013; Sabbagh, Xu, Carlson, Moses, & Lee, 2006; Wang, Low, Jing, & Qinghua, 2012; Wellman, Fang, Liu, Zhu, & Lin, 2006), there are still relatively few studies of populations outside of North America, Europe, Australia, and Asia.

Asian cultures make up the primary non-Western group receiving attention regarding theory of mind development. Wellman et al. (2006) compared the performance of Chinese children living in Beijing with English-speaking children in the U.S. and Australia on a theory of mind scale consisting of six tasks. The researchers found that Chinese children showed a consistent sequence of development that was similar in many ways to those found for American and Australian children. Sabbagh et al. (2006) similarly assessed theory of mind development among Chinese and U.S. preschoolers, as discussed in the section on theory of mind and executive functioning, and found similar performance between groups. More specifically, Sabbagh et al. found that while Chinese preschools out-performed the U.S. children on measures of executive functioning, they did not perform significantly differently on theory of mind tasks.

Wang et al. (2012) also assessed false-belief understanding among Chinese children, although no comparison Western group was included in their analyses. However, in addition to evaluating behavioral performance on unexpected-transfer and unexpected-contents tasks, Wang et al. also assessed implicit theory of mind understanding using anticipatory looking when there was a violation of expectation. They found that, similarly as to has been found recently in studies of Western children, Chinese children also showed accurate anticipatory looking across a range of false-belief tasks, despite erring on verbal responses to direct questions. This suggests a similar developmental trend in terms of implicit to explicit theory of mind understanding among Western and Chinese children. Barrett et al. (2013) also evaluated Chinese children using gaze-analysis, as well as children from Ecuador and Fiji. All children were from traditional, non-Western societies. Barrett et al. administered three spontaneous-response false-belief tasks that had previously been used with Western children. The tasks assessed preferential-looking and anticipatory looking during two modified unexpected-transfer tasks and a violation-of-expectation task. They found that children tested similarly to Western children across tasks, indicating “a remarkable degree of convergence between early false-belief understanding in Western and non-Western populations” (p. 5).

One notable contrast to these previous studies is that from Ahn and Miller (2012). Ahn and Miller compared children from Korea with children in the U.S. on false-belief understanding using three unexpected transfer tasks. Contrasting with the findings involving Chinese children, Ahn and Miller found that the Korean children outperformed American children on the measures of false belief. This indicates that perhaps there are further intricacies and differences in culture among Asian cultures that may play a role in theory of mind development. While there is some support for this from Lewis, Koyasu, Oh, Ogawa, Short, and Huang's (2009) study of three Asian cultures (Korean, Japanese, and Chinese), a more comprehensive examination of performance among children from different Asian countries would have to be conducted in order to determine this.

Avis and Harris (1991) conducted one of the few studies involving children in a unique population – Baka children living in the rain forests of southeast Cameroon. Avis and Harris administered a form of the typical unexpected transfer false belief task to a group of 34 Baka children. In the task, the children were invited to move a portion of desirable food from a container to a hiding place while the adult preparing the food was absent. The children were then asked to predict where the adult would look for this food upon his return. The majority of older children (mean age = 5 years) and a minority of the younger children (mean age = 3.5 years) correctly predicted that the adult would look in the incorrect, original location. Avis and Harris's results suggest that as the children were able to demonstrate false belief understanding at an age similar to Western children, this supports the notion that theory of mind reasoning develops universally among children.

Vinden (1996) also studied theory of mind development among a unique group, Junín Quechua children in Peru. Vinden used a false belief location task also modeled on the unexpected transfer task, as well as an unexpected contents task and an appearance/reality task. Despite the tasks being administered by a native Quechuan collaborator, children between the ages of 4 and 8 years performed poorly on all of the tasks. This suggested that either the Quechuan children did not understand false belief even by the age of 8 years, or that possibly the tasks did not translate well into their culture.

In a second study, Vinden (1999) adapted the task used by Avis and Harris (1991) to assess theory of mind in four cultural groups: Mofu schooled children from Northern Cameroon, Tolai schooled children from Papua New Guinea, Tainae unschooled children from a remote jungle village in Papua New Guinea, and Western children of European descent also from Papua New Guinea. The Mofu children were attending French immersion schools and the Tolai were attending English preparatory schools. Ages of the Mofu and Tainae children had to be estimated as the children in these groups did not know how old they were. Vinden noted that it was extremely difficult to obtain participants under 5 years of age, and that very few female Tainae children were willing to participate, leading to a Tainae sample that was 80% male.

Vinden (1999) found mixed results among children from the different cultures, indicating that "some areas of emotional development in children may be quite stable across cultures, whereas others may not be" (p. 39). Specific to false belief understanding, she suggested that "children in a variety of non-Western cultures eventually come to understand that another person can have a false belief, and will act on that belief rather than merely reacting to the way the world is" (p. 40). Additionally, despite having few 4-year-old and no 3-year-old children in the sample, her results suggest that there is a clear trend toward understanding false belief, though potentially at later ages than found among Western cultures. The Western sample in the study followed the typical trend of development, although slightly later than found among similar children in their homelands. Due to issues with collecting a representative sample (including children under 5 years of age and females), as well as some issue Vinden reported with the translation of questions relating to thinking, the findings are not entirely clear, although they do provide some initial data on children from distinctly non-Western cultures.

Callaghan et al. (2005) conducted a cross-cultural study measuring false-belief understanding in five cultures: Canada, India, Peru, Samoa, and Thailand. Callaghan et al. used a simplification of the naturalistic task used by Avis and Harris (1991) and Vinden (1999) to assess false belief understanding. Unlike in its previous uses, Callaghan et al. did not ask questions about the protagonist's thoughts and emotions, only about his or her behavior. This was done in order to minimize issues of translation, as was seen in Vinden's (1999) use of the task. Results showed that, consistent with general results among Western children, few 3-year-old children passed the task, 4-year-olds passed and failed in approximately equal numbers, and the majority of 5-year-olds passed the task. This pattern was consistent across cultures, indicating "synchrony in the age at which children of diverse cultures pass the false-belief task" (p. 381). The authors do report that whether such synchrony occurs due to biological maturation or from experiences universal across cultures, or both, remains unclear. As all of the children included in their samples were schooled, it makes it difficult to rule out the possibility of schooling and social interaction as a key toward development. Pointing to delays experienced among deaf children, the authors suggest conversation may be a crucial mechanism toward theory of mind development, as "conversation brings other individuals' mental views to light and brings a vocabulary necessary to the transaction of mental states" (p. 382). They highlight the fact that, apart from deaf children born to hearing parents, all children are exposed to conversation through their lives, making it particularly difficult to tease apart the effects of this exposure and those of biological maturation.

Finally, Chasiotis, Kiessling, Hofer, and Campos (2006) examined inhibitory control as well as theory of mind among children in three different cultures: Germany, Costa Rica, and Cameroon. Chasiotis et al. tested the relationship between false belief understanding and inhibitory control among these children, all of whom were 3- to 5-years of age. In addition to using batteries to test for inhibitory control and theory of mind, they also evaluated age, gender, siblings, language understanding, and mother's education as control factors. Results of regression analysis show a relationship between conflict inhibition and false belief understanding that was culture-independent. However, delay inhibition had no significant relationship to theory of mind either before or after controlling for interaction effects with culture. This provides support for a strong correlation between false belief and conflict inhibition tasks, while also providing evidence against a relationship between false belief and delay inhibition tasks. The researchers suggest that higher working memory demands inherent to conflict inhibition and theory of mind tasks, but not delay inhibition tasks, may be the underlying reason for this difference. Additionally, their results provide further evidence for similarity in development of theory of mind across cultures.

While this works toward expanding the current knowledge on cultural differences in development, there still remains a large gap in the literature in evaluating children in developing countries, specifically with African children. However, the evidence from these studies suggests that there may be more similarities than differences in theory of mind development among children around the world. Differences in theory of mind development due to culture appear to be related to age of explicit understanding, although this is likely constrained to within a couple of years' difference, and the middle order of scaling, as suggested by Wellman et al. (2006). While tasks continue to be modified to best suit cultures and more diverse cultures are examined repeatedly to establish reliability of findings, these subtle differences will become more clear.

Deafness and Theory of Mind

A group of children that sparked particular interest in terms of theory of mind development was children with autism. Baron-Cohen, Leslie, and Frith (1985), as well as subsequent studies, showed that autistic children display unusual difficulty in tests of false belief understanding. Following this, children with other developmental disabilities were similarly tested in order to determine whether this was a common problem amongst special populations. Children with Down's Syndrome, intellectually handicapped children, emotionally disturbed children, and children with severe specific language impairments did not demonstrate similar deficiencies, suggesting specific difficulties with false-belief tasks are unique to children with autism (Baron-Cohen et al., 1985; Baron-Cohen, 1989; Leslie & Frith, 1988; Siddens, Happe, Whyte, & Frith, 1990).

While several developmental disabilities apart from autism had been explored in relation to mastery of theory of mind, little was yet known about the effects of other sensory, physiological, or social handicaps (Peterson & Siegal, 1995). Of particular interest to Peterson and Siegal (1995) were children who experienced profound, prelingual hearing loss. Given that most deaf children are born to hearing parents and do not join a community of native signers until in primary school, these children are likely to have limited access to conversation in their formative years, particularly about unobservable mental states (Wood, Wood, Griffiths, & Howarth, 1986). Theoretically, this impairment could severely limit the child's exposure and access to information about other people's mental states, a similar restriction as experienced by autistic children, although for different reasons. Alternatively, these children may have access to this information, but due to the nature of their limited exposure they may not have developed the ability to exploit that access. In either case, this theoretical reasoning, along with the results from Peterson and Siegal's 1995 study, sparked a wealth of studies on deafness and theory of mind.

Early theory of mind and deafness research. Peterson and Siegal (1995) tested 26 signing profoundly deaf children with normal mental ability (aged 8-13 years) using two trials of the typical unexpected transfer false-belief task. It was not specified whether any of the children were native signing, but based on general proportions it is reasonable to assume a large portion of the sample were late signing. In order to test the idea of using a conversationally-supported question (Siegal & Beattie, 1991), the children were split into two equal groups. Group 1 was asked the belief question, "Where will Sally look for her marble?" Group 2 was asked the modified, conversationally-supported question, "Where will Sally *first* look for her marble?" Both groups received identical reality ("Where is the marble really?") and memory ("Where did Sally put the marble in the beginning?") control questions. Children were required to pass both trials in order to be credited with possessing an understanding of false belief.

Each child was tested individually with two adults present: a male experimenter and a female professional Auslan (Australian Sign Language) interpreter. The interpreter was experienced with the style of manual communication used by the children in their classrooms and employed this "Total-Communication" medium in translating the tasks to the children. The experimenter acted out each step of the scenario and spoke with his lips clearly visible. The interpreter immediately translated the spoken commentary into signed English. Both adults independently recorded the child's pointing responses and the interpreter supplied an ongoing oral translation of the child's signed communications. This interpretation was recorded both electronically and in writing by the experimenter.

Seventeen percent of children in Group 1 succeeded, whilst 50% of children in Group 2 succeeded. However, this difference was not significant. There was no significant difference in either chronological age or intelligence between the group of children that succeeded on the task and those that did not.

A comparison between the performance of the combined deaf groups and 14 children with Down's Syndrome (Baron-Cohen et al., 1985) showed significantly higher performance on the task by the Down's Syndrome children, even despite the fact that these children did not have the modified "conversationally-supported" questioning as was used in Group 2. A comparison between the combined deaf sample and a sample of 20 autistic children tested with the non-conversationally-supported question showed no significant difference between groups (Baron-Cohen et al., 1985). Similarly, there was also no significant difference between Group 2 and a group of 20 children with autism given the same questions (Prior, Dahlstrom, & Squires, 1990).

Peterson and Siegal held the position that both deaf and autistic children may have had inadequate conversational input about mental states from family members at home in order to cross a minimal threshold of false belief understanding necessary for success on the tasks. Further, they believed that a basic ignorance about other people's belief states in deaf children results from the lack of a fluent conversational partner at home prior to entry into school. They posited that in the case of autistic children, rather than the lack of a fluent common language amongst family members obscuring glimpses into their mental states, it may be due to an unwillingness of the child to attend to others or the inability to draw accurate inferences about other people's communicative intentions (Frith, 1989).

Steeds, Rowe, and Dowker's 1997 study was designed as a follow-up to Peterson and Siegal's (1995), and was intended to expand upon the original study as well as to assess whether similar delays were found amongst a sample of English children. Steeds et al. (1997) tested a sample of 22 signing profoundly deaf English children with normal mental ability. The children were aged between 5 and 12 years (mean 9;8). Whilst Peterson and Siegal employed two Sally-Anne false-belief tasks, Steeds et al. tested children on one Sally-Anne task and Baron-Cohen's (1991) adaptation of the Breakfast Cereal task (Harris, Johnson, Hutton, Andrews, & Cooke, 1989).

Task 1 was the Sally-Anne task, which was presented similarly to in Peterson and Siegal's study. Task 2, the Breakfast Cereal task, assessed understanding of desires with two sets of desire questions, beliefs with one set of belief questions, and included two memory checks. The child was shown two boxes of cereal and a doll, which was said to like one of the cereals, but not the other. The child was asked whether the doll would feel happy or sad if presented with one box, and then the other (desire test 1). The doll left the scene and the child was shown that the 'preferred' box was actually empty, and the 'disliked' box actually contained the preferred cereal. When the doll returned the child was asked again what the doll would feel if presented with either box (belief test). The child watched as the doll was shown what was actually contained in the two boxes and once again was asked whether the doll would feel happy or sad if presented with either box (desire test 2).

Each child was tested individually with two adults present: a female experimenter and a female who was profoundly deaf and fluent in British Sign Language (BSL), which was the principal means of communication for all of the children. The experimenter and Deaf storyteller manipulated the objects used in each story in conjunction while the storyteller told the stories involved in each task using BSL. Both adults independently recorded the responses given.

Children taking part in this study performed better than those tested by Peterson and Siegal (1995). While Peterson and Siegal found that 35% of their deaf children passed the Sally-Anne task, Steeds et al. found a somewhat higher rate with 14 out of 20 (70%) passing. However, over one-third of children included in this analysis failed at least one of the control questions, and Steeds et al. did not remove these children from further analysis. If the argument that children should not be counted as having a true understanding of false belief unless they are able to successfully pass both the control questions as well as the belief questions, this brings the passing rate down to 50%. The difference in pass rates between these two studies could be down to language of task presentation (Sign-Supported English versus BSL), the possibly disjointing of the tasks in Peterson and Siegal given that the tasks were spoken and then interpreted, or even variability among deaf children, especially considering the somewhat small sample sizes presented. The fact that the children in Steeds et al. outperformed those in Peterson and Siegal's study "should not obscure the fact that they still performed less well than would be expected on the basis of their chronological age" (Steeds et al., 1997, p. 192). Regardless of whether a strict (50%) or lenient (70%) criterion is applied, the deaf children in this sample performed well below the level expected from hearing children of the same age range.

It is of interest to note, however, that while the children had significant trouble with the belief tasks, the same difficulty was not witnessed on the desire tasks. Indeed, all 20 children that took part in the breakfast task passed both desire questions. It appears from this study that whatever their age, and whether or not they passed all of the control questions, they had no problems in understanding desire. While this may reflect a difference in the ease of task comprehension between the two tasks, it may also be that children with verbal communication difficulties do understand desire better than belief. Desire, contrasted with belief, is more communicable by nonverbal means including pointing and facial expressions. If this is the case, it may be that different forms of communicative experience have differential effects on the various aspects of theory of mind. Additionally, desire has been shown to be understood much earlier than belief, as young as 18 months, by typical children as well (e.g., Gopnik & Repacholi, 1997); this could also explain the difference in performance on desire versus belief trials.

Russell et al. (1998) also followed on from Peterson and Siegal's initial study, with two general aims. The first aim was to examine the generality of the finding that deaf children have difficulty with theory of mind tasks. The second aim was to examine the possibility of age-related improvement in deaf children's theory of mind ability. The second hypothesis, that improvement is age related, is based upon the consideration that the acquisition of proficient sign language and communication skills is a progressive process. They believed that it therefore may take "some years before increased opportunities for learning about mental states aggregate sufficiently to impact upon the deaf child's theory of mind development" (p. 905).

Russell et al. used the same general task procedures as used in Peterson and Siegal (1995) when testing 32 signing profoundly deaf children, although without the inclusion of the conversationally-supported questioning. Similarly to previous experiments, these children were of normal mental ability, but the age range studied was broadened (ages 4-16 years). Participants were split into three groups by age; the youngest group (n = 12) were between 4 and 8 years of age (mean = 6;7), the middle group (n = 10) were between 8 and 13 years of age (mean = 10;11), and the oldest group (n = 10) were between 13 and 16 years of age (mean = 15;5). Each child was tested individually with two female adults present: a qualified teacher of the deaf, who signed and enacted the story, and an experimenter who videoed the test and recorded responses.

A stringent passing criterion was again employed, requiring passing of both versions one and two, both the false-belief and control questions. This greatly reduced the likelihood of including passes obtained through guessing. Unlike in Steeds et al. (1997), the pass rate of the sample would not have increased significantly had a more lenient pass criterion been used, such as requiring only that the child answer the false belief question and not the control questions correctly.

Of the total sample of 32 children, 28% passed; this is not inconsistent with the 17% found to have passed the standard version presented by Peterson and Siegal (1995) or the 20% of autistic children found to have passed in Baron-Cohen et al. (1985). When split into the three age groups, it becomes apparent that the ability to pass the false-belief test is associated with age: 17% of children in the youngest group, 10% of children in the middle group, and 60% of children in the oldest group passed. It does not appear that cognitive level positively influenced passing rate. In fact, the children passing the false-belief test had lower IQ equivalents than those failing, likely based on the fact that the average IQ of the oldest group was lower than those of the other two age groups. However, this may be due to the fact that IQ is generally calculated relative to age norms, and as such the older children were not necessarily less cognitively advanced than the younger children.

Results confirm both that deaf children show a delay in false-belief task performance when compared with hearing children in other studies which use the same kind of test and pass criterion, and that the older deaf children performed better than the younger deaf children. As the majority of children in the study correctly answered the control questions, yet failed the questions specifically testing their understanding of false belief, it is reasonable to conclude that there is a relatively specific difficulty in understanding the implications of false belief. The fact that a significantly greater portion of the oldest children (13- to 16-year-olds) passed the test compared with each of the two younger groups provides evidence of an age-related improvement in test performance. The results "suggest that the biggest improvement in deaf children's performance on the false-belief test occurs after the age of about 13 years" (p. 908). This may explain why Peterson and Siegal (1995) failed to find a significant age effect, as the upper age limit of their sample was 13 years of age.

This suggests that the difficulty in theory of mind abilities in deaf children is a developmental delay, and a rather marked one at that: only 14% of children 4- to 12-years of age passed the test compared with 85% of 3- to 5-year-old hearing children in the study by Baron-Cohen et al. (1985). Even amongst the oldest deaf group, aged 13- to 16-years-old, only 60% passed.

Effect of language background. Not all deaf children come from similar language backgrounds, even within the same cultural group or region. While it is true that approximately 90% of deaf children are born to hearing parents, there is still a minority of deaf children that are born in households with other deaf family members. Often these deaf family members are sign language users themselves, creating an opportunity for the deaf children to be exposed to a more complex language system from birth than that which is accessible to deaf children of non-signing parents. Considered "native" signers, these deaf children experience a very different early childhood in regards to language, one considerably more similar to that experienced by hearing children of hearing parents. In addition, not all deaf children born to hearing parents are raised to be "late" signers. There is a significant portion of deaf children of hearing parents that are classed as "oral"; that is, they primarily use speech and listening (either residual or, often, with the help of hearing aids or cochlear implants) over other forms of communication such as sign language. This difference in linguistic backgrounds and modes of communications leads to an important question – do these groups of deaf children perform the same on theory of mind tests?

Peterson and Siegal sought to provide an answer to this question with their 1999 study. The study's aim was to provide a direct comparison of the performance on a range of tasks requiring representation of others' mental states between deaf children from a variety of different conversational backgrounds and both autistic and normal hearing children.

One hundred two Australian children took part in this study, each classified in one of three main categories: 59 deaf children (mean age = 9;5), 21 children of normal hearing and abilities (mean age = 4;6), and 22 autistic children (mean age = 9;6). The deaf children were further classified into one of three subgroups. Group 1 consisted of 34 severely and profoundly deaf signers from hearing families (mean age = 9;4), Group 2 consisted of 11 severely and profoundly deaf native signers (mean age = 10;3), and Group 3 consisted of 14 oral deaf children with moderate to severe hearing loss (mean age = 9;2). To clarify, oral deaf children are those children with moderate to severe hearing loss who have grown up with spoken language input. These children, with the assistance of amplifying hearing aids worn since infancy, have acquired speaking and listening skills in oral-aural language. These children are sometimes referred to as oralists.

Again two versions of the unexpected transfer task were administered, similar in procedure to that previously used (Peterson & Siegal, 1995). In addition to the standard changed-location false belief tasks, Peterson and Siegal also included one version of a change-appearance task, adapted from Leekam and Perner (1991), and one version of an unexpected contents task (Perner, Frith, Leslie, & Leekam, 1989). In the change-appearance task, a mother doll comments on a girl doll's pretty yellow dress and goes off to find hair ribbons of the same colour. While the mother is absent, the girl changes into a differently coloured dress. Children are asked: (1) a test question – "Which of these ribbons did Mum bring?", (2) a memory control – "When Mum left, what colour was the girl's dress?", and (3) a reality control – "Now what colour is her dress?". The standard Smarties unexpected contents task was slightly simplified to reduce repetition of prompt and control questions. In the task, a misleadingly familiar sweets container is presented to the child, and is shown to actually contain pencils. After discovering the unexpected contents, the child is asked what a naïve classmate would say on first seeing the closed container, and what his or her own belief had been. In order to be judged as passing, correct responses to both questions were required.

Late signing deaf children performed the poorest on the three tasks. Their performance was lowest on the changed-location task (38% passing), versus 59% passing the changed-appearance task and 47% who passed the unexpected contents task. The children with autism performed slightly better (50%, 58%, and 50%, respectively), while oral deaf children achieved 64%, 71%, and 86% passing on the three tasks. Native signers (mean age 10 years, 3 months) performed roughly equivalently to normal pre-schoolers (mean age 4 years, 10 months): 82% of native signers passed the changed-location task, versus 86% of normal pre-schoolers; 100% of native signers passed the changed-appearance task, versus 90% of normal pre-schoolers; and 91% of native signers passed the unexpected contents task, versus 76% of normal pre-schoolers.

Late signing deaf children did not differ significantly from the autistic group, but they did pass significantly fewer false-belief tasks than the native signers, the oral deaf children, and the normal hearing children. No significant differences were found among the latter three groups. Patterns of success on individual tasks were consistent with overall performance: late signers and autistic children performed similarly, and performed at a lower standard than the native signers and oral children.

Courtin (2000) was also interested in the effect of language background on theory of mind development in deaf children. In a similar study, 155 deaf children (5- to 8-years-old) of three linguistic backgrounds and normally developing hearing children (4- to 6-years-old) were tested on two unexpected change and one unexpected contents false-belief tasks. The deaf children were divided into the same three groups as previously employed: deaf children of deaf parents, signing deaf children of hearing parents, and oral deaf children of hearing parents. An additional fourth category was proposed but dropped due to extremely low numbers of oral children of deaf parents.

Effects of hearing status were evaluated in four sets of analyses. The first set of analyses compared hearing children with deaf children of deaf parents. Results indicated that at 5 years of age, a marginally non-significant effect reflecting greater success among the second-generation deaf children was found ($p = .09$); this effect was more profound among 6 year olds ($p < .05$). When data were pooled from the two age groups, second-generation deaf children significantly outperformed hearing children ($p \leq .01$).

Performance of 8-year-old signing deaf children of hearing parents was roughly equivalent to that of hearing 5-year-olds. When data were pooled across age groups, signing children of hearing parents did not perform significantly differently from hearing children, despite the deaf children’s higher mean ages. An analysis of the mean number of tasks correctly performed by children in these two groups did indicate significantly better performance among the hearing children in comparison with the oral children. Deaf children of deaf parents performed significantly better than signing or oral deaf children of hearing parents (p < .001) across and between all age groups. While late signers and oral deaf children did not differ at specific age groups, the signing children tended to outperform the deaf oral children ($p \leq .07$).

Results confirmed previous findings that hearing children and native signers performed very similarly, although results from the study indicated somewhat higher performance by native signers, suggesting no delay among second-generation deaf children. Both hearing and second-generation deaf children significantly outperformed both groups of first-generation deaf children. However, contrary to results found by Peterson and Siegal (1999), signing and oral deaf children of hearing parents only performed marginally significantly differently from each other.

A similar study was conducted in 2005 by Courtin and Melot, with similar results. In addition to three false-belief tasks (two unexpected-change tasks and one unexpected-contents task), the children were given three trials of an appearance-reality task. In the appearance-reality tasks, the children were shown an object that looked like one object, but was truly another. For example, the child was shown a piece of sponge that looked like a rock, and was asked “When you look at this, what is it, what does it look like?” After the child responded with the intended appearance (a rock), they were shown that the object was in actuality a sponge. Once the true nature of the object was affirmed for the child, he or she was asked two questions: “What is it really? Is it really a rock or really a piece of sponge?” and “When you look at this right now, does it look like a rock or does it look like a piece of sponge?” (p. 19).

Children were again divided into three groups based on parental hearing status and child's communication modality, resulting in native signers, late signers, and oral deaf. Consistent with previous findings, children who were native users of a language, whether that be hearing children using spoken language or signing deaf children of deaf parents, outperformed those who were exposed to language later in life (both groups of deaf children with hearing parents) (ps < .001). Native signing deaf children had better performances than late signing deaf children ($F(1, 48) = 30.26$, $p < .001$), and hearing children had better performances than oral deaf children, $F(1, 64) = 37.19$, $p < .001$. The two groups of native language users did not differ from one another (*ns*); similarly, late signing deaf children differed from oral children, but only to a marginally non-significant level, $F(1, 54) = 2.92$, $p = .09$.

The effects of language modality were examined by evaluating performance on the false belief and appearance-reality tasks separately. Deaf native-signing children outperformed hearing children on the false-belief task ($p < .05$), but not on the appearance-reality task (*ns*). Additionally, hearing children significantly outperformed late-signing deaf children on both tasks (ps < .05). Both oral deaf and late-signing deaf children did not perform significantly differently on either task (*ns*). Native signers showed equal performance on both tasks, whereas hearing children, late signers, and oralists all showed better performance on the appearance-reality task.

These results indicated that, for deaf children, the exposure to sign language from birth may yield a facilitative effect. Additionally, use of oral language among deaf children did not improve the development of false belief understanding, as evidenced by the fact that hearing children significantly outperformed the oral deaf children. The finding that native signers passed significantly more false-belief tasks than their late-signing counterparts was consistent with the findings of Peterson and

Siegal (1999). However, Peterson and Siegal found no difference between the performance of hearing children and oral deaf children, which is inconsistent with Courtin and Melot's (2005) finding.

Meristo et al. (2007) went further to examine the effect of bilingual and oralist school environments on theory of mind reasoning. In Italy, deaf children receive school instruction in a variety of ways, with two of the primary environments being oralist environments and bimodal/bilingual environments. Some children attend mainstream government schools with their hearing peers, and receive instruction in spoken Italian. While occasionally this oral instruction is supplemented with the use of Italian Sign Language (LIS) or Sign-Supported Italian (SSI), Meristo et al. focused on children in a strict oralist environment in their experiments. Other deaf Italian children attend schools that provide bimodal/bilingual instruction; that is, instruction is given in a combination of LIS or SSI and spoken Italian. In this bimodal/bilingual environment, students receive either direct SSI instruction (spoken Italian accompanied with LIS signs) from their teachers, or an LIS interpreter simultaneously translates what is being taught. Additionally, students receive LIS grammar and vocabulary as a subject for between 1 and 6 hours per week. The interactions between students and teachers and among the students independently are carried out in LIS, SSI, or a combination, meaning deaf children are immersed in a signing environment.

Meristo et al. (2007) found in this first experiment that deaf Italian children in attendance at schools with bimodal/bilingual instruction significantly outperformed their peers in oralist schools on theory of mind tests, even when age, nonverbal intelligence, and level of sign language were partialled out. Further, performance of a sample of hearing children between 3 and 6 years of age was contrasted with the groups of students. While hearing children did not outperform native-signing deaf students receiving bimodal/bilingual instruction, they did outperform native-signing deaf students receiving oralist instruction, as well as all late-signing students, regardless of school environment.

Meristo et al. (2007) followed up this first experiment with an evaluation of Swedish and Estonian deaf students, as deaf education in these two northern European countries places much greater focus on a bilingual environment without the use of sign-supported teaching methods. In Estonian non-oralist schools, Estonian Sign Language (ESL) is used by teachers, many of whom are also deaf, with few lessons presented in spoken Estonian (Meristo et al., 2007). In Sweden, the aim is to prepare children to live and work in society as bilingual individuals, and as such both Swedish Sign Language (SSL) and Swedish are both used in instruction and taught as language courses, although sign-supported methods are not used. Family members are also given the opportunity to learn SSL to encourage the use of functional sign language within the home (Meristo et al., 2007).

The results of the second experiment indicated that native signers instructed in ESL in conjunction with spoken Estonian or SSL in conjunction with spoken Swedish outperformed both bilingually instructed late signers and native signers attending oralist schools. Similarly as to in the first experiment, the native signers under bilingual instruction performed on par with age-matched hearing children. It is apparent from these findings that the additional use of signed language, rather than just spoken, at school aids development in native signing children. Yet, although the native and late signers were both taught in bilingual environments, the addition of signing did not boost the abilities of the late signers to the same level as was attained by native signers; once again this implies that earlier access to sign diminishes delays.

Effect of mental state talk. While it was previously speculated that mental state talk by parents is a critical factor in the delay of false-belief understanding found among late-signing deaf children, Moeller and Schick (2006) employed an integrative approach to look specifically at its effect. Mothers in particular were focused on, as they are typically the primary caregivers of small children. This study also differs in another way from past studies; hearing mothers with either deaf or hearing children were assessed, in contrast to studies that examined deaf children with deaf or hearing parents. The mother's sign proficiency and talk about the mind were examined in order to evaluate the effect of these elements on child ability.

Mothers and children were videotaped for one hour in a playroom setting while participating in three play activities designed to elicit mental state talk. In a follow-up, children were given a standard false-belief task and mothers were interviewed about family and signing background and given a sign vocabulary test.

The hearing children (mean age 5.0 years) had significantly higher false belief scores (M = 85.58%) than the deaf children (mean age 6.9 years, M = 52.27%), d = 0.92, p = .002. Mothers of hearing children produced significantly more mental state references than did mothers of deaf children, although there was no difference between the groups in terms of the number of utterances without mental state terms. The total number of maternal utterances was significantly correlated with the use of mental state terms for the mothers of hearing children (r = .48, p = .02), but not for mothers of deaf children (r = .092, p = .69). Mothers of deaf children who scored above 75% on the verbal false belief tasks used significantly more instances of mental state terms than mothers of deaf children who scored below 75%. Among mothers of deaf children, a significant relationship between maternal talk about mental states and deaf children's performance on theory of mind tasks was found, providing support for the previously theorised concept that access to conversations about the mind is important for deaf children's theory of mind development. Contrary to previous work by Ruffman, Slade, and Crowe (2002), no relationship was found between maternal talk and false belief understanding in the group of mothers with hearing children, possibly due to the restricted age and performance range of the comparison group. Mothers' nonmental state talk and the overall transcript length were not related to the deaf children's false belief understanding, suggesting that the overall amount of maternal talk was not as influential as talk that focused on mental states.

Brown (2007) agreed that it is important to measure parents' sign language abilities in the development of deaf children's theory of mind abilities. Brown acknowledged that while Moeller and Schick (2006) have taken a first step in this direction, their study falls short, as it takes no measurement of the mothers' nonverbal communication ability. It is a common understanding among proficient users of many different sign languages in use worldwide that the facial expression is an extremely important grammatical feature, important to issues such as syntax and morphology. Brown therefore encouraged further studies including this additional analysis.

Meristo et al. (2012) focused on the role of language input for deaf and hearing infants in order to assess the effects of early language reception, including mental state talk, on implicit false belief understanding. Meristo et al. compared the performance of 20 17- to 26-month-old children who were hearing (mean age 23 months) or were deaf with hearing families (mean age 23 months), and thus delayed in access to early conversational input. Of the ten deaf children, five used cochlear implants and the other five used hearing amplifications. The mean age of cochlear implantation was 14 months and the mean time since implantation was 7 months; the mean time since first use of hearing amplification was 14 months. While the parents of the deaf infants were acquainted with Swedish Sign Language (SSL) and communicated with their infants in spoken Swedish supported with signs, none of the deaf infants showed proficiency in SSL. The infants watched true-belief and false-belief test trial cartoons on a monitor while having their gaze tracked. Hearing infants significantly outperformed the deaf children in anticipating the search actions of the cartoon character with the false belief about where an object was located. Performance did not differ between hearing and deaf children on the true-belief trial. This provides evidence that access to conversational input early in life contributes to early theory of mind reasoning. The importance of such early input is highlighted by the fact that all of the deaf children had had access to some sort of hearing assistance and had at least some conversational input, albeit delayed.

Implications for limits to development from Nicaraguan Sign Language users. Research among a special population of deaf people has recently offered a unique way to study theory of mind development in groups with delayed exposure to language. In 2006, Morgan and Kegl looked at this distinctive group, users of Nicaraguan Sign Language (ISN). This population is unique in that ISN first appeared among deaf children that arrived at special education schools in the 1970s and early 1980s; these children developed an early form of the language. The language further expanded when a second group of children arrived at the schools in the mid-1980s. More recent examination of the two groups shows that the second cohort displays a more developed form of the language than the first cohort (e.g., Senghas, 1995; 2003). This allows for a new way to investigate the nature of the relationship between language development and false-belief understanding.

Participants in the study by Morgan and Kegl were aged 7 to 39 years and were separated into two groups: participants who were exposed to ISN by 10 years of age (early signers) and those who were exposed to ISN after 10 years of age (late signers). Participants were tested on the "thought pictures" task previously used by Woolfe et al. (2002) and on a non-verbal cartoon task designed to elicit mental state talk. The non-verbal cartoon task involved the retelling of a short non-verbal cartoon by the participants to a fluent adult signer. The cartoon focuses on moral dilemmas faced by the main character, Mr. Koumal. For scoring purposes, five adult fluent signers completed the task and transcripts were coded by the authors and trained research assistants with intercoder reliability above 90%. A total of eight core mental states were mentioned by all five fluent adult signers, which made up the standard narrative content against which participants' narratives could be compared. The eight mental states used in scoring were lack of knowledge, knowledge/belief, doubt, desire, thinking, decision, purpose/goal, and deception. Early sign access acted as a strong predictor of performance on both tasks; however, late signers were still able to demonstrate a general ability to use mental state expressions in a narrative. Length of exposure to ISN was not related to performance on the false-belief task, but it was related to participants' narrative abilities. The amount of exposure to ISN appeared to influence the ability to talk about mental states in a narrative; better signers were able to talk more in general and about mental states than those with less exposure.

Viewing the two tasks in conjunction, the participants that passed the false-belief task talked more about mental states than those that failed the task. Of the 14 who passed, 10 mentioned all 8 possible mental state propositions in their narratives; this is in sharp contrast to the group of 8 who did not pass, of which none mentioned all 8 propositions. There appears to be a strong relationship between the two tasks for picking out aspects of theory of mind reasoning skills. While this study reinforces the theory put forth by many researchers in this field that there is a critical relationship between language development and theory of mind, it also shows that late exposure to language does not preclude deaf children from developing theory of mind abilities.

Pyers and Senghas (2009) also aimed to investigate the relationship between language development and false-belief understanding by working with ISN signers. The study examined mental-state vocabulary and performance on a low-verbal false-belief task in two cohorts of ISN users: adults and adolescents. Mental-state vocabulary was assessed using an elicitation task that involved watching a set of 30-second live-action video clips designed to elicit mental state talk (Gale, de Villiers, de Villiers, & Pyers, 1996). The false-belief assessment involved a picture-completion task based on the unexpected transfer task. Participants had to choose a sixth card that completed a story, illustrating where a character would look for an object in both true-belief and false-belief conditions.

Participants were tested at two time points, 2 years apart – in 2001 and 2003. At Time 1, the first cohort was comprised of 8 signers, all of whom were exposed to ISN before 1984 (the point in time when the language benefitted from the second cohort in schools). The second cohort was comprised of 10 signers, all of whom were exposed to NSL in 1984 or later. At Time 1 participants from the first cohort signed significantly fewer mental-state terms than second-cohort participants. The two groups did not differ either on the length of their narratives or on the number of desire-state verbs, suggesting that the second cohort had developed mental-state vocabulary that the first cohort lacked. On the false-belief trials, performance correlated negatively with age; that is, the younger participants from the second cohort outperformed the older, first-cohort participants. At Time 2, the groups no longer differed significantly in mental-state term production, the result of first-cohort participants increasing their production of mental-state vocabulary from Time 1 to Time 2. The first-cohort participants also improved significantly in their performance on the false-belief task, and at Time 2 the two cohorts no longer differed significantly.

These results demonstrate a narrowing of the gap between the cohorts over the course of the study. The data collection for this study was well timed; between 2001 and 2003 first- and second-cohort signers began socializing at the deaf association. The authors hypothesized that “with the increasing contact, first-cohort signers were exposed to a form of [ISN] that was richer than their own and that included the new mental-state words produced by their younger peers” (p. 810). While there may be a transition from an implicit understanding of mental states to an explicit understanding of false belief, it appears language may enable this transition, and in certain unusual cases, this transition may not occur until decades later than what is typical. It seems this, more than anything, truly demonstrates that the problems experienced by late-signing deaf are indeed delays, rather than deficits in development.

Effects of receptive language skills and executive functioning. While many studies have taken chronological and mental age into consideration when completing analyses, Jackson (2001) also investigated the relationship between receptive language skills, executive functioning, and theory of mind abilities. Children were categorized in one of four groups, this time including children from a hearing impaired unit (HIU) in addition to groups of native signers, late signers, and oral deaf children. Hearing controls were also included in the study. Three false-belief tasks, four nonverbal executive function tasks, and either the BSL Receptive Skills Test (Hellman, Holmes, & Woll, 1999) or the British Picture Vocabulary Scale were administered to all children.

Analysis showed that language ability and theory of mind ability were significantly and positively related. Age was also correlated with language ability for both deaf and hearing children. However, age was an underlying factor of the relationship between theory of mind and language ability for both deaf children with signing parents and hearing children, but not for non-native signing, HIU, or oral deaf children. Additional analyses showed that executive function performance in deaf children was not related to theory of mind.

Woolfe, Want, and Siegal (2002) also investigated the links between theory of mind, receptive language skills, and executive functioning, although they used a procedure somewhat different from the typical false-belief task in order to assess theory of mind in deaf children. The "thought pictures" task was chosen to minimize verbal task-performance requirements and was administered in two studies. Deaf children were tested in BSL by a deaf experimenter, a native BSL signer himself.

In Study 1, children were tested using the BSL Receptive Skills Test (Herman et al., 1999), the "thought pictures" task (Wellman, Hollander & Schult, 1996), and Raven's Progressive Matrices (Raven, 1963). In the four trials of the thought pictures task, the child was asked to identify what a character believed was hiding behind a flap and what was truly there, assessing the central character's true beliefs and false beliefs in each trial. Hearing children received the thought pictures task as a measure of age norms for typically developing children. Despite being significantly younger, again the native signers significantly outperformed the late signers on the theory of mind tasks. When compared with the hearing children, the difference between late and native signers was comparable with the difference between performances from hearing 3- and 4-year-olds. This result remained even when participants in both groups of signers were matched for BSL proficiency and spatial mental age.

Study 2 was designed to examine the role of executive functioning in both groups of deaf children, and an additional measure of false representations (in this case, physical rather than mental) was included. Again native-signing children outperformed late-signing children on the theory of mind tasks, although they did not differ significantly on tests of either false physical representation or executive functioning. Therefore, the differences between native and late signers do not appear to be due to general differences in representation or executive functioning.

Evaluation of executive functioning among deaf children has been expanded to include deaf adolescents and young adults as well. Remine, Care, and Brown (2008) evaluated the relationship between language ability and verbal and nonverbal executive functioning among oral deaf students between the ages of 12 and 16 years. They found a significant relationship between expressive language and verbal measures of executive functioning, with expressive language ability accounting for over 40% of the variance in performance on an executive functioning test. However, no significant relationship was found between language ability and non-verbal measures of executive functioning. Further, they found that participants demonstrated age-appropriate spatial planning and organization skills, as well as rule learning and inhibition.

Parasnis, Samar, and Berent (2003) found that young deaf adults of hearing parents showed greater impulsivity than a standard normative sample, which was in contrast with Marschark and Everhart's (1999) findings of no difference in impulsivity between deaf and hearing children in a range of age groups. Rhine (2002) found that deaf children of hearing parents received higher negative ratings on the inhibit, shift, and working memory subsets of the Behavior Rating Inventory of Executive Functions (BRIEF; Gioia et al., 2000, as cited in Rhine, 2002) than did hearing children. Hauser, Lukomski, and Isquith (2007, as cited in Hauser, Lukomski, & Hillman, 2008) administered the adult version of the BRIEF to deaf and hearing college students. They found no general difference between the deaf and hearing students; however, they did find that deaf students with deaf parents had better ratings than deaf students with hearing parents. These studies give a conflicting presentation of how executive functioning abilities among deaf individuals ranging in age from childhood to young adulthood relate to those among similarly aged hearing individuals.

Executive functioning research evaluating skills among deaf children with cochlear implants paints a clearer picture. Beer, Pisoni, and Kronenberger (2009) reported that analysis of BRIEF scores among children using cochlear implants showed problems in shifting, emotional control, initiation, working memory, planning and organization, and organization of materials in comparison with a group of typical hearing children. Similar examination of BRIEF scores among 45 cochlear implant users between 5 and 18 years of age showed similar results: significantly elevated scores on inhibit and working memory scales (Beer, Kronenberger, & Pisoni, 2011). The researchers suggest that executive functioning may be impaired due to the period of auditory deprivation in early life. These findings are consistent with the finding that a sample of deaf children with cochlear implants scored lower than a normal-hearing sample on working memory, fluency-speed, and inhibition-concentration, despite having above average nonverbal IQ (Kronenberger, Pisoni, Henning, & Colson, 2013).

Figueras, Edwards, and Langdon (2008) assessed executive function and language in deaf children (aged 8 to 12 years) both with and without cochlear implants. Both implanted and nonimplanted deaf children performed lower on tests of oral receptive language and executive functioning than a group of age-matched hearing children. No significant differences were found between implanted and nonimplanted deaf children. A positive correlation was found between language ability and executive functioning in both hearing and deaf children. The researchers suggested that deaf children's disinhibition and poor working memory may have been due to poor language skills, as that may have made it difficult for them to use internal speech to hold information in mind and use it to plan and guide their behaviour. The authors concluded that “deaf children’s deficits in EF are not an intrinsic consequence of deafness but are linked to delayed language acquisition (in the same way that deaf children’s delays in Theory of Mind development are associated with delayed language)” (p. 374).

Deafness and metalinguistic awareness. McLarey (1995) stated that a deaf child needs “to have a certain meta-linguistic awareness which can aid in his understanding of what sign language is, of what Swedish [or English] is and of the fact that the two are different languages” (p. 14). While there has been some research into the connection between deafness and metalinguistic awareness, the majority of this research focuses on reading and writing of a spoken language. Knight and Swanwick (1999) highlighted the deficit in more theoretical research on metalinguistic awareness among deaf individuals:

> One particular area which needs to be further developed is our understanding of deaf children’s metalinguistic awareness. Metalinguistic awareness requires a more abstract knowledge and understanding of language which involves the ability to think and talk about language, to recognise characteristics of a language and to see how language is structured. (p. 167)

Miller (2013) evaluated the similarities and differences in processing of written text by deaf high school and university students of different reading levels that used Hebrew as their spoken language and Israeli Sign Language as their mode of manual communication. Miller hypothesized that deaf individuals who had high reading comprehension levels would have higher metalinguistic awareness than their counterparts with lower reading comprehension levels. Findings did not support this hypothesis; results showed no link between deaf individuals' reading comprehension and their metalinguistic skills.

Bilingualism and Theory of Mind

Several studies have been conducted evaluating the effect of bilingualism on theory of mind development. Goetz (2003) evaluated theory of mind development among English/Mandarin bilinguals versus English monolinguals and Mandarin Chinese monolinguals. The children were given appearance-reality, level 2 perspective-taking, and false belief tasks. The bilinguals were tested in each of their languages. Results showed that 4-year-old children outperformed 3-year-old children in each group. Both of the monolingual groups performed similarly, and the bilinguals performed significantly better than monolinguals in both groups.

Farhadian et al. (2010) found similar results when assessing theory of mind development among Kurdish-Persian bilingual and Persian monolingual pre-schoolers. Children were given two unexpected transfer and one unexpected contents tasks; a larger proportion of bilingual children (45%) passed all theory of mind tasks than monolingual children (14%). A hierarchical multiple regression revealed that bilingualism contributed significantly toward predicting preschoolers' theory of mind development when age and verbal ability were controlled for.

Kovács (2009) sought to assess whether the advantage witnessed among bilingual children in terms of theory of mind development is due to advanced inhibitory control. Kovács found that, despite having equal mean ages, both bilingual children outperformed the monolingual children on both a standard and a modified theory of mind task. As the modified task was constructed to mimic a language-switch situation that bilingual children often encounter, and bilingual children performed similarly on the modified and standard tasks, the author concluded that the advantage witnessed among bilingual children is likely not due to social experience, but rather due to heightened inhibitory control. This provides evidence that maturing executive functions may contribute to solving standard ToM problems, as exposure from birth to two languages enhances development of EF (see Kovács & Mehler, 2009) and indirectly boosts ToM performance.

Rubio-Fernandez and Glucksberg (2012) were interested in the long-term effects of this bilingual advantage. They used a traditional false belief task coupled with eye-tracking among bilingual and monolingual adults to see whether bilingual adults have an advantage over monolingual adults in false-belief reasoning, similarly to the difference found among children. Findings indicated that adults in general have problems with interference from their own perspective when reasoning about others' beliefs. Bilinguals were found to be reliably less susceptible to this egocentric bias than were monolinguals. Additionally, performance on the false belief task was significantly related to performance on an executive functioning task. The authors argued that the advantage in terms of egocentrism for bilinguals is due to their early sociolinguistic sensitivity, and possibly enhanced executive control.

Bilingualism and executive functioning. One of the primary researchers of executive functioning in bilinguals is Ellen Bialystok. Bialystok and her colleagues have put forth many studies highlighting the fact that early bilingualism and continued use of multiple languages enhances certain cognitive processes among children (e.g., Bialystok, 1999; 2010; Bialystok, Craik, & Ryan, 2006; Bialystok & Viswanathan, 2009). In working with a group of Chinese-English bilingual children, Bialystok (1999) found that the bilingual children outperformed non-Chinese English monolingual children on the DCCS. It was suggested that experience in switching between languages improves children's cognitive control, which aids performance on this and similar tasks. More recently, Martin-Rhee and Bialystok (2008) assessed inhibitory control among bilingual and monolingual children. Two tasks involving inhibition were administered – one involving inhibition of attention to a specific cue (e.g., Simon says game) and one requiring inhibition of a habitual response (e.g., day-night Stroop task). Bilingual children outperformed monolinguals in terms of controlling their attention, but not regarding inhibition of prepotent responses. This suggests that bilinguals may be particularly advanced on tasks requiring control over attention to competing cues, but not necessarily to tasks requiring control over competing responses.

Additionally, Costa, Hernandez, and Sebastian-Galles (2008) found that bilingual children were not only faster in performing an attentional network task aimed at assessing orienting, alerting, and executive control, but they were also more efficient in these latter two networks. The bilinguals were aided more by the presentation of an alerting cue and were better at resolving conflicting information. Costa, Hernandez, Costa-Faidella, and Sebastian-Galles (2009) found evidence that bilinguals outperform monolinguals on tasks that require a great deal of monitoring resources.

Kovács and Mehler (2009) assessed executive functioning among bilinguals and monolinguals in an attempt to determine whether early bilingual input leads to advantages in executive functioning prior to speech onset. Seven-month-old bilingual infants were found to outperform monolinguals on executive functioning tasks. During a cognitive control task, both bilingual and monolingual infants were taught to respond to a speech or visual cue to anticipate a reward on one side of a screen; however, only bilingual infants were able to successfully redirect their anticipatory looks when the cue began signalling the reward on the opposite side. These results indicate that perceiving and processing different languages was able to enhance executive functioning well before the onset of speech.

In terms of bilingualism from birth versus later language learning, Carlson and Melzoff (2008) examined inhibitory control skills to determine the effects of early versus late bilingualism. Carlson and Melzoff assessed multiple measures of executive functioning by administering a battery of tasks to three groups of kindergarteners. The groups consisted of Spanish-English native bilinguals, English monolinguals, and English speakers who were enrolled in second-language immersion kindergarten. The Spanish-English bilinguals did not differ on raw scores in comparison to the other two groups, despite having lower verbal scores and socioeconomic status as assessed by parent education and income levels. After controlling for verbal scores, socioeconomic status, and age, they found that the native bilingual children outperformed both other groups on the battery. Regarding specific tasks, the bilingual children showed a distinct advantage on tasks requiring management of conflicting attentional demands (conflict inhibition), but not on impulse-control tasks (delay inhibition). Interestingly, Chastiotis et al. (2006) found that performance on conflict inhibition tasks was correlated with performance on false belief tasks, but delay inhibition was not correlated to false belief performance. This suggests that, while researchers have proposed that advanced inhibitory control among bilingual children may explain their advantage on theory of mind related tasks, it appears that it may be more specifically related to the advanced ability to handle conflicting attentional demands.

Bilingualism and metalinguistic awareness. Similarly as to with theory of mind development and executive functioning skills, bilinguals have been found to have enhanced metalinguistic awareness in comparison with their monolingual peers. Galambos and Hakuta (1988) examined the relationship between bilingualism and metalinguistic awareness among a sample of Puerto Rican Spanish-English bilinguals. The children were enrolled in first through fifth grades in a transitional bilingual program in the U.S. A set of younger children were followed through two grades and assessed regarding their abilities to note and correct ungrammatical sentences in Spanish. A set of older children were followed through two grades and were assessed regarding their abilities to detect ambiguity in sentences and to paraphrase the possible meanings of the sentence. Results from both groups of students indicated that native language proficiency and degree of bilingualism both significantly predicted metalinguistic awareness. That is, children with a higher degree of bilingualism, with the same level of Spanish proficiency, exhibited higher levels of metalinguistic awareness.

Cromdal (1999) also assessed metalinguistic awareness among bilinguals. A sample of English-Swedish bilinguals was contrasted with a group of Swedish monolinguals on three tasks aimed at assessing metalinguistic awareness: symbol substitution, grammaticality judgment, and grammaticality correction. The results of the study were consistent with past findings (e.g., Bialystok & Ryan, 1985; Galambos & Hakuta, 1988), that degree of bilingualism is related to degree of metalinguistic skill. More specifically, general bilingualism was found to have an effect on tasks requiring a high control of linguistic processing.

Problem Statement

Studies have been conducted assessing varying aspects of theory of mind among children from around the world, although the majority of these studies have been concentrated in Western societies, and more recently, East Asian societies. While there have been a few cross-cultural studies conducted investigating mental state reasoning, these typically have included only a single non-Western culture, and varied task methodology has made comparison of results difficult (Callaghan et al., 2005). Researchers have shown a relationship between the development of theory of mind and metalinguistic awareness among hearing children (e.g., Doherty, 2000; Doherty & Perner, 1998; Perner, Stummer et al., 2002). Theory of mind development has also been shown to correlate with executive functioning development among hearing children (e.g., Carlson, Mandell, & Williams, 2004; Carlson & Moses, 2001; Gordon & Olson, 1998, Kloo & Perner, 2003). Additionally, many studies have highlighted the fact that deaf children, particularly those born to hearing parents, tend to develop theory of mind skills at a delayed rate in comparison with hearing children (e.g., de Villiers & de Villiers, 2012; Peterson & Siegal, 1995, 1999; Schick, de Villiers, de Villiers, & Hoffmeister, 2007).

Despite the extensive amount of research that has been conducted regarding the effect of language and cultural background on theory of mind, metalinguistic awareness, and executive functioning skills, there remain deficits of knowledge within the body of literature. An in-depth assessment of how language background affects the development and intertwining of these skills is lacking, particularly in regards to the effects of deafness and bilingualism. Furthermore, very little research regarding theory of mind development among African children has been conducted, despite the wealth of research involving children of other cultures worldwide. While these gaps in the literature are of interest in and of themselves, a larger purpose can be served through investigations aimed at addressing these gaps; information gleaned can be used practically in identification of children at risk for delays and subsequent interventions and educational strategies aimed at countering delays.

Purpose Statement

The purpose of this doctoral thesis was to examine the relationships between theory of mind, metalinguistic awareness, and executive functioning development. Effects of language and cultural background on development of these abilities were also of interest. In order to assess the effect language experience has on developing these abilities, monolingual English-speaking, bilingual English and Spanish-speaking, deaf signing, and deaf oral children were included in in samples of Studies 1, 2, and 4. To assess impact of cultural background on development, hearing and deaf children from the United Kingdom and Ghana were included in the samples of Studies 1, 2, and 3. Quantitative methods were used to assess the hypotheses developed that correspond with the study research questions, with some supporting qualitative analyses included in Study 3. Data collection methods included a variety of tasks designed to assess theory of mind, metalinguistic awareness, and executive functioning skills. Surveys were used to collect demographic data regarding the participants involved. Full details of the methods and instruments used are described in regards to each study in Chapters 2 – 5.

Research Questions

Six research questions were used to guide the study. These research questions were:

Research Question 1: Are there relationships among theory of mind, metalinguistic awareness, and executive functioning development? If so, what is the nature of those relationships?

Research Question 2: Does language background affect the development of theory of mind?

Research Question 3: Does language background affect the development of metalinguistic awareness?

Research Question 4: How do performance rates on a variety of theory-of-mind-related tasks vary among deaf children?

Research Question 5: Does cultural background affect the development of theory of mind?

Research Question 6: Does cultural background affect the development of metalinguistic awareness?

Definition of Terms

Bilingual. There are a variety of definitions of bilingualism used by researchers. Given that young children (aged 7 years and younger) were included as the bilingual group in Study 4, it is likely that many of these children fit a stricter definition of bilingualism as posed by Bloomfield (1993, as cited in Butler & Hakuta, 2004): "native-like control of two languages" (p. 114). However, to avoid being too prohibitive in using this definition, the present study employed the fairly broad definition proposed by Butler and Hakuta (2004), that bilinguals are "individuals or groups of people who obtain communicative skills, with various degrees of proficiency, in oral and/or written forms, in order to interact with speakers of one or more language in a given society" (p. 115).

Deaf. While the most basic definition of deafness is a partial or total inability to hear (Encyclopædia Britanica, 2013), the term 'deaf' takes on different meanings within deafness research dependent on situation. Emmorey (2002) highlighted the differences in the terms *deaf* and *Deaf* as such:

> Lane et al. (1996) argue that the use of capitalized Deaf for children reflects that fact that if a child with little or no hearing is given the opportunity, he or she would naturally acquire a signed language and would be a member of Deaf culture. Similarly, Navajo children or Black children are called Navajo or Black

as soon as they are born, even though they have not yet been exposed to Navajo or Black culture. As with adults, I use *deaf* when deafness itself is the critical issue and *Deaf* to emphasize sign language acquisition or use. (p. 8)

Executive functioning. The term executive functioning refers to a set of mental processes that are related to self-control of thought, attention, or action (Doherty, 2009). This "set of higher-order cognitive processes" included "impulse control, set-shifting, … and working memory" (Bernier, Carlson, Deschenes, & Matte-Gagne, 2012, p. 12).

False belief. This term refers to the discrepancy between what one believes is the state of the world and what is the actual state of the world (Doherty, 2009). A false belief may cause an individual to "behave in ways that cannot be predicted or explained by reference to the real situation" (Doherty, 2009, p. 8).

False belief task. According to Doherty (2009), the false belief task is "considered to be the diagnostic test of 'theory of mind'" (p. 213). He further stated that "'theory of mind' is informally taken to require the ability to predict action on the basis of a character's belief, rather than on the basis of the real state of affairs. In order to distinguish between these two possibilities, the belief in question needs to be false" (p. 213). The two commonly used forms of the false belief task are the unexpected transfer task and the unexpected contents task, as previously described.

Metalinguistic awareness. Metalinguistic awareness is defined as "an awareness of the underlying linguistic nature of language use" (Malakoff & Hakuta, 1991, p. 147), that is, the understanding of the representational nature of language (Doherty, 2009). Cazden (1974) defined metalinguistic awareness more formally as "the ability to make language forms opaque and attend to them in and for themselves" (p. 29). Malakoff and Hakuta (1991) stated that "a metalinguistic task, in the most general sense, is one which requires the individual to think about the linguistic nature of the message: to attend to and reflect on the structural features of language" (pp. 147-148). Doherty and Perner (1998) further argued that metalinguistic awareness has its roots in metarepresentation, with support from Kamawar and Olson (2009).

Theory of mind. Premack and Woodruff defined theory of mind quite simply as "the individual imputes mental states to himself and others" (1978, p. 515). However, since that definition the term has been used in a variety of ways and is now "best treated as an umbrella term for children's understanding of mental states," with particular attention paid to belief and desire (Doherty, 2009, p. 7).

Significance

While there has been extensive research conducted over the past three decades on theory of mind and metalinguistic awareness, several key questions remain unanswered. The goal of the research presented in this thesis was to address some of these key questions and help bridge the significant gaps in literature. Study 1 was conducted to further establish whether theory of mind development and metalinguistic awareness are related, and whether this relationship is associated with, or even driven by, development of executive functioning skills. Study 2 and Experiments 3A and 3B were conducted to probe deeper into the issue of theory of mind development and deafness. Particular interest was placed on effects of task manipulation on performance, as well as whether theory of mind and metalinguistic awareness are related among deaf children. Study 3 was conducted to evaluate cultural effects on theory of mind development, particularly by examining false-belief task performance among both hearing and deaf Ghanaian children. Study 4 was conducted to evaluate the effects of language development, namely Spanish-English bilingualism, on development of theory of mind and metalinguistic awareness skills.

The results of the research conducted for this thesis will have implications beyond contributing to the existing literature. Gaining a greater understanding of the underlying mechanisms driving the development of theory of mind and metalinguistic awareness may aid in the creation of intervention strategies aimed at children at risk of experiencing developmental delays. In order to plan effective interventions and determine best practices in working with young children to ensure proper development, it is vital to gain as complete a view of how development takes place and what differences may arise in developmental patterns due to environmental and atypical developmental factors.

Chapter Two

Study 1: Hearing Replication and Extension

Introduction

Between the ages of 3 and 5 years children typically develop the understanding that others may have different beliefs or desires to their own, and accordingly, recognise that others can indeed have *false* beliefs, or think something about a state of affairs that is untrue. Children's theory of mind is often measured using this key point, as it is critical to passing what is now a common theory of mind assessment, the false-belief task (Wimmer & Perner, 1983). It is around this same age when children are able to complete tasks which require the ability to understand that language is representational, that it carries meaning. Several studies have demonstrated that this timing is not coincidental, but that false-belief understanding and metalinguistic awareness are related even beyond age and verbal ability (Doherty, 2000; Doherty & Perner, 1998).

Metalinguistic awareness requires the ability to reflect on language as an object and the ability to control, monitor, and plan linguistic processing. Doherty (2009) suggests this definition for metalinguistic awareness is then comparable to that for theory of mind; while theory of mind involves reflection on mental states, metalinguistic awareness involves reflection on language.

Doherty and Perner (1998) showed empirically that the traditional false belief task correlated strongly with a synonym task, a measure of metalinguistic awareness. This relationship was maintained even after accounting for control tasks and verbal intelligence, supporting the idea that both tasks relate to a development of understanding representations. Doherty and Perner concluded that the association between the metalinguistic tasks and the false belief task was due to the metarepresentational nature of the tasks. This hypothesis was further supported by Perner, Stummer et al. (2002) with the finding that the relationship extends to hierarchically related words, such as rabbit versus animal. Perner, Stummer et al. (2002) found that a combined measure of this new categories task and the synonym task correlated with false belief when given as judgement-based tasks ($r = .67$, $p < .001$, partialling out age and verbal intelligence) or production-based tasks ($r = .58$, $p < .005$).

Perner, Stummer et al. acknowledged that executive demands on children might explain why results on an alternative naming categories task resulted in findings similar to the synonyms task. In an attempt to address this executive demand hypothesis, two additional tasks similar in format to the synonym and categories tasks were introduced in the 2002 study, the colour/colour (CC) task and the part/part (PP) task. In the CC task a puppet names one of two colours present in a picture and the child must name the other colour present, with a similar design for the PP task. According to Perner, Stummer et al., these tasks should present the same Stroop-like executive demands as the synonym and categories tasks, and therefore should be as difficult. Yet, performance on these two tasks was near ceiling (87% correct on all CC items, 92% correct on all PP items) whereas performance on the synonym and categories tasks ranged from 21% to 42% correct on all items, providing evidence against the executive demand hypothesis.

Farrar and Ashwell (2012) further tested this hypothesis using direct measures of executive demand and metalinguistic rhyming tasks designed to assess phonological awareness. The semantic version of the task included a semantically-related distracter from the target rhyming word, not present in the non-semantic version. Children also took part in measures of theory of mind as well as the measures of executive functioning. Study 1 used a shortened version of the dimensional card sort task

(DCCS) (Frye, Zelazo, & Palfai, 1995) as a measure of inhibitory control and the Woodcock-Johnson Memory for Sentences (WRMT-R; Woodcock & Johnson, 1989, as cited in Farrar & Ashwell, 2012) as a measure of general verbal memory. Study 2 included a measure of semantic relatedness and the day-night task (Gerstadt, Hong, & Diamond, 1994) as a measure of inhibitory control typically used in theory of mind research. Both studies showed a link between phonological awareness and theory of mind performance, although the non-semantic rhyming task relation was weaker, presumably because the metalinguistic demands are not as high due to semantic associations being low. Measures of inhibitory control and memory for sentences were not related to the rhyming tasks after controlling for age in the individual studies, although they did correlate moderately with rhyme in the aggregate. However, when controlling for memory for sentences and inhibitory control measures, the relationship between theory of mind and rhyming tasks remained significant. In a hierarchical regression for predicting total rhyming, only verbal mental age (as assessed by the Peabody Picture Vocabulary Test – Third Edition; Dunn & Dunn, 1997) and theory of mind were significant predictors. Farrar and Ashwell concluded that executive functioning, inhibitory control in particular, is an unlikely explanation of the relationship between metalinguistic awareness and theory of mind; they suggested the nature of the related emergence is due to children's developing ability to shift between perspectives.

While Farrar and Ashwell (2012) found a relationship between metalinguistic awareness and theory of mind, success on the rhyming tasks relies on word sound rather than meaning, making perspective-taking less salient, particularly for the non-semantic task. The present study aims to further examine the relationships between theory of mind, metalinguistic awareness and executive functioning using an alternative naming task, for which perspective taking is key, similar to that used by Perner, Stummer et al. (2002). While Perner, Stummer et al. report that Stummer found significant positive relationships between false belief and categories tasks when controlling for age and verbal intelligence ($r = .42$, $p \leq .05$, 1997; $r = .65$, $p \leq .01$, 2001, see Perner, Stummer et al., 2002, Table 2.1), data from Perner, Stummer et al.'s study show that this relationship was no longer significant when controlling for these factors ($r = .25$, $p \geq .05$ for production task, $r = .32$, $p \geq .05$ for judgement task).

The research question that guided Study 1 was Research Question 1: Are there relationships among theory of mind, metalinguistic awareness, and executive functioning development? Experiment 1A was designed to examine the relationship between theory of mind and metalinguistic awareness directly, in part to determine the replicability of Stummer's findings, as well as to create a baseline of performance and investigate the types of errors common on the alternative naming task. Additionally, while findings have shown the relations between the synonyms task, the alternative naming task, and the false belief task, these findings occasionally have not been robust, so additional attempts at replicability can only strengthen the base argument that metalinguistic awareness and theory of mind development are related. Finally, the decision was made to use the alternative naming task versus the synonym or homonym tasks given that issues arose during the attempted creation of like tasks using sign language. The alternative naming task lent itself well to be reworked using sign language, so for the purpose of comparability this task was chosen above the others for assessing metalinguistic awareness.

Versions of the alternative naming task and colour/colour control task were developed to be administered along with a standard false-belief unexpected transfer task and a measure of verbal intelligence. Experiment 1B built upon this by incorporating an additional unexpected transfer task and two measures of executive functioning, the DCCS and Day/Night task, as there had been no direct examinations of the relations between alternative naming and false belief tasks with executive functions to date.

Experiment 1A Method

Participants. Thirty-one children (15 boys, 16 girls) from one nursery school in Stirling, Scotland participated. Ages ranged from 2;8 (2 years, 8 months) to 4;9 (mean age 4;0, *SD* = 6.88 months).

Design. Each child was tested on four tasks in one session lasting roughly 10-15 minutes. The tasks were a false belief unexpected transfer task (FB), the alternative naming (AN) task, the colour/colour control (CC) task, and the British Picture Vocabulary Scale (BPVS) short form (Dunn, Dunn, Whetton, & Pintillie, 1982). The presentation of the CC and AN tasks were counterbalanced, with the FB task given in between in order to break up the two similarly-designed tasks. The BPVS was administered at the end of each session.

Procedure. Each child was tested individually in a corner of the nursery classrooms.

Sally FB. The Sally FB task was based on the false belief task used by Doherty (2000), and was very similar in structure to Peterson and Siegal's adaptation of Baron-Cohen et al.'s (1985) Sally-Ann test (Peterson & Siegal, 1995; 1999). In this task, the child was shown a story acted out with two small dolls (1 male, 1 female), one small black jar, one small black box, and one marble. Sally first put her marble in the box, then went out to play. While she was gone, Tony moved the marble to the jar, and then also went out to play. Sally returned and the child was asked three questions.

Belief question: Where will Sally first look for her marble?

Reality question: Where is the marble really?

Memory question: Where did Sally put the marble in the beginning?

The script for the Sally FB task was:

In our next game we have a box, a jar, and two dolls. This is a little girl, her name is Sally. What's her name? Right, Sally! This is a little boy, his name is Tony. What's his name? Right, Tony!

Now, Sally has a marble. Sally puts her marble into the box. Now Sally goes out to play. What does Tony do while she's gone?

He takes the marble out of the box and puts it in the jar, like this. Now Tony goes out to play.

Here comes Sally back in.

Where will Sally first look for her marble?
Where is the marble really?
Where did Sally put the marble in the beginning?

Great job! Now Sally and Tony are going to go away and play together.

AN task. The AN task was based on the superordinate/basic categories task (NN-categories) used as a metalinguistic awareness measure by Perner, Stummer et al. (2002). The decision was made to use the AN task rather than a synonym or homonym task as used by Doherty (e.g., Doherty, 2000) as the use of synonyms or homonyms in signing versions of the task with deaf children proved prohibitive. As the NN-categories task was easiest to adapt into sign language, it was chosen over the other forms of metalinguistic tasks considered.

The AN task comprised three phases: the vocabulary check, the training phase, and the test phase. For the vocabulary check, four cards (all A4 in size) were used with four pictures on each. One or two of the pictures were critical items which were later used in either the training phase or the test phase (e.g., apple/fruit, milk/drink). Children were asked to point to, e.g., an "apple" on the first pass through the cards, and then a “fruit” on the second pass through the cards. In this manner it was established that the child could identify each of the critical items by both of the names that would be used later in the experiment.

In the experimental portion of the task, the child was told that the experimenter had different pictures, and each picture had two different names. First the experimenter would say one name, and then the child should say the other name. There was one large picture centred on each of the six cards used in the rest of the task, with the first two cards serving as training cards. If the child struggled to think of a different name during the training phase, the child could be encouraged and helped to come up with the second name. In the test phase, no such help was given.

The four final cards made up the test phase, and each card was shown twice, in two full passes through all four cards. Whether the experimenter said the basic or superordinate term first was counterbalanced among participants, and the two levels were alternated for each picture. If the child was told the basic term, e.g., milk, on the first pass through the cards, then in the second pass he was told the superordinate term, i.e., drink, and vice versa. If the child was able to give both the basic and superordinate terms for a picture, that picture was coded as a correct pair. If the child was only able to give one or none of the terms for a picture, that picture was coded as an incorrect pair.

The script for the AN task was:

Ok now in this game we’re going to look at some pictures. When I say a word, you show me which picture it is. Ok let’s give it a try.

(Order of lists counterbalanced)

Point to the apple.	*Point to the fruit.*
Point to the dog.	*Point to the books.*
Point to the drink.	*Point to the milk.*
Point to the rose.	*Point to the flower.*
Point to the plane.	*Point to the shoe.*
Point to the animal.	*Point to the cat.*

Point to the burger.	*Point to the food.*
Point to the chair.	*Point to the bear.*
Point to the bear.	*Point to the sun.*
Point to the bird.	*Point to the owl.*
Point to the ring.	*Point to the house.*
Point to the carrot.	*Point to the ring.*

Very good! Now, I have some pictures. Each picture has 2 names. I'll say the first name, then you say the other name. Ok? Let's give it a try.

(Practice phase items)

This is a fruit. What else is it?	*This is a rose. What else is it?*

(Items counterbalanced)

This is a drink (/milk). What else is it?	*This is milk. What else is it?*
This is a cat (/an animal). What else is it?	*This is an animal. What else is it?*
This is food (/a burger). What else is it?	*This is a burger. What else is it?*
This is an owl (/a bird). What else is it?	*This is a bird. What else is it?*

Great job!

CC task. The CC task was adapted from the CC-task used by Perner, Stummer et al. (2002). However, rather than using a puppet that names the colours, the experimenter herself named the colours during the game. Similarly to the AN task, the CC task was also comprised of three phases: the colour check, the training phase, and the experimental phase. In the colour check, the child was shown an A4 card with six circles, each one of the following colours: red, blue, green, yellow, orange, and brown. The child was asked to point to each colour individually to establish that the child could identify each of the different colours.

In the experimental portion of the task, the child was told that the experimenter had different pictures, and each picture had two different colours. First the experimenter would say one colour, and then the child should say the other colour. During the training phase, which consisted of the first two of six A4 cards, the child was allowed help and encouragement to name the second colour. In the test phase, no such help was allowed, however the procedure remained the same. Each child saw each of the four experimental cards one time, and each picture was marked as correct or incorrect. Which colour the experimenter named first for each card was counterbalanced between children.

The script for the CC task was:

Ok, the first game is about colours. You know your colours? Good!

Show me, where is blue? Where is brown? Where is yellow? Where is green? Where is red? Where is orange?

Very good! Now, I have some pictures. Each picture has 2 colours. I'll say the first colour, then you say the other colour. Ok? Let's give it a try.

(Colours counterbalanced)
This picture is red (/yellow). What other colour is it?
This picture is brown (/blue). What other colour is it?
This ball is red (/blue). What other colour is it?
This turtle is brown (/green). What other colour is it?
This butterfly is blue (/yellow). What other colour is it?
This present is yellow (/red). What other colour is it?

Good job!

BPVS. The BPVS short-form (Dunn et al., 1982) was used to assess verbal mental age. Standard scores were calculated for each participant's raw score based on chronological age. Standard scores were included in the analyses where BPVS was specified.

Experiment 1A Results

Sally FB task. Baron-Cohen et al. (1985) required correct responses to the test question and control questions, rather than just the test question, for a passing score on the false belief task. Many researchers have also elected to use this more stringent requirement (e.g., Jackson, 2001; Peterson & Siegal, 1998), and as such this criterion was used for determining passing scores on this and all false belief tasks administered and reported throughout this thesis. Approximately half (51.6%) of the children passed the test (see Table 2.1). All of the children who answered the belief question correctly also answered both the reality and memory control questions correctly. A total of 4 children (12.9%) failed a control question; one child failed the reality question, three children failed the memory question, and none failed both.

AN task. Of a maximum of four, the mean for correct pairs given was 1.68 (*SD* = 1.33). The trials on which children had to provide the superordinate rather than the basic term (mean correct of four = 1.74) were significantly more difficult for the children than the subordinate to basic trials (mean correct of four = 3.23), $t(30) = 8.03$, $p < .001$. The animal to cat item was particularly easy for children, with 100% correct responses. The converse of this item, cat to animal, was the most difficult for children, with only 25.8% getting it correct. In order to compare performance on the AN task to performance from the FB more directly, children who were able to provide at least three of four correct pairs were considered as passing the task, whereas those who were only able to provide two or fewer correct pairs were considered as failing the task. The decision to use the criterion of three out of four pairs correct was made due to the low number of children achieving all four pairs (just 6.5%), while also maintaining a score of over 50% passing. As such, when looked at in terms of passing or failing, performance on the AN task (35.5% correct) was weaker than for the FB task (see Table 2.1).

CC task. Again, if we look at the task in terms of passing (with at least three correct trials) or failing, children performed better on the CC task than on either the AN task or FB tasks (see Table 2.1). Mean correct trials completed was 3.19 of four (*SD* = 1.40).

Table 2.1

Percentage of Children Passing Each Task in Experiment 1A

Tasks	% Passing (n = 31)
FB	51.6
AN	35.5
CC	74.2

Comparison of tasks. Table 2.2 shows correlations between the two measures of age and performance on the FB, AN, and CC tasks. Partial correlations controlling for both chronological age (in months) and standard score on the BPVS are represented in parentheses. Although FB was correlated with both the AN and CC tasks, only the relationship between FB and AN remained significant when age and BPVS score were partialled out.

Table 2.2

Correlations between Age Measures and the Experimental Tasks of Experiment 1A (Partial correlations controlling for age and verbal mental age in parentheses)

	FB	AN	CC	BPVS
Age	.381*	.393*	.258	-.285
FB	-	.800***	.417*	.034
AN	(.758***)	-	.358*	.109
CC	(.344)	(.268)	-	.042

*p < .05, **p < .01, ***p < .001

In order to compare all tasks, children were scored as passing the AN task if they correctly produced three out of four pairs and passing the CC task if they correctly answered three out of four trials. The FB task was significantly more difficult than the CC task (McNemar, binomial, p = .039), as was the AN task (p = .002). The FB and AN tasks did not differ significantly in difficulty (p = .125).

Experiment 1A Discussion

The results from Experiment 1A are consistent with the findings from Stummer (1997; 2001, both as cited by Perner, Stummer et al., 2002). However, while Stummer (1997; 2001) found robust relationships between the alternative naming task and false-belief tasks when controlling for age and verbal intelligence, the significant correlations between these tasks were not maintained in the broader Perner, Stummer et al. (2002) study when controlling for these factors. This led to some question as to the robustness of Stummer's (1997; 2001) findings when taking age and mental ability into account. The results of the present study have provided further credence for Stummer's findings, as the strong positive relationship between false belief and alternative naming was once again found and was maintained when accounting for age factors.

What was consistent with Perner, Stummer et al.'s (2002) findings, however, was the fact that the alternative naming task was significantly more difficult for children than were the other "say-something-different" tasks implemented by Perner, Stummer et al. – the CC task and the PP task. Perner, Stummer et al. argued that these tasks, which are similar in design and method, should elicit the same Stroop-like executive demands on children as the alternative naming task under the executive demand hypothesis, and therefore should result in similar performance on the three tasks. Similarly to as found by Perner, Stummer et al., children had significantly more difficulty with the AN task (35.5% passing) than they did with the similarly structured CC task (74.2% passing). This supports Perner, Stummer et al.'s stance against the executive demand hypothesis.

However, without more formally assessing the executive demands hypothesized to mediate the relationship between metalinguistic and false belief ability, as Farrar and Ashwell (2012) attempted, it is difficult to make concrete claims regarding the true merit of the executive demand hypothesis. As such, Experiment 1B was conducted with the aim of further investigating the role of executive functioning in the relationship between theory of mind and metalinguistic awareness.

Experiment 1B Method

Participants. Participants were 50 children (28 boys, 22 girls) from one nursery school and one playgroup in Stirling, Scotland. Their ages ranged from 2;10 (2 years and 10 months) to 5;1 (mean age of 3;10, *SD* = 6.98 months).

Design. Each child was tested in two sessions lasting roughly 10-15 minutes about 2 weeks apart. The first session consisted of one false belief task, the CC control task, and the Dimensional Change Card Sort (DCCS) task. Session two consisted of a second false belief task, the AN task, and the Day/Night Stroop (DNS) task. In the first session, the false belief task was administered after the other two tasks, whilst in the second session the false belief task was administered prior to the other two tasks. The BPVS short form was administered at the end of the second session. Rather than standard BPVS scores, as used in the analyses for Experiment 1A, however, calculated verbal mental age in months was included for the present analyses.

Procedure. The Sally FB, AN, and CC tasks were administered using the same materials and procedures as in Experiment 1A.

Puppet FB. A secondary false belief task was implemented in addition to the Sally FB task in order to create a more robust false belief measure. The task, while maintaining the basic structure of the original false belief task, included interaction with the child and the use of deception. A meta-analysis by Wellman et al. (2001) indicated that the inclusion of a deceptive motive and participation in the task improved performance; thus, the inclusion of these factors in the Puppet task provided children with a strong opportunity to pass the task.

In this task, the child was introduced to Puppet and told the following story with a green frog puppet, a small covered box, and a small key. Puppet had his house key, which is very important, so he needed to put it somewhere safe. He decided to put in the box. Then, because Puppet was very tired, he left to take a nap. While Puppet was asleep, the experimenter told the child that they were going to play a trick on Puppet and move his key. They moved the key to under a piece of paper. Puppet woke up and came back, and the child was asked three questions.

Belief question: Where will Puppet first look for his key?

Reality question: Where is the key really?

Memory question: Where did Puppet put his key in the beginning?

The script for the Puppet FB task was:

Oh! I hear something! It's Puppet! What's that you've got Puppet?
What does Puppet have?
Right, a key! Is that your house key Puppet? [Puppet nods]
You don't want to lose that, do you? [Puppet shakes head]
Where will you put it? [Puppet puts key in box]
Good idea.
Are you tired Puppet? Are you going for a nap? [Puppet nods, then goes "to sleep" in bag]
Night night Puppet!

[Whispered] *Let's play a trick on Puppet. I'm going to move his key from the box to… let's see, where should we put it? Under this paper? Good – let's hide it here.*
I hear Puppet waking up!

Where will Puppet first look for his key?
Where is the key really?
Where did Puppet put his key in the beginning?

Oh here it is, Puppet! See you later!

DCCS. The DCCS procedure was modelled after that used by Kloo and Perner (2003; 2005). In the DCCS, the child was first introduced to the two black boxes (26cm × 7.5cm × 18cm), each with a laminated picture (9cm × 9cm) adhered to the front of the box, one with a blue apple and one with a red dog. The colour and shape of the pictures on each box was named. Ten cards (9cm × 9cm) were used for sorting, five with red apples and five with blue dogs, with two additional cards used for demonstration or sorting. The cards were designed to match one box on one sorting criterion (colour) and the other on the other sorting criterion (shape). The child was also shown that there was a slit at the top of each box, where things could be put inside.

The child was told that they would begin by playing the colour game. In the colour game, the experimenter explained that all of the red cards go into the red box, and all of the blue cards go into the blue box, simultaneously demonstrating sorting one card of each colour. Then the child was given five cards, one at a time, and asked to place them into the appropriate boxes. As each card was handed to the child, the appropriate sorting criterion (in this case, colour) was stated, e.g., “Here is a red card”. During this phase of the experiment, the child was allowed help, correction, and feedback from the experimenter.

Once the five cards had been sorted by colour, the experimenter then said that they were going to play a new game, the shape game. In the shape game, all of the dog cards go into the dog box, and all of the apple cards go into the apple box. The child was then given five cards, one at a time, which were labelled by the appropriate shape sorting criterion and asked to sort them into the two boxes. The child was given no feedback or help during this test phase.

The script for the DCCS was:

Now, a new game. In this game, we have 2 boxes. This one has a blue apple. This one has a red dog. See the holes on the top? We can put things inside.

First we’ll play the shape game. In the shape game, all the dogs go in the dog box and all the apples go in the apple box. I’ll try first. Here is an apple. It goes in the apple box. Here is a dog. It goes in the dog box. Now you try.
Here’s an apple. Where does it go in the shape game?
Here’s a dog. Where does it go in the shape game?
...

Ok now let's play a new game. It's called the colour game. All the red pictures go in the red box and all the blue pictures go in the blue box. Understand? Ok you try.
Here's a blue one. Where does it go?
Here's a red one. Where does it go?
...
Good job!

DNS. The DNS task procedure was very similar to the original used by Gerstadt et al. (1994), however only the experimental condition was presented. The child was shown a laminated card (21cm × 14.85cm) with a white moon and stars on a black background and told, "When you see this card, I want you to say 'day'." After confirming this response by having the child repeat the word 'day', the child was shown a card with a yellow sun on a blue background and told, "When you see this card, I want you to say 'night'." Once again the response was confirmed with repetition. Examples of the two card designs are included in Appendix B.

The child was then shown a black moon card with no instruction. If the child did not respond, he or she was prompted with the question, "What do you say for this one?" If the child responded correctly, praise was given and the experimenter moved on to the white sun card. If the child responded correctly to the white sun card, these two cards were counted as trials 1 and 2 of testing and testing continued. If the child responded incorrectly to either of the first two trials, they were counted as practice and the child was reminded of the rules of the game. Once the child was able to correctly name each card for trials 1 and 2, testing continued.

Eight 'day' cards and eight 'night' cards were presented in a pseudorandom order for a total of 16 trials. If the child did not respond to a card, he or she was prompted with the question, "What do you say for this one?" or "What do you say to this picture?" No feedback was given during the 16 test trials.

The DNS script was:

Now let's have a look at our next game.
Whenever you see this picture, I want you to say "Day". What do you say?
Right! "Day"!
Whenever you see this picture, I want you to say "Night". What do you say?
Right! "Night"!
Right, now let's give it a try.
(If wrong in first 2, repeat and say - What do you say to this picture?)
Good job, you did very well!

Experiment 1B Results

False belief. More children (94%) answered the reality question correctly on the Sally task than answered the memory question correctly (82%). Of the 50 children, only 30 (60%) answered the belief question correctly on the Sally task. A total of 28 children passed both the belief question and the two control questions for a pass rate of 56% on the Sally task. Again, slightly more children passed the reality question (94%) on the Puppet task than passed the memory question (92%). Thirty-two children (64%) passed the belief question, with 31 (62%) passing both the belief question and the two control questions. Performance on the two tasks was significantly correlated (r_{φ} = .385, p = .006) and a total of 22 children (44%) passed both versions of the false belief task.

When considered in aggregate, the children gave near-perfect responses to the reality control question (Where is the object now?) in both tasks (90% correct in both tasks). Although they were slightly less reliable in their answers to the memory control questions, most still responded correctly in both tasks (82% correct in both tasks). In total, 40 of the 50 children (80%) answered both control questions in both stories correctly, yet only 25 of the 50 children (50%) answered both test questions correctly.

AN task. Children were near perfect in the vocabulary check, with 94% correctly identifying all critical items. Children performed similarly to as in Experiment 1A, with a mean score of 1.44 correct pairs out of four (*SD* = 1.48). Out of the 50 children, 23 (46%) were able to correctly produce both the basic and superordinate terms to at least three of the four item pairs, which was considered 'passing' the task. It is clear that the difficulty arose for children when given the basic term and having to produce the superordinate term. Forty-seven of the 50 children (94%) were able to produce the basic term for at least two items, but only 23 (46%) were able to produce the superordinate term for at least two items. A paired-samples *t*-test confirmed that the children's scores on basic-to-superordinate items (M = 1.52) were significantly lower than their scores on superordinate-to-basic items (M = 3.46), $t(49) = 9.86$, $p < .001$.

CC task. Again, children were near perfect in the colour check (96% achieving a perfect score). Performance was once again similar to performance in Experiment 1A, with a mean score of 3.74 out of four (SD = .80). Performance was very strong on the experimental portion of the task with 46 out of 50 children (92%) passing the task by correctly answering at least three out of four trials.

DCCS. Children performed well on the DCCS, with 34 of 50 (68%) correctly sorting all five cards in the post-switch phase. Eight of the fifty children (16%) were unable to correctly sort any of the five cards in the post-switch phase, with another eight correctly sorting between one and four cards. The mean number of correct trials was 3.78 (SD = 1.99).

DNS task. Children also performed well on the DNS Task, with slightly over a quarter of the sample (n = 13, 26%) achieving a perfect score. The mean score on the task was 12.08 (SD = 4.85).

Task relatedness. Table 2.3 shows correlations between all tasks administered and both measures of age. Partial correlations controlling for effects of age are presented in parentheses. Only two significant relationships remained when controlling for age. A marginally non-significant correlation was found between false belief and

DCCS performance (r = .29, p = .052), suggesting a possible trend between the two tasks. False belief performance also correlated moderately and significantly with performance on the AN task (r = .465, p = .001). This relationship between false belief and AN task performance remained when accounting for both measures of age, both measures of executive functioning, and the CC task, r = .447, p = .002.

Table 2.3

Correlations between Age Measures and the Experimental Tasks of Experiment 1B (Partial correlations controlling for age and verbal mental age in parentheses)

	FB	AN	CC	DCCS	DNS	BPVS
Age	.301*	.345*	.170	.380**	.412**	.566***
FB	-	.588***	.154	.407**	.289*	.376**
AN	(.465**)	-	.322*	.325*	.238	.256
CC	(.032)	(.207)	-	.219	.115	.363*
DCCS	(.288)	(.116)	(.136)	-	.101	.383**
DNS	(.207)	(.08)	(.031)	(-.055)	-	.266

* p < .05, ** p < .01, *** p < .001

Displayed in Figure 2.1 is the proportion of false belief scores according to the number of AN pairs correctly produced.

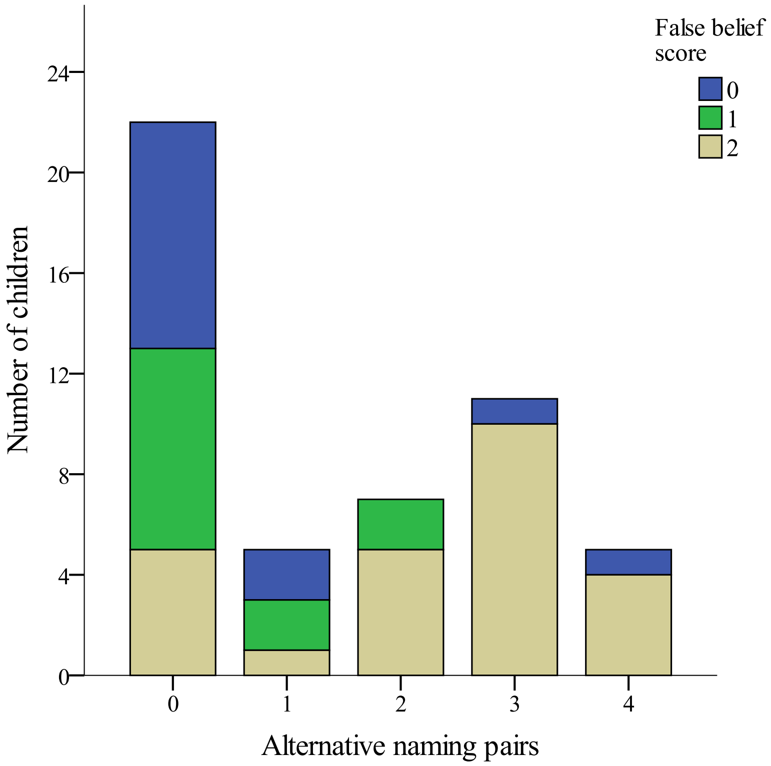

Figure 2.1. Number of children providing 0-4 alternative naming pairs and showing false belief understanding in Experiment 1B

In order to compare all tasks, once again children were scored as passing the AN task if they correctly produced three out of four pairs and passing the CC task if they correctly answered three out of four trials. A passing score on the DCCS was considered correctly sorting at least 4 out of 5 cards or correctly sorting the last three. This criterion was based on that used by Frye et al. (1995). The DNS task was considered passed if the child correctly completed 14 of the 16 trials, similarly as to the criterion of 13 out of 15 trials as used by Tager-Flusberg, Sullivan, and Boschart (1997, as cited in Perner & Lang, 1998). The two FB tasks were of equal difficulty (McNemar, binomial, p = .607), so the two FB tasks were combined for a total measure of FB. For the purpose of task comparison, a child was considered passing the FB portion of the experiment only if he or she passed both FB tasks. Percentages of children passing each task are shown in Table 2.4.

The CC task was significantly easier than each of the other tasks (McNemar, binomial, *p*s $< .022$). The AN task was significantly more difficult than the DNS and DCCS tasks (*p*s $< .015$), but not the FB tasks ($p = .180$). The FB portion was significantly more difficult than the DCCS ($p = .003$), but not the DNS. The DNS and DCCS did not significantly differ in difficulty ($p = .134$).

Table 2.4

Pass Rates for Each Task in Experiment 1B

FB	AN	CC	DCCS	DNS
44%	32%	92%	74%	58%

Regression. A hierarchical regression was performed, with number of AN task pairs as the dependent variable, age and BPVS as control variables, followed by measures of executive functioning and the CC task in step 2, and finally FB in step 3. Evaluation of collinearity statistics indicated that the assumption of non-multicollinearity was met (all VIF < 10, T > .10). As seen in Table 2.5, only FB performance was significantly related to performance on the AN task. False belief still contributed to the metalinguistic awareness measure even after all other variables were controlled for.

Table 2.5

Hierarchical Regression for Experiment 1B Data Predicting Total AN Pairs Produced

Variable	*B*	*B*(SE)	Beta	*p*
Step 1[a]				
Age	.027	.037	.124	.480
BPVS	.018	.019	.171	.333
Step 2[b]				
Age	.016	.041	.077	.689
BPVS	.007	.020	.065	.734
DCCS	.077	.123	.100	.537
DNS	.026	.048	.086	.594
CC	.361	.285	.198	.213
Step 3[c, d]				
Age	.025	.037	.115	.506
BPVS	-.006	.019	-.059	.736
DCCS	-.041	.116	-.054	.725
DNS	-.009	.044	-.028	.849
CC	.375	.256	.206	.151
FB	.888	.268	.500	.002**

[a] $R^2 = .069$, $p = .202$
[b] $\Delta R^2 = .122$, $p = .476$
[c] $\Delta R^2 = .307$, $p = .001$
[d] Model 3 significant, $F(6, 41) = 3.027$, $p = .015$
**$p < .01$

Experiment 1B Discussion

The results of Experiment 1B confirm those of Experiment 1A, that there is a strong relationship between false belief and alternative naming understanding. Performance on the AN task was not related to either measure of executive functioning, and the relationship between FB and AN performance remained even when accounting for age differences and executive functioning performance. The AN task once again appears more difficult for the children, with a lower passing rate than FB tasks, extending the pattern from Experiment 1A. Consistent with previous research, performance on the CC task was high, indicating that despite having similar inhibitory control demands as the AN task, it is inherently easier. False belief, while intially positively related to both aspects of executive functioning, was only marginally related to DCCS performance after accounting for measures of age. This is somewhat inconsistent with previous research, and warrants further inspection.

Study 1 General Conclusion

The results of Experiments 1A and 1B support the hypothesis that theory of mind and metalinguistic awareness development are related. These results confirm the previous work of Doherty and Perner (1998), Doherty (2000), and Perner et al. (2002), as well as extending them through the included evaluation of executive functioning skills in the relationship. Results also confirm Farrar and Ashwell's (2012) findings that executive functioning was unlikely to explain the relationship between metalinguistic awareness and theory of mind. The results therefore support the theory that the related emergence of these two skills is due to the development of improved perspective taking skills. Given that Farrar and Ashwell's study was reliant on sound rather than meaning, the use of the AN task provides stronger evidence for perspective taking ability as the underlying mechanism driving false belief and metalinguistic awareness skills. Contrary to Farrar and Ashwell, the present results did not show a significant relationship between vocabulary and performance on the metalinguistic awareness task. This may be an artefact of the nature of the metalinguistic tasks used.

Also contrary to Farrar and Ashwell's (2012) findings, performance on the DCCS did not correlate with performance on the AN task, although it did correlate positively and highly significantly with false belief performance. While Farrar and Ashwell appear to support Kloo et al.'s (2010) suggestion that the DCCS task may tap into perspective taking given that it correlated with performance on their theory of mind and rhyming tasks, this conclusion is questionable as the correlation between DCCS and false belief performance did not remain once age and verbal mental age had been taken into account. While it could be argued that perhaps the relationships Farrar and

Ashwell identified were spurious due to the fact that DCCS performance was no longer significantly related to rhyming task performance in their hierarchical regression model when age and verbal mental age were accounted for in step 1, it is just as likely that the relationship is not very specific or is not a strong relationship. This latter point is highlighted by the fact that the false belief task has been found to both correlate (e.g., Frye, Zelazo, & Palfai, 1995; Henning, Spinath, & Aschersleben, 2011; Perner, Lang, & Kloo, 2002) and to not correlate (e.g., Remmel, Bettger, Weinberg, Novotny, & Eberwein, 2000, as cited in Remmel, Bettger, & Weinberg, 2001) with DCCS performance, depending on study. This issue can only be resolved with further investigation, and it is suggested that other tasks aimed at assessing set shifting be included rather than dependence on one test, the DCCS.

Despite these differences regarding the effects of vocabulary and relationships with the DCCS and its potential nature, the overarching result of the present finding and that of Farrar and Ashwell (2012) remains consistent: metalinguistic awareness and theory of mind abilities are related in typically developing children, even above and beyond chronological age, mental verbal age, and executive functions of inhibitory control and set-shifting ability. This provides strong evidence for a common underlying developmental mechanism supporting development of these tasks. It is proposed that this underlying mechanism includes an aspect of perspective taking ability.

Chapter Three

Study 2: Deaf Extension

Introduction

Much theory of mind research has been conducted with the non-typical group of deaf children, with a large amount of evidence suggesting deaf children can be extremely delayed in theory of mind development (e.g., Courtin, 2000; Meristo et al, 2007; Peterson & Siegal, 1995; Steeds et al., 1997). A variety of tasks, many of them variations on the typical false-belief task, have been used with deaf children with the aim of evaluating theory of mind skills in deaf children. Some researchers, however, argue that use of one primary form of evaluation is too prohibitive in making claims that young deaf children have not yet developed a theory of mind (Marschark, Green, Hindmarsh, & Walker, 2000). Using a storytelling-based task, Marschark et al. (2000) claimed that despite being unable to pass the false belief task, deaf children still have theories of mind, and they are at least as well developed as those of their hearing peers. Although there is some controversy regarding task and interpretation of false belief task performance, the majority of deaf theory of mind research indicates that there is a delay in some form of development attached to the ability to pass the false belief task and related tasks.

Not all deaf children have been found to exhibit such delays, however. Native deaf children, that is, deaf children of deaf parents, have been found to develop the ability to pass the false belief task at ages comparable to typically developing hearing children (e.g., Courtin, 2000; Courtin & Melot, 2005; Peterson & Siegal, 1995). Peterson and Siegal (1995) were some of the first researchers to suggest that conversational access to references of other people's mental states in early childhood might be vital to theory of mind development. They suggested that late-signing children may lack the crucial exposure to conversational input about other's mental states during a critical period of brain development. Autistic children, who also struggle with delays in the ability to pass the false belief task, likely also lack sufficient "access" to early mental state talk, albeit for different reasons than being unable to hear conversation.

Moeller and Schick (2006) found results suggesting hearing mothers of deaf children produce significantly less mental state utterances in interactions with their children than do hearing mothers of hearing children, providing some support for Peterson and Siegal's claim. A more recent study of early theory of mind reasoning among 17- to 26-month-olds showed hearing infants of hearing parents outperformed deaf infants of hearing parents in an anticipatory task based on false belief (Meristo et al., 2012). This study provided further, strong evidence that early access to language and conversational input contributes to theory of mind reasoning. While the lack of early language access appears to be the most viable explanation as to why late-signing deaf children experience a delay in false belief understanding, it is unclear how exactly this lack of access is tied to the underlying development. Additionally, the extent of the delay in terms of related skills has yet to be fully investigated.

Use of alternative tasks. Remarking upon the use of the false-belief task as the primary measurement of theory of mind ability, Gray and Hosie (1996) warned that researchers should be "reluctant to pin faith on a single measure as an indicator" (p. 229). Marschark et al. (2000) agreed with this view, particularly because they found it somewhat absurd that "theory of mind is an area in which chimpanzees have been credited with abilities that are denied to children who are deaf" (p. 1067). Marschark et al. (2000) examined stories told by groups of deaf and hearing children in order to assess theory of mind through expressions of mental states and behaviours being ascribed to themselves and others. The claim of the study was that while deaf children may have been shown to fail the false belief task, they may still have theories of mind at least as well developed as their hearing peers, under the assumption that a full-fledged theory of mind encompasses many mental phenomena apart from just beliefs.

In Marschark et al.'s (2000) study, 15 deaf (9- to 15-years-old) and 15 hearing (10- to 15-years-old) adolescents took part. Videotapes of the participants signing or speaking stories, respectively, were selected from a large pool of videotapes previously recorded for past studies. Selection of participants' videotapes was based on age matching among 9- to 15-year-old children in the pool. According to school records, all deaf children had severe to profound hearing loss, had hearing parents, were enrolled in a school with a total communication philosophy, and used sign language as their primary means of communication at school.

Transcriptions of the hearing children's stories were prepared directly from the videotapes. Transcription of the deaf children's stories was completed by a nationally certified (U.S.) sign language interpreter. Three of the authors scored each transcript independently for both occurrences of mental state attributions to self or another and classification of the mental state attribution involving elements such as belief, doubt, desire, knowledge, or thinking. After coding, retraining, and recoding, 78% of attributions were agreed upon by the three scorers. Analyses were conducted using both attributions identified by all three scorers, and by those identified by at least two scorers.

Analysis using the more conservative three-scorer criterion resulted in marginal effects of hearing status, with children who are deaf producing more mental state attributions than children who are hearing. When using the less conservative two-scorer criterion, the main effect of hearing status was reliable. Further analysis with the younger children only, aged 9 to 13 years to somewhat match the age range used by Peterson and Siegal (1995), showed that younger deaf children produced significantly more mental state attributions than the younger hearing children. An analysis of the types of beliefs (self versus other, and true, false, or indeterminate belief) mentioned showed no difference overall or in interactions between deaf and hearing groups. There were reliably more true beliefs (M = 1.36) mentioned than false (0.42) or indeterminate (0.16) beliefs. There were also significantly more true self-attributions of belief than any other alternative.

The authors argued that the disconnect in findings between their study and the studies of others involving the false-belief task is due to the fact that demonstrating a theory of mind requires children to understand their own and others' mental states and to recognize that these states lead to behaviour, yet the false-belief task requires the additional step that children predict the behaviour of others based on inferred mental states (p. 1072). It therefore appears that perhaps deaf children may indeed have some understanding of theory of mind, yet lack some critical skill that results in the application of understanding. It may also be argued that the current study was testing theory of mind in an implicit way, rather than the more explicit measure of the false-belief task. While Marschark et al. may have demonstrated that perhaps the delay or deficit experienced by deaf children is not as deep-seated or severe as previously thought, it remains that there is still something significantly different happening in development between not just deaf and hearing children, but also native and late signing deaf children. It can surely be argued that application of understanding in real-life situations is an important part of development, and something that appears to be lacking in distinctive cases.

This is just the stance that Edmondson (2006) took in response to the claim of Marschark et al. (2000) that deaf children understand mental states, but have trouble using this understanding to predict the behaviour of others based on inferred mental states. Edmondson argued that, “a functional understanding of false belief and an ability to predict the behaviour of others is a key cognitive component of social development and an essential life skill” (p. 162). Edmondson chose to use a ‘deceptive box’ task, a variation of the unexpected contents task, in addition to the traditional unexpected transfer task in order to recreate as accurately as possible a deceptive situation for the children to interpret. Once again, this study confirmed the findings from other studies that deaf children of deaf parents fare better on false-belief tasks than deaf children with hearing parents. Edmondson also interpreted one fail and one pass on the two tasks as a ‘partial’ understanding of false belief. While he acknowledges that practice effects may have played a part in this, he also suggests that there may be a gradual and socially mediated process of development, rather than a relatively sudden cognitive shift.

Study 2 was guided by the research question: What are the relationships among theory of mind, metalinguistic awareness, and executive functioning development among school-aged deaf children? The aim of Experiment 2A was to evaluate application of potential underlying theory of mind ability on two versions of the false belief task among deaf children, as well as to establish whether the deficit commonly found spans into other areas of cognition, namely metalinguistic awareness and executive functioning. Given that explicit demonstration of theory of mind and the metalinguistic awareness necessary to be successful on an alternative naming task appear to be strongly related in hearing populations, examining whether a similar relationship exists among deaf children may provide insight into the nature of the delay in theory of mind development.

Experiment 2A Method

Participants. Eighteen deaf children (9 boys, 9 girls) took part in Experiment 2A. Eleven of these students were recruited from a school for the deaf in California, USA, and seven were recruited from a school in central Scotland. The decision was made to initially conduct data collection in Southern California as the researcher was originally from the area and knew there to be a large deaf population present. Additionally, the experimenter was able to use pre-existing knowledge of American Sign Language (formally trained to ASL level 3) during this data collection process while working on improving her British Sign Language skills in order to conduct research within the U.K. Due to restrictions imposed by the deaf school, data collection in California proved to be more difficult than had previously been planned, resulting in additional data collection within Scotland being necessary to increase the sample size. After completing the Level 1 certificate in BSL (later receiving Level 2 certification), the experimenter had gained sufficient vocabulary and skill to conduct additional data collection within the central belt of Scotland, providing the ability to increase the sample size obtained in California.

Students aged in range from 5;7 to 15;9 (mean age 10;2, *SD* = 29.73 months). Twelve of the eighteen participants indicated they prefer signed communication, while six indicated no preference between signed and oral communication. Only three participants had a cochlear implant, and eight participants had at least one deaf family member. Eight participants indicated having at least one deaf parent, and seven indicated having at least one deaf sibling; each of these participants is therefore considered native signing as they have an immediate deaf family member.

Design. Each student was tested in one session lasting between 10 and 20 minutes. The tasks used in Experiment 2A were the same tasks as administered in Experiment 1B, apart from the vocabulary test conducted. The tasks were two FB tasks and the AN, CC, DNS, and DCCS tasks. Rather than the BPVS (Dunn et al., 1982), the PPVT (Dunn & Dunn, 1997) was used. While similar in form, the PPVT edition was newer than the BPVS edition and the PPVT had been normed to American children, who were estimated to make up the majority of experiment participants prior to data collection. However, due to problems with using the PPVT with deaf children, the task was discontinued after the first 11 participants. No measure of verbal mental age was therefore included in the analyses. Tasks were administered in sign language, spoken language, or a mix based on participant preference.

Materials and procedure. All tasks for Experiment 2A used identical materials as for Experiment 1B, apart from the measure of verbal mental age. For data collection in the U.S., a native Deaf signer attended all sessions and interpreted instructions into ASL for participants. The interpreter was a native Deaf signer who had grown up in the region, attended the school for the deaf that participants were currently attending, and was undertaking an undergraduate degree at a local university. An interpreter was used during the U.S. sessions due to the primary researcher's short amount of time in the country prior to testing, limiting preparation time to ensure tasks were signed in a manner the children would understand. During the testing sessions with children in California, the researcher and the Deaf interpreter sat with each child. The researcher acted out and spoke the tasks in English, while the interpreter signed what was spoken. For data collection with deaf children in the U.K., rather than using an interpreter, the primary researcher worked with a sign language teacher prior to data collection in order to be trained on how to conduct the tasks in BSL correctly. Each child was tested in a one-on-one session with the researcher.

Experiment 2A Results

False belief. Nearly all of the eighteen children answered the reality and memory questions correctly on the Sally task (n = 17, 94.4% on both). However, only six participants answered the belief question correctly, resulting in a passing rate of 33.3%. All children passed both control questions on the Puppet task. The pattern for the Puppet task was much different from that of the Sally task; 15 of 18 participants got the belief question correct for a passing rate of 83.3%. A correlation analysis indicated that performance on the two tasks was not significantly related, $r = .316$, $p = .201$. Therefore when considering the relationship between false belief results and other task results, the two tasks were considered separately.

AN task. All children correctly identified 100% of the items named in the vocabulary check phase. Children performed well on the AN task, with a mean score of 3.56 correct pairs out of four ($SD = 0.78$). Out of the 18 children, 15 were able to correctly produce both the basic and superordinate terms to at least three of the four item pairs, resulting in a pass rate of 83.3%. Contrasting with the finding from Experiment 1B, no significant difference was found between children's scores on basic-to-superordinate items ($M = 3.61$) and their scores on superordinate-to-basic items ($M = 3.89$), $t(17) = 1.57$, $p = .135$.

CC task. Performance on the colour check phase was perfect, with all children correctly identifying all colours. All children also answered all four test trials correctly, for a passing rate at ceiling (100%).

DCCS. Children performed well on the DCCS, with 16 of 18 (88.9%) correctly sorting all five cards in the post-switch phase. The other two participants did not sort any of the five cards correctly in the post-switch phase. The mean number of correct trials was 4.44 (*SD* = 1.62).

DNS task. Performance was again strong on the DNS Task. Sixteen of eighteen participants (88.9%) achieved a perfect score of 16. An additional child scored a 15, bringing the passing rate to 94.4%. The mean score on the task was 15.78 (*SD* = 0.73).

Task relatedness. Table 3.1 shows correlations between all tasks administered along with chronological age in months. Partial correlations controlling for effects of age are presented in parentheses. No significant relationships were found between any tasks, both with and without controlling for age.

Table 3.1

Correlations between Age Measures and the Experimental Tasks of Experiment 2A (Partial correlations controlling for age in parentheses)

	Sally FB	Puppet FB	AN	DCCS	DNS
Age	.107	-.401†	-.111	-.437†	.106
Sally	-	.316	.103	.250	.221
Puppet	(.394)	-	.130	.316	-.140
AN	(.116)	(.095)	-	.258	.023
DCCS	(.332)	(.171)	(.234)	-	-.110
DNS	(.212)	(-.107)	(.035)	(-.072)	-

†$p < .10$

In order to compare all tasks, passing scores as determined based on the criteria outlined in Study 1 were compared. Percentages of children passing each task are shown in Table 3.2. The CC task was not included in these analyses as performance was at ceiling. Performance on the Sally task was significantly lower than from each of the other tasks (ps ≤ .012), indicating it was the most difficult task. No other tasks differed significantly.

Table 3.2

Pass Rates for Each Task in Experiment 2A

Sally	Puppet	AN	CC	DCCS	DNS
33.3%	83.3%	83.3%	100%	88.9%	94.4%

Regression. A hierarchical regression was performed, with number of AN task pairs as the dependent variable, age as a control variable, followed by measures of executive functioning in step 2, and finally the two FB tasks in step 3. All three models were nonsignificant (ps ≥ .662). Additionally, as shown in Table 3.3, none of the tasks individually predicted AN task performance.

Table 3.3

Hierarchical Regression for Experiment 2A Data Predicting Total AN Pairs Produced

Variable	*B*	*B*(SE)	Beta	*p*
Step 1[a]				
Age	-.003	.007	-.111	.662
Step 2[b]				
Age	< .001	.008	-.001	.997
DCCS	.128	.139	.263	.375
DNS	.056	.278	.052	.845
Step 3[c, d]				
Age	.000	.009	.018	.959
DCCS	.121	.161	.250	.465
DNS	.060	.317	.056	.852
Sally	.009	.540	.006	.986
Puppet	.132	.691	.065	.851

[a]$R^2 = .012$, $p = .662$
[b]$\Delta R^2 = .069$, $p = .660$
[c]$\Delta R^2 = .073$, $p = .977$
[d]Model 3 non-significant, $F(5, 12) = 0.188$, $p = .961$

Experiment 2A Discussion

The results of Experiment 2A clearly illustrate a different pattern of development and association between abilities than was found among hearing children in Experiment 1B. Whereas performance on the false belief tasks and alternative naming tasks were very strongly associated among hearing children in Study 1, even after controlling for age and verbal mental age, no such association was found among the deaf sample. Importantly, the results for Experiment 2A show no association between performance on the false belief tasks and the alternative naming task regardless of whether age was controlled for or not. Similarly, whereas false belief performance significantly predicted alternative naming performance beyond the effects of age, verbal mental age, executive functioning skills, and performance on the control task in Experiment 1B, this was not the case in Experiment 2A.

The pass rates for children greatly differed dependent on whether they were hearing or deaf. The hearing children in Study 1 had greater difficulty with the alternative naming task than the false belief tasks (Experiment 1A FB 51.6%, AN 35.5%; Experiment 1B FB 44%, AN 32%). This pattern was reversed among the deaf children, who experienced much greater difficulty on the Sally false belief task (FB Sally 33.3%, AN 83.3%). Curiously, the deaf children appeared to have significant difficulty with the Sally task, but did not struggle as a whole with the Puppet task (Sally 33.3%, Puppet 83.3%). Among the deaf sample, performance on the two false belief tasks was not correlated, as was expected due to the similar nature of the task and the fact that performance was moderately correlated among the hearing sample ($r_\varphi = .385$, $p = .006$).

The difference in performance on these two tasks witnessed among deaf children may be due in part to the deceptive nature of the Puppet task. In the task, the experimenter states to the child that they are going to play a trick on Puppet and hide the key while he is sleeping. Wellman et al. (2001) found that "a deceptive motive enhances children's performance, and does so for children of all ages" (p. 666). In the meta-analysis Wellman et al. stated that a task using deceptive motives can increase the odds of a child being correct by 1.90; that is, "if children are 50% correct at 44 months without deception, then they are 66% correct with deception" (p. 666).

Additionally, in the Puppet task the researcher asks for the child's help in hiding the key. The children were told, "Now, we're going to play a trick on Puppet and hide the key! Where do you think would be a good hiding place?" On most occasions the child indicated under the paper that had been placed directly in front of them, although occasionally they point to other nearby locations. On those occasions the researcher hid the key where the child indicated. When the child did not make any response to the question, they were prompted, “How about under this paper? This looks like a good place to hide it.” Wellman et al. (2001) also found that “participation by the child in transforming the target object is also important” (p. 666). They found that when the child helps in manipulating the task situation or story props positively influences children’s performance. As the Puppet task incorporated both deception and child participation, this may explain why the children performed at a much higher rate on the Puppet task than on the Sally task. The same tendency for better performance on the Puppet task was seen in Experiment 1B, although the difference was much less pronounced (Sally 56%, Puppet 62%).

Children in the deaf sample in Experiment 2A were also much better at the DCCS and DNS tasks than those in Experiment 1B. The majority of children in Experiment 2A passed the DCCS (88.9%) and the DNS (94.5%), while only 75% of those in Experiment 1B passed the DCCS and 58% passed the DNS. The obvious explanation for the differences in abilities on the executive function tasks is the difference in ages between the two groups. The average age of the hearing children was 3 years, 10 months, whereas the average age for Experiment 2A was 10 years, 2 months. Given the wealth of information showing executive functioning skills develop with age, the difference in performance is not very surprising. It does, however, highlight that the delays witnessed on false belief understanding among deaf children do not appear to be related to deficits in executive functioning skills.

As Experiment 2A appears to establish that the delays in theory of mind development among deaf children is fairly limited to theory of mind, rather than linked with a general metacognitive deficit, Experiment 2B was designed to further investigate the delay. Additional tasks were developed to be used in conjunction with the false belief task to assess aspects related to theory of mind, such as understanding that seeing leads to knowing and what information can be gained from different senses. Additionally, a variation on the typical unexpected transfer task, in which the test question on belief is asked first, was used to determine if question order affects performance.

Experiment 2B Method

Participants. Eighteen deaf children (12 boys, 6 girls) took part in Experiment 2B. All 18 students were recruited from central Scotland. Students ranged in age from 5;0 to 15;7 (mean age 10;6, *SD* = 33.37 months). Children were recruited through two schools for the deaf, one in Edinburgh and one in Falkirk, as well as one organisation, the West of Scotland Deaf Children's Society.

Design. Each child was tested in two sessions, with some children being tested on each session one day apart and some children being tested with a 15 minute interval between sessions. This variation in testing design was due to convenience for the child's caregiver at the time of testing. Some children were tested at school and could only miss a short portion each day, and were thus tested in two sessions, whereas the other children were tested at home with their parents present and were thus tested with just a short break for the child. The first session consisted of six tasks, which were fully counterbalanced: the Smarties task, the Tunnel task, the AN task, the CC task, the DNS task, and the DCCS. The second session also included six counterbalanced tasks: the Draw a Man task, the Puppet FB task, the Mary FB task, the Sally FB task, the Backward Explanation task, and the Lift/See task.

The doctoral researcher conducted all data collection with children in this group. By this point in the data collection process the researcher had completed the Level 2 Certificate in BSL. Additionally, in order to ensure the tasks were conducted in a manner that would be understandable to participants, the researcher worked through all of the tasks with her BSL Level 2 instructor, a native Deaf signer, who gave suggestions and advice on how best to conduct the tasks. The training session with the Deaf instructor was videotaped so the researcher could review the tasks and advice to practice prior to beginning data collection.

Materials and procedure. The materials and procedures for the Puppet FB task, the AN task, the CC task, the DCCS, and the DNS were identical to those used in Experiment 2A. The materials used for the Sally FB task were identical to those used in Experiment 2A. The procedure for the Sally task was also identical to that previously conducted when in the standard version; however, a *revised* version was also implemented, in which students were asked the belief question last rather than first.

Smarties task materials. The Smarties unexpected contents task was chosen to assess recognition of false belief in the self and in others; this task could potentially provide insight into deaf children's understanding or assessment of their own false beliefs, in addition to merely reflecting on the false beliefs of others. The materials for the Smarties task included an empty Smarties tube, a candy common in the U.K., and a set of coloured pencils. The tube was approximately 14 cm in length, with a diameter of approximately 2.5 cm. The container was chosen both for its common use in previous studies (e.g., Hogrefe, Wimmer, & Perner, 1986; LaLonde & Chandler, 1995; Perner, Leekam, & Wimmer, 1987) and its familiarity to British children.

Smarties task procedure. The experimenter first showed the child the Smarties tube and asked "What do you think is inside here?" After the child responded with "Smarties," "sweets," or something similar, the box was opened to show the child that instead of candies there were coloured pencils inside. The child was then asked two test questions in the order shown below.

Other knowledge question: If your teacher walked in and looked at the tube, what would (s)he think is inside?

Own knowledge question: Before I opened the tube and showed you what was inside, what did you think was inside?

Tunnel task materials. The Tunnel task was based on a similar experiment conducted by O'Neill, Astington, and Flavell (1992). The Tunnel task was chosen for inclusion in the battery of tests in order to examine the children's understanding that the "acquisition of certain types of knowledge depends on the modality of the sensory experience involves" (O'Neill et al., 1992, p. 474). A "tunnel" was constructed from a cardboard box (30 cm × 20 cm × 12 cm) that was painted matt black. The box was open at each end, and the bottom had a small (16 cm × 8 cm) hole cut into it. Each of the open ends had a black fabric 'curtain' glued to it, so that one could not see into the box, but both experimenter and testee were able to easily reach into the box to either place or feel an object inside. The objects used in the training task were a red crayon and a green ball. The ball was made of hard rubber and approximately six centimetres in diameter. The experimental task used two socks (one grey, one white), two toothbrushes (one green, one yellow), two black bags (one filled with hard beans, one with soft cotton), and two juice cartons/boxes (one empty, one full). The objects were kept covered by a black piece of cloth when being transferred to the tunnel. Photographs showing the materials used in the task are presented in Appendix C.

Tunnel task procedure. The training phase of the Tunnel task consisted of illustrating to the participant that one can either see what is inside the tunnel by lifting the box, or feel what is inside by reaching a hand inside one of the curtained sides. A red crayon covered by a black cloth was transferred into the box by the experimenter. The experimenter then explained to the child that something was put in the box and she wanted to know what the colour of the object was. The child was instructed to lift the box in order to see the object and name the colour. After doing so, the experimenter explained that the child can lift the box to *see* an object inside, and a picture of an eye was placed in front of the box to further draw the link between lifting the box and using one's eyes to see what is inside. After removing the crayon, the green, hard ball was transferred into the box. This time the child was instructed to place his or her hand inside the box and to report whether the ball was hard or soft. After confirming the ball was hard, the experimenter explained that the child can put his or her hand in the side in order to *feel* what is inside. A picture of a hand was placed in front of the box, beside the picture of the eye, in order to illustrate the two choices the child would be given in the task.

In the experimental phase, the child had to decide whether to look inside the box or feel inside the box in order to determine a particular characteristic of each of four objects. For each of four trials, two objects were shown to the child, their similarities and differences demonstrated, and then one was transferred (covered) into the box. Two of the trials involved two objects that looked the same, but felt differently, and two of the trials involved two objects that felt the same, but were different colours (and therefore look differently). For the two identical looking objects the child was told the experimenter wanted to know whether the one in the box was soft or hard. The child was then asked to choose whether to lift the box to look inside or reach inside to feel the object. For the two identical feeling objects the child was told the experimenter wanted to know the colour of the object in the box and again was asked to choose whether to lift or reach inside the box to find out. The child received a total score out of four, signifying whether the correct choice was made in each trial.

Mary FB task materials. The Mary FB task was structured very similarly to the Sally FB task and previous versions of the Sally-Ann test (e.g., Peterson & Siegal, 1995). The primary difference between the tasks and the choice to include this revised FB task in the battery of tests is in the order in which test questions are asked. In the "standard" version of the FB unexpected transfer task, the belief question is asked last. However, in order to investigate whether question order makes a difference in performance, in the revised version of this and the Sally FB task the belief question was asked first. The Mary task used two small dolls (a 'mother' doll and a 'Mary' doll), a toy refrigerator, a toy cupboard, and a small toffee candy.

Mary FB task procedures. The procedure for the Mary task was very similar to that for the Sally task. The child was introduced to the two dolls, Mary and her mother, and shown a story. Mary had a sweet that she wanted to keep for later, so she put it in the cupboard. Mary then went out to play. While she was outside, her mother moved the candy to the refrigerator and subsequently left to clean the house. Mary returned from playing and wanted the candy. The children were then asked three questions.

Belief question: Where will Mary first look for her candy?

Reality question: Where is the candy really?

Memory question: Where did Mary put the candy before?

The order of these questions was varied based on which version of the task was being administered. The standard version had the belief question asked first, whereas the revised version had the belief question asked last. The standard and revised versions were alternated between children and the opposite version from the Sally version was administered. That is, half of the children received the standard Sally task and the revised Mary task, while the other half received the revised Sally task and the standard Mary task.

Backward Explanation task materials. The Backward Explanation task was included in the battery of tasks as Robinson and Mitchell (1995) claimed this version of the task was easier for children than the standard FB task, although Perner, Lang, and Kloo (2002) found no support for this claim. The materials and procedure for the Backward Explanation task were based on Robinson and Mitchell's (1995) work. The Backward Explanation task used nine bound laminated A4 cards shown to the children one at a time. The pictures illustrated a story about twin brothers as it unfolded, as shown in Appendix C.

Backward Explanation task procedure. The students were shown the story one card at a time with accompanying signs telling the story. In the story are two identical twins brothers, Paul and Mark. The twin brothers each have a drawer, one red and one blue. The brothers together put the ball away in the red drawer, then Paul leaves to go outside and Mark stays inside. Mark decides to play with the ball again, so he takes it from the red drawer, plays, and then puts it in the blue drawer and leaves. Both boys appear with their mother, who asks them where the ball is. One twin says it is in the red drawer and the other says it is in the blue drawer.

At this point the child was shown a recap of the story using cards 2, 4, 5, 6, 8, and 9. The child was then told the experimenter wanted to know which twin was the one that went to the wrong (red) drawer – Paul who went outside to play, or Mark who stayed inside to play? When asking this question, the experimenter showed the child card 4, which shows one twin leaving and one saying. The order of naming the twins was counterbalanced between children.

Lift/See task materials. The Lift/See task was adapted from a similar task created by Lind and Bowler (2010). This task was included in the battery of tests in order to assess the children's understanding the seeing-knowing relationship as a precursor to false belief competence (i.e., understanding whether someone has knowledge or ignorance of a piece of information given the perceptual access the person has to that information). The Lift/See task was divided into a control phase and an experimental phase. The control phase made use of two sets of three bound laminated A4 cards. One set depicted the action the girl took in a short-story described to the children, whilst the other set depicted the action the boy took in the story. Children circled their answers (boy or girl) on an A4 answer sheet.

The experimental phase made use of one of two sets of ten laminated A4 cards. Each set showed five cards of the boy either opening and looking in or lifting each of five differently coloured boxes. The other five cards in the set showed the girl doing the opposite action for the same five coloured boxes. The actions depending on box colour were counterbalanced amongst the two sets of cards, and the two sets were counterbalanced among participant groups. For example, in Set A, the boy looks in the orange box while the girl lifts the orange box. In Set B, the boy lifts the orange box while the girl looks in the orange box. A third set of bound cards (21cm × 14.85cm) showed each of the five coloured boxes on its own. The children circled their answers (again, boy or girl) on the same A4 answer sheet as was used in the control portion of the task.

Lift/See task procedure. The control phase comprised three stories, each illustrated on a card. The three stories were signed to the children as the corresponding image was shown:

> Story 1: Sarah and John go out to play in the park. Sarah falls over and cuts her knees and John gets muddy knees. Who gets sore knees?
>
> Story 2: John does some colouring while Sarah goes for a long run. Who gets tired out?

Story 3: John and Sarah are very hungry. Sarah has a small glass of water and John has a big dinner. Who gets full up?

In each case the child responded by signing either ‘boy’ or ‘girl.’ The researcher then recorded whether the response was correct.

The experimental phase consisted of showing the child, one at a time, pictures of five differently coloured boxes and being told there was something inside each box. For each box the child was then shown corresponding images of the boy and girl, one lifting the box and one opening up the box and looking inside. The child was then asked, “Who knows what’s in the box?” Responses were again recorded as to correctness.

Draw a Man task materials. The Draw a Man task was used as a measure of intellectual ability. The task was based on that developed by Goodenough and Harris (Harris, 1963). The decision to use the Draw a Man task was based on the fact that the task had previously been used as a “largely nonverbal measure of general intellectual ability” by Peterson and Siegal (1995), who argued that “in at least one study (Clarke School for the Deaf, 1953), it has proved better at predicting deaf children’s academic achievement than either the WISC or the Leiter measures” (p. 465). Peterson and Siegal also used the task as a measure of nonverbal IQ score for testing deaf children in their 1999 follow up study, as did Russell et al. (1998). The materials for the Draw a Man task were one piece of A4 white paper and one pencil with eraser.

Draw a Man task procedure. Each child was asked to draw a picture of a man, and to make sure to show the whole man, from his head to his feet. The child was given up to 10 minutes to complete the drawing. Raw scores were converted to standard scores using the Draw a Man Short Scoring Guide (Harris, 1963), which were used in the analyses.

Experiment 2B Results

False belief unexpected transfer tasks. Performance on the Puppet task and the Mary task was equal, with 77.8% of participants passing each. For the Puppet task, one participant answered the memory question incorrectly, but all eighteen participants correctly answered the reality question. Fifteen children correctly answered the belief question. For the Mary task, all participants answered both the reality and memory questions correctly. Fourteen of the participants also answered the belief question correctly. While all participants answered the Sally reality question correctly, two missed the memory question. Five students answered the belief question incorrectly, with one of those students having also answered the memory question incorrectly for a passing rate of 66.7%.

Pass rates did not differ significantly between the three tasks (p = .304). To examine the effect of question order on performance, two formats were given for the Sally task and the Mary task. No significant difference in either task was found between children that had the standard order and those that had the revised order (Sally p = .755, Mary p = .814).

The majority of participants passed all three false belief tasks (n = 11, 61.1%). Consistency of performance across the three tasks was assessed using phi statistics. Performance between all three tasks was positively, significantly correlated. Correlations between the three tasks are shown in Table 3.4.

Table 3.4

Correlations Among FB Tasks for Experiment 2B

	Sally	Mary
Puppet	.472*	.679**
Sally	-	.472*

*p < .05, **p < .01

AN task. Two-thirds (66.7%) of the participants achieved a perfect score of 4 on the AN task. An additional 16.7% obtained a score of 3, resulting in a total passing rate of 88.2% for the task. The mean number of correct pairs produced was 3.53, out of 4.

CC task. Participants' performance was perfect on the CC task. All participants achieved a full score of 4 on the task, resulting in a passing rate of 100%.

DCCS. The majority of participants (83.3%) achieved a full score of 5 on the DCCS. One participant scored a 4 on the task, and the remaining two participants scored a 3 on the task. None of the participants scored less than 3 on the task. The passing rate for the task was 88.9% and the mean score was 4.72 (*SD* = 0.67).

DNS. Performance on the DNS was also nearly perfect. The criterion for determining whether a participant passed or failed the task was the same as was used for Experiments 1B and 2A. Seventeen of the eighteen participants achieved a full score 16. The one participant that did not pass the task with a score of 14 or higher had a score of 13. The mean score was 15.83.

Smarties task. Fourteen of the eighteen children (77.8%) responded correctly to the other's belief question, and nine (50.0%) responded correctly to the own belief question. All nine of those who responded correctly to the own belief question also responded correctly to the other's belief question, resulting in a total of nine children who correctly answered both task questions.

Tunnel task. Ten of the eighteen participants (55.6%) gave correct answers for all four test trials. An additional four children (22.2%) responded correctly to three trials. The mean score on the Tunnel task was 3.22 out of 4. Children responded better to the 'feel' trials than the 'see' trials. Sixteen children (88.9%) answered correctly for the bags trial, followed by 83.3% for the boxes, 77.8% for the socks, and 72.2% for the toothbrushes. A non-parametric Friedman test showed no significant difference in responses based on stimuli, $\chi^2(3) = 2.308$, $p = .511$.

Backward Explanation task. The majority of participants (n = 13, 72.2%) answered the Backward Explanation task correctly.

Lift/See task. The maximum for the control portion of the task was 3, which all but two participants achieved (n = 16, 88.9%). Those two participants that did not score 100% on the control portion received a score of 2 out of 3. The test portion of the task had a maximum score of 5. Of the 18 participants, 14 (77.8%) received the maximum score, with an additional participant scoring a 4. For consistency with the scoring system for the DCCS, which also had a maximum score of 5, a score of 4 or better was considered passing for this task. The pass rate was 83.3%. The mean score on the task was 4.39 (*SD* = 1.38).

Comparison of tasks. Correlations and partial correlations between tasks after controlling for age and standard scores from the Draw a Man task are shown in Table 3.5. Potential scores ranged as follows: maximum of 2 for Smarties task, maximum of 4 for Tunnel, AN, and CC tasks, maximum of 16 for DNS task, maximum of 5 for DCCS and Lift/See tasks, maximum of 3 for FB tasks, and maximum of 1 for Backward Explanation task.

Age was significantly, positively related to performance on the Lift/See task and negatively related to standard Draw a Man scores. The Smarties task was strongly, significantly related to FB performance, even after controlling for age and Draw a Man scores. DNS scores were significantly related to performance on the tunnel performance; this relationship was marginally non-significant when controlling for age and Draw a Man scores. Lift/See and AN scores were not initially correlated; when controlling for age and Draw a Man scores they were strongly, significantly, positively related.

Table 3.5

Correlations between Age and Experimental Task Scores from Experiment 2B
(Partial correlations controlling for age and Draw a Man standard score in parentheses)

	Smarties	Tunnel	AN	DNS	DCCS	FB	Backward Explanation	Lift/See	Draw a Man
Age	-.217	-.254	-.350	-.303	.178	-.066	.354	.482*	-.500*
Smarties	-	.462	-.198	.386	.148	.823***	-.094	-.152	.577*
Tunnel	(.457)	-	.189	.523*	-.157	.254	.134	-.304	.222
AN	(-.154)	(.161)	-	-.139	.080	-.013	-.054	.318	-.112
DNS	(.368)	(.481†)	(-.228)	-	-.104	.274	-.150	-.111	.265
DCCS	(-.216)	(-.223)	(.291)	(-.046)	-	.324	-.265	.124	.255
FB	(.767**)	(.238)	(.106)	(.311)	(-.053)	-	-.216	.209	.441
BE	(.022)	(.254)	(.104)	(-.070)	(-.366)	(-.183)	-	.180	-.190
LS	(-.100)	(-.218)	(.628*)	(.056)	(-.022)	(.290)	(.028)	-	-.233

†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

To compare performance on the tasks, scores for tasks were converted to pass/fail scores. AN, CC, DNS, and DCCS scores were judged as passing based on criteria previously discussed. Children were considered to have passed the Smarties task if they correctly answered both task questions. For consistency with AN and CC scores, which are also based on a scale of 0 to 4, Tunnel scores were deemed as passing if they were 3 or above. As there were three FB tasks in this experiment, a passing FB score was 2 out of 3 tasks correct. For consistency with a passing score on the DCCS, the Lift/See task was considered as passed with at least 4 correct trials. Pass rates were compared using McNemar's test to determine which pass rates were significantly different from each other. CC task was excluded from these analyses given that the pass rate was at ceiling. Results from the McNemar's analyses indicated that the Smarties task was significantly more difficult than the DCCS (p = .039) and the DNS (p = .008). No other tasks differed in terms of difficulty. Pass rates for the nine tasks are presented in Table 3.6.

Table 3.6

Pass Rates for Each Task in Experiment 2B

Task	Pass Criterion	Pass Rate
Smarties	2 of 2	50%
Tunnel	3 of 4	77.8%
AN	3 of 4	83.3%
CC	3 of 4	100.0%
DNS	14 of 16	94.4%
DCCS	4 of 5	88.9%
FB	2 of 3	72.2%
Backward Explanation	1 of 1	72.2%
Lift/See	4 of 5	83.3%

Experiment 2B Discussion

One of the primary questions associated with conducting Experiment 2B was whether the order of the questions presented in the false belief unexpected transfer task had some influence on performance. After working with the children in Experiment 2A and seeing them answering the first question asked during the task with the present location of the object, the question was raised as to whether children were misinterpreting the question being asked. According to Adams (1997), hearing parents with children who have a lesser degree of hearing loss or use a hearing aid "may believe that their children can understand more of what is happening in their environment than they actually do" (p. 77). The children often receive distorted information or may misinterpret information they receive. Mbaluka, Kurebwa, and Wadesango (2013) stated that not only may parents misinterpret facts stated be their children, but children may also fail to comprehend what their parents say.

As a deaf child growing up with hearing parents and siblings, it stands to reason that there are countless instances of misunderstanding on the part of the deaf child. These children may therefore develop the tendency to try to further interpret what they are being told in an attempt to avoid misunderstandings, particularly in the case of dealing with a hearing conversational partner. This was the reasoning behind implementing a variation on the unexpected transfer task; perhaps while children understood the belief question being asked of them, they did not understand the value of answering the question directly, but instead thought the asker was instead querying the location of the object. This would explain the tendency for these children to offer the location at which the object was presently located in response to the first question being asked, rather than providing the correct answer.

Based on the findings from Experiment 2B, however, this does not appear to be the case. If this were indeed the case, it would be expected that deaf children perform much better on the revised version of the unexpected transfer task than on the standard version. As witnessed, however, there was no significant difference on tasks based on whether the standard order or reversed order was used. This suggests that there is something inherently difficult in the question itself for deaf children.

The vast difference in performance between the Puppet and Sally tasks that was witnessed in Experiment 2A was not replicated in Experiment 2B. While there was still a difference in passing rate between the two tasks in favour of the Puppet task, it was approximately an 11% difference rather than a 50% difference. Additionally, performance was equal on the Puppet and Mary FB tasks, despite the fact that the Mary task does not involve deception and is a passive task for the child.

The passing rate on the Sally task was improved in Experiment 2B over that in 2A. Additionally, whereas the Sally and Puppet task performances were not correlated in Experiment 2A, the two tasks were significantly, positively related among the sample from Experiment 2B. The Puppet task and Mary task were also strongly correlated. This discrepancy between Experiments 2A and 2B may warrant further research to establish whether individual differences or the nature of the sample can explain the difference in performance on the Sally task between the two groups.

Performance on the other tasks in common between the two experiments was identical. Both groups had 83.3% pass the AN task, 100% pass the CC task, 94.4% pass the DNS, and 88.9% pass the DCCS. The results from Experiment 2B therefore provide further support that the delay is false-belief specific, rather than being related to metalinguistic awareness or executive functioning.

Passing rates were identical for the FB tasks and the Backward Explanation task, suggesting equivalent difficulty of tasks. This stands in contrast with Robinson and Mitchell's (1995) claim that the task was easier than the typical false belief task, which they claimed masked children's insight into the representational character of mind. This result is consistent, rather, with that discussed by Perner, Lang, and Kloo (2002), who found little evidence that the explanation task works better than the typical prediction task.

Passing rates on the Tunnel, Lift/See, and AN tasks were all fairly similar, indicating a similar level of difficulty for children. The Tunnel task proved slightly more difficult for children, although over three-quarters of them were able to pass the task with three out of four correct trials. Results regarding the errors made were similar to those described by O'Neill et al. (1992). O'Neill and colleagues indicated that the dominant error was to respond with the same chosen action on all four trials, and this chosen action was the feel the object rather than look at it; similarly, the most errors were made on the two 'see' trials, indicating that children preferred the 'feel' choice, regardless of whether it would help them to identify the requisite characteristic.

The Smarties task proved the most difficult for the children. While the number of correct responses to the other belief question was fairly consistent with the passing rate for the unexpected transfer FB tasks, the own belief question proved quite difficult for the children. Only half of the children were able to correctly state that prior to being shown the pencils, they thought Smarties were inside the tube. While it may intuitively seem that children should be better at identifying their own false beliefs because of their personal experience of having that belief, this appears not to be the case. This indicates that perhaps this group of children particularly struggles with self-assessment and introspection as to their own beliefs.

Study 2 General Conclusion

Study 2 was conducted to serve two primary purposes. Firstly it was aimed at assessing whether the close relationship found between theory of mind and alternative naming development found among hearing children extends to the special population of deaf children. This group of children was of particular interest given the literature that highlights their struggles with the ability to pass the typical false-belief test. Secondly, given the delay found among deaf children, it was of interest to determine the extent of the delay or impairment and whether it extends beyond theory of mind to other areas of cognition.

Evidence from Experiments 2A and 2B suggest that the relationship witnessed in Study 1 does not extend to deaf children. While there may be some underlying mechanism that promotes development of theory of mind and metalinguistic awareness in close conjunction among hearing children, it does not appear that a similar mechanism exists for deaf children. Alternately, perhaps the mechanism is in place for all children, but due to lacking some specific form of input, deaf children are unable to develop theory of mind beyond a certain point to an explicit ability.

The positive outcome to this study is that deaf children do not appear to be particularly delayed, at least not to the extent as visible with false belief understanding, on a broader range of cognitive skills. While manipulations of the false belief task perhaps enhance false belief ability to some extent, the passing rate was still well below what would be expected from groups of children with these ages. Understanding what specific abilities are delayed, however, may help future researchers in working towards closing the gap between hearing and deaf children in regards to theory of mind through early intervention strategies.

Chapter Four

Study 3: Ghanaian Theory of Mind

Introduction

Information gleaned from the review of the literature on deafness and theory of mind teamed with the results of the previous study results indicate there is a persistent deficit in theory of mind, or perhaps more specifically, understanding and application of false belief in pertinent situations, amongst deaf children. Based on the results of Study 2, it appears theory of mind development is most retarded, with metalinguistic awareness and aspects of executive functioning less difficult for school aged deaf children.

While historically deaf and hard of hearing students were primarily placed in schools exclusively for children with hearing difficulties, there has been a shift in placement over the past few decades, with 85% of deaf and hard of hearing children in the U.S. aged 6 through 21 years being either fully or partially mainstreamed (Schick et al., 2012). Due to economic, social, and legal changes, mainstreaming into public schools is now the norm within the U.S. (Hall, 2005). Similarly, the majority of deaf children in England, Wales, and Northern Ireland are educated in mainstream schools (Haynes, 2012). Results from a survey conducted by the Consortium for Research into Deaf Education (CRIDE) indicated that 86% of school-aged deaf children in Scotland attend mainstream schools, of which 8% attend mainstream schools with resource provision (NDCS, 2013). Additionally, only about 9% of deaf children in Scotland use sign language, either on its own (2%) or with English (7%; NDCS, 2013).

In addition to there being fewer specialized schools for the deaf due to increases in inclusion within the U.S. and the U.K., children are also receiving cochlear implants at an increased rate. According to a study by Bradham and Jones (2008) based on 2000

U.S. Census Data, approximately 55% of children with severe to profound hearing loss between the ages of 12 months and 6 years had received a cochlear implant. Hyde and Power (2005) estimated the implantation rate in the U.K. to be approximately 73%, and approximately 80% in Australia and Sweden. It is also noteworthy that these percentages refer only to children with cochlear implants, and do not indicate the number of children who have other forms of amplification and support, such as hearing aids.

The challenges of obtaining sufficient numbers of deaf children to take part in research combined with the reduced number of children that do not have hearing modifications makes it difficult to obtain a sample that is useful for teasing apart the nature of the observed deficit. While it may be easy to dismiss the need for such research by stating that with fewer numbers of deaf children that do not receive cochlear implants in early childhood the need for understanding the underlying mechanisms of the delay is reduced, there still remain a large portion of children who would still benefit from such knowledge. As the estimates of percentage of young children with severe to profound deafness that receive a cochlear implant in developed countries can range from 55-80%, this means that up to half of these children will still experience severe limitations to language input.

Additionally, in many non-Western countries cochlear implants and hearing aids are not available or are simply too expensive for practical implementation. “At least one-third of the world’s population lives in poverty, and a disproportionate number of deaf individuals live in these environments;” therefore implants are only available to a fraction of children worldwide who would benefit from them (Saunders & Barrs, 2011, p. 74). It is estimated that 278 million people in the world have debilitating hearing loss, with approximately 80% of these people living in poor, developing countries

(Saunders & Barrs, 2011). While there are “no comprehensive population studies for Africa [regarding hearing loss]… the available studies suggest that the prevalence is high” (Saunders & Barrs, 2011, p. 74). As such, the understanding of why there is a delay in false belief understanding among deaf children without early exposure to signed language remains important worldwide.

As there were limitations with obtaining sufficient sample sizes in the U.S. and U.K., the decision was made to explore recruiting participants in other countries, particularly in one in which the prevalence of cochlear implantation is low. Ultimately the decision was made to work with a large school for the deaf in central Ghana. There are several schools for the deaf in Ghana, and the Cape Coast School for the Deaf, also known as Cape Deaf, is the only such school within the Central Region of Ghana. The choice of Ghana as a site for data collection was made based on the researcher’s previous experience as a volunteer teacher in Ghana, an experience during which she became familiar with Cape Deaf and found she was able to communicate with deaf individuals there as the sign language was a variant of ASL.

There have been relatively few studies examining differences in theory of mind development based on culture. Wellman et al.’s (2001) meta-analysis suggested there may be slight differences in the age at which children typically pass a false-belief test based on country of origin: children in the U.S., U.K., and Korea perform similarly, with children in Australia and Canada performing slightly better and those in Austria and Japan performing slightly worse. One of the few available studies of false-belief among African children indicated that the children were able to demonstrate false belief understanding at an age similar to Western children (Avis & Harris, 1991).

Despite the lack of clarity regarding cultural differences in false-belief performance in the literature, the aim of the present study was to evaluate deaf performance in relation to their hearing counterparts, rather than comparing deaf children from different countries. A sample of young, hearing Ghanaian children was therefore also recruited to take part in this study. This group of children was also drawn from the Central Region of Ghana.

Experiment 3A was designed to evaluate theory of mind, metalinguistic awareness, and executive functioning skills among deaf Ghanaian children. Experiment 3B was qualitative in nature, and was designed to provide a perspective of teachers' experience with and theories regarding Ghanaian student performance. Experiment 3C was designed to specifically evaluate theory of mind skills among hearing Ghanaian children to serve as a cultural control against which theory of mind performance among the deaf children could be compared.

Experiment 3A Method

Setting. All participants were drawn from Cape Coast School for the Deaf, located in Cape Coast in the Central Region of Ghana. Education of the deaf in Ghana was introduced by Rev. Dr. Andrew Jackson Forster in the late 1950s. In 1957, Dr. Forster, an African-American Deaf Evangelist, opened a class of 13 deaf students at Christianborg Presby Middle School in Accra. After further development on the part of Dr. Forster, the Ghanaian government recognized the need for deaf education and took over the administration of the school in 1962. Training of teachers of the deaf began shortly thereafter based on the recommendation of the NUF Field Foundation and Commonwealth Relation Office. There are now 13 basic schools for the deaf in Ghana, of which Cape Coast School for the Deaf is one (E. Abiew, personal communication, June 29, 2011).

The Cape Coast School for the Deaf was started in November of 1970. The school was established with the aim to provide formal education to hearing impaired school-aged children in Cape Coast and the surrounding region. The school began with 15 pupils, 10 of which were boys. The school was initially run as a foster system whereby the pupils stayed with foster parents. In 1994 the school was moved to its current premises and serves as a boarding school for many of its students. As of late 2010, 394 students attended the school. The school offers 2 to 3 years of pre-school education, 6 years of primary education, 4 years of junior secondary education, and an optional 3 years of technical and vocational training. Classes at the school follow the same curriculum as presented in hearing schools, with some adaptations. At the end of the course students must take a final examination set by the West African exams Councils and National Vocational Training Institute for certification along with their hearing counterparts (E. Abiew, personal communication, June 29, 2011).

Participants. Seventy deaf students (34 male, 36 female) from the Cape Coast region in Ghana served as participants in the study. Their ages ranged from 8;6 (8 years and 6 months) to 24;3 (mean age of 15;6, *SD* = 44.125 months).

Design. Each child was tested in two sessions. The first session was conducted individually with the researcher and consisted of six tasks: a modified Smarties task, the Tunnel task, the AN task, the CC task, the DNS task, and the DCCS. The order of these six tasks was fully counterbalanced among participants. The second session was conducted in a small group setting, consisting of 4-8 students, the researcher, and a teacher from the school to aid in communication. The second session also included six tasks, the order of which was counterbalanced: the Draw a Man task, the Puppet FB task, the Mary FB task, the Sally FB task, the Backward Explanation task, and the Lift/See task.

Materials and procedure. While some of the tasks were presented using the same materials as used in Experiment 2B, several tasks were modified to reflect objects relevant to Ghanaian children. All communication, including task instructions, was conducted in Ghanaian Sign Language, which is a variety of American Sign Language and is the primary form of communication at the school.

Modified Smarties task materials. As the Ghanaian children are unfamiliar with the candy Smarties, the task was modified to use a container that would be familiar to children. For the task, a small yellow cardboard box that had previously had teabags in it was used. The box had a picture of a cup of tea on it so the children would understand that it held teabags. Inside the box were six small coloured pencils (Appendix C).

Modified Smarties task procedure. In the task, the experimenter showed the child the box of tea and asked "What do you think is inside the box?" After the child responded with "tea", the box was opened to show the child that instead of tea there were coloured pencils inside. The child was then asked two test questions, as follows.

Other knowledge question:	If your teacher walked in and looked at the box, what would (s)he think is inside?
Own knowledge question:	Before I opened the box and showed you what was inside, what did you think was inside?

FB task materials. The materials for the three false belief tasks varied slightly from those used in Experiment 2B. The materials for the Puppet task remained the same: one green frog puppet, a small box with a removable lid, a small key, and a piece of white paper. Sally task made use of two small dolls (1 male, 1 female), one small black jar, one small black box with a hinged lid, and one marble. The Mary task used two small dolls (a 'mother' doll and a 'Mary' doll), a toy refrigerator, a toy cupboard, and a small square candy called Chocomilo. The primary difference in materials for the Sally and Mary tasks was the ethnicity of the dolls used (brown colouring versus light colouring) and the culture-specific candy. Additionally, as the false belief tasks were administered in a small group setting, each of the three tasks used one half A4 sheet of paper per participant on which the participants circled their answers. The Puppet task showed a piece of paper and the box with removable lid as options for the three questions asked in the task; the Sally task showed the jar and the box as options for the three questions; and the Mary task showed the refrigerator and the cupboard as options for the three questions. Photographs of the manipulative materials used for the Sally and Mary tasks are presented in Appendix C along with illustrations used on the response papers.

FB task procedures. While the materials varied slightly from Experiment 2B, the procedures remained largely the same. The manipulation of materials was conducted in the same manner as previously explained, although when participants were asked the three questions for each task they were told to circle their answer on the response sheet in front of them. Students were also reminded by the experimenter and the teacher present that they should keep their eyes on their own papers and not look to their neighbour's paper for help.

Backward Explanation and Lift/See tasks. The Backward Explanation task and the Lift/See task were administered very similar as for Experiment 2B. The materials differed, however, in that all pictures were of African children (brown skinned) rather than Caucasian children. Additionally, as these tasks were administered in the group setting, each child was given a half sheet of paper for the Backward Explanation task and a whole sheet of paper for the Lift/See task to record their answers. Examples of these response forms are provided in Appendix C.

Tunnel task. The materials and procedure for the Tunnel task were identical as to what was described for Experiment 2b, apart from the use of a purple spoon in place of a red crayon in the instructional phase.

AN, CC, DNS, DCCS, and Draw a Man tasks. The materials and procedures for the AN task, CC task, DNS task, DCCS task, and Draw a Man task were identical to those as described for Studies 1 and 2.

Experiment 3A Results

False Belief Unexpected Transfer tasks. Of the three False Belief Unexpected Transfer tasks, performance was best on the Puppet task (37.1% passing), slightly lower on the Sally task (32.9%), and lowest on the Mary task (24.3%). Pass rates did not differ significantly based on task, however (p = .157). A summary of the response rates for the questions associated with the three tasks is presented in Table 4.1. As both the Sally task and Mary task were given in two formats, one with the standard order of questions and the other with a revised order of questions, these two tasks were examined further to determine if question order had an effect on performance. In the Sally task, no significant difference was found between children that had the standard order and those that had the revised order (p = .274). However, children that were administered the standard version of the Mary task performed better (35.3% passing) than those that received the revised version (13.9% passing), $t(59.872) = 2.105$, p = .039.

Table 4.1

FB Task Pass Rates for Experiment 3A

Task	Question			Passed
	Reality	Memory	Belief	
Puppet	75.1%	51.4%	47.1%	37.1%
Sally	74.3%	52.9%	44.3%	32.9%
Mary	70.0%	48.6%	47.1%	24.3%

Less than 10% of the sample passed all three false belief tasks (*n* = 5, 7.1%). The largest portion of participants did not pass any of the three false belief tasks (*n* = 31, 44.3%). Slightly over two-thirds of the group failed the false-belief portion of the experiment by passing fewer than two of the three tasks (*n* = 48, 68.6%). To test for consistency in performance across the three measures, phi statistics were calculated. While performance on the Sally task was significantly, positively related to performance on both the Puppet task ($r_\varphi = .406$, $p < .001$) and the Mary task ($r_\varphi = .242$, $p = .043$), Puppet task performance and Mary task performance were not significantly correlated, $r_\varphi = .116$, $p = .338$.

AN task. Slightly over half of the participants (55.7%) achieved a passing score of 3 or 4 on the AN task. Twenty-four achieved a score of 3 and fifteen achieved a perfect score. The mean score was 2.50 pairs produced. If broken down from pairs into individual answers for a total score of 8, 77.2% achieved a score of 6 or better.

CC task. The participants performed overwhelmingly better on the similarly designed CC task than the AN task. Of the 70 participants, 69 of them achieved perfect scores of 4, with the remaining participant achieving a score of 3. The mean score was 3.99.

DCCS. The majority of participants (72.9%) achieved a full score of 5 on the DCCS. However, there was a sizeable group that did not sort any of the cards correctly (17.1%), with only 10% of participants achieving a partial score. The mean score was 3.87 (*SD* = 1.98).

DNS. Performance on the DNS was also nearly perfect. Sixty-six participants received a full score of 16, with only one participant achieving a score of less than 14. The mean score was 15.79, with a standard deviation of 1.34.

Modified Smarties task. On the other belief question, 18 (25.7%) of participants responded correctly, while the other 52 (74.3%) responded incorrectly. On the own belief question, only 13 (18.6%) of participants responded correctly, with 57 (81.4%) responding incorrectly. When looking at the scores cumulatively, seven (10%) participants passed both questions, 17 (24.3%) passed one question, and 46 (65.7%) did not pass either question.

Tunnel task. Of the 70 children, 15 (21.4%) gave correct answers for all four test trials. Twenty-two (31.4%) responded correctly to three trials, with the remaining 47.1% responding correctly to two or fewer trials. The mean score was 2.64 out of 4. Children responded better to the ‘feel’ trials than the ‘see’ trials; 80% correctly responded to the bags and 77% correctly responded to the juice boxes; 59% responded correctly to the socks and 49% responded correctly to the toothbrushes. A Friedman test showed there was a significant difference between one or more stimuli pairs, $\chi^2(3) = 21.127$, $p < .001$. Post-hoc testing using a Bonferroni correction ($\alpha = .05/6 = .0083$) showed that children performed significantly better on the juice box trial than on the toothbrush trial ($p = .002$) and significantly better on the bag trial than on either the toothbrush trial ($p = .001$) or the sock trial ($p = .007$).

Backward Explanation task. The majority of participants (72.9%) answered the Backward Explanation task incorrectly.

Lift/See task. The maximum for the control portion of the task was 3, which 38.6% of participants achieved. A further 38.6% received a score of 2, with 22.8% scoring 0 or 1. The test portion of the task had a maximum score of 5. Of the 70 participants, 22 (31.4%) received the maximum score, with a further 6 (8.6%) scoring 4 and 21 (30%) scoring 3. The mean score was 3.29 (*SD* = 1.44).

Comparison of tasks. Correlations and partial correlations between tasks after controlling for age and standard scores from the Draw a Man task are shown in Table 4.2. Age was significantly, positively related to performance on the FB tasks, Backwards Explanation task, and Lift/See task, and negatively related to standard Draw a Man scores. DCCS scores significantly, positively correlated with performance on the majority of the other tasks: Tunnel, AN, CC, FB, Backwards Explanation, and Lift/See. Once age and Draw a Man scores were partialled out, DCCS remained significantly, moderately correlated with Tunnel, AN, and FB scores. While AN task scores were positively correlated with CC and FB scores, only the relationship between AN and CC remained significant after partialling out age and Draw a Man scores.

Table 4.2

Correlations between Age and Experimental Task Scores from Experiment 3A
(Partial correlations controlling for age and Draw a Man standard score in parentheses)

	Smarties	Tunnel	AN	CC	DNS	DCCS	FB	Backward Explanation	Lift/See	Draw a Man
Age	.000	.035	.164	.029	.097	.208	.369**	.435**	.324**	-.267*
Smarties	-	-.135	-.178	.080	.042	.043	-.005	.028	.032	-.019
Tunnel	(-.133)	-	.046	.082	-.084	.338**	.101	.061	.150	.169
AN	(-.179)	(.034)	-	.263*	-.061	.398**	.241*	.183	.210	-.004
CC	(.081)	(.076)	(.261*)	-	-.019	.237*	-.007	.073	.193	.028
DNS	(.014)	(-.076)	(-.076)	(-.020)	-	-.093	.133	.026	-.073	-.093
DCCS	(.049)	(.316**)	(.376**)	(.234)	(-.105)	-	.314**	.236*	.243*	.114
FB	(-.002)	(.071)	(.193)	(-.024)	(.116)	(.242*)	-	.133	.144	.025
BE	(.039)	(-.004)	(.118)	(.060)	(.002)	(.120)	(-.077)	-	.216	.138
LS	(.036)	(.131)	(.165)	(.192)	(-.105)	(.175)	(.014)	(.060)	-	.007

*$p < .05$, **$p < .01$

To compare performance on the tasks, scores for tasks were converted to pass/fail scores according to the same requirements as indicated in Experiment 2B. Pass rates were then compared using McNemar's test. CC task was excluded from these analyses given that the pass rate was at ceiling. Pass rates for the nine tasks are presented in Table 4.3.

Table 4.3

Pass Rates for Each Task in Experiment 3A

Task	Pass Criterion	Pass Rate
Smarties	2 of 2	10.0%
Tunnel	3 of 4	52.9%
AN	3 of 4	55.7%
CC	3 of 4	100.0%
DNS	14 of 16	98.6%
DCCS	4 of 5	74.3%
FB	2 of 3	31.4%
Backward Explanation	1 of 1	27.1%
Lift/See	4 of 5	40.0%

Results from the McNemar's analyses were used to group tasks according to difficulty. Table 4.4 indicates task grouping. Those tasks that did not differ significantly appear in the same column. As indicated, the Smarties task was significantly more difficult than all other tasks administered, while the DNS was significantly easier than all other tasks, apart from the CC task.

Table 4.4

Order of Task Difficulty for Experiment 3A

Most Difficult				Least Difficult
Smarties (10.0%)	Backward Exp. (27.1%)	Lift/See (40.0%)	DCCS (74.3%)	DNS (98.6%)
	FB (31.4%)	Tunnel (52.9%)		
	Lift/See (40.0%)	AN (55.7%)		

Experiment 3A Discussion

The results of Experiment 3A indicate a similar pattern to that seen in Experiment 2B with deaf children from the U.K. However, children in the present study generally performed worse on tasks than the children included in the sample of Experiment 2B. Among the sample of 18 deaf children from the U.K. in Experiment 2B, half passed the Smarties task, the lowest pass rate in that group. The Smarties task was also the most difficult for the Ghanaian sample, but the pass rate was just 10%, far lower than that seen among the U.K. sample. While performance on the DNS task was similar between the two groups, and in fact slightly higher among the Ghanaians (U.K. 94.4%, Ghanaian 98.6%), the Ghanaian group demonstrated lower pass rates on all other tasks. The lower success rates are likely due to the nature of deaf education and early childhood for deaf children in Ghana. Many of the deaf children at the Cape Coast School for the Deaf do not begin attending school until they are 7, 8, 9, 10 years, or even older. None of the children have hearing aids or cochlear implants, and the majority of their parents have no sign language knowledge. As such, they have very little linguistic input until they begin attending school. The extensive delays in access to language, which is much more pronounced than in the U.K. and other Western countries, likely leads to even greater delays in developing skills.

Table 4.5 illustrates the comparison between the sample from the U.K. and the Ghanaian sample on the nine tasks administered, from lowest to highest pass rate. As can be seen, the order of pass rates is very similar between the two groups, with only two discrepancies: the U.K. group had equivalent pass rates on the Backward Explanation task and the FB tasks, while the Ghanaian group performed slightly lower on the Backward Explanation task, and performance on the Tunnel and Lift/See tasks were reversed between the two groups.

Table 4.5

Comparison of UK and Ghanaian Pass Rates

Task	UK Pass Rate		Ghana Pass Rate	Task
Smarties	50%	Most difficult	10.0%	Smarties
Backward Explanation	72.2%		27.1%	Backward Explanation
FB	72.2%		31.4%	FB
Tunnel	77.8%		40.0%	Lift/See
Lift/See	83.3%		52.9%	Tunnel
AN	83.3%		55.7%	AN
DCCS	88.9%		74.3%	DCCS
DNS	94.4%		98.6%	DNS
CC	100.0%	Least difficult	100.0%	CC

Despite the similarity in pattern of performance on the tasks between the group from the U.K. and the Ghanaian group, differences were witnessed in the correlations of task performances. Among the Scottish group, age was positively correlated with performance on the Lift/See task and negatively related to Draw a Man standard scores. These two relationships remained among Ghanaian participants, with the addition of positive correlations between age and performance on the FB and Backward Explanation tasks.

After age and Draw a Man scores were partialled out, only the FB and Smarties tasks and AN and Lift/See tasks remained correlated among the U.K. sample. These relationships did not exist among the Ghanaian sample. Rather, among the Ghanaians, after partialling out age and Draw a Man scores, the DCCS remained positively correlated with the Tunnel, AN, and FB tasks, and the AN and CC tasks were positively correlated.

The correlation between DCCS score and Tunnel, AN, and FB tasks suggests there are elements of set-shifting and inhibitory control in each of these tasks. The correlation between DCCS scores and FB tasks supports previous research by Kloo and Perner (2003), in which training children in either executive skills or false belief understanding enhanced performance on the other skill. Given the stark contrast in passing rates between the FB tasks and DCCS task, however, it is clear that while there may be elements of executive functioning that are necessary for passing the false belief task, this is not the defining element and there remains some other skill or understanding that has yet to be fully developed among this group of deaf children.

The individuals that work most closely with these deaf children and witness their development over time is their teachers. Therefore, for Experiment 3B, a focus group was held with a group of teacheres in order to get a feel for what deficits and delays the teachers witness in the classrooms and in their interactions with their students.

Experiment 3B Method

Participants. Participants included five teachers from the Cape Coast School for the Deaf. The subjects taught by the teachers were science, English, and kindergarten. The teachers had been teaching at the school for between 6 weeks and 17 years.

Design. A focus group was conducted in which qualitative data were collected. The researcher met with the five participating teachers for one 20 minute session to discuss aspects related to working with deaf students. The session was videotaped and later transcribed by the researcher. Due to the setting in which the focus group was conducted, in a classroom during a break while students played nearby outside, some portions of the audio were unable to be transcribed due to heightened background noise. These appear in the transcript as [inaudible]. The transcript is included in Appendix D.

Experiment 3B Results

Prior to beginning the interview portion involving discussing their experiences in working with the children, the participants were asked about the requisite training for becoming a teacher of the deaf and whether they had experience in teaching hearing children. Responses indicated that they must attend university to study education, and they must focus on special education specifically in order to be a teacher of the deaf. In addition to studying their discipline, such as mathematics, they also had to take specialised courses in educational behaviour, human behaviour, and mental issues. All participants indicated they had previous experience in teaching hearing children, as this was part of the process of becoming a special education teacher.

Participants indicated that they had different experiences that led to them becoming special education/deaf teachers. One indicated that many go into special education because of a mentor they have. This was the case for one participant, who stated this was her reason for coming to the school. Another mentioned that her interest in special education was piqued after taking a course for her teaching program. The two male teachers indicated it was their personal interaction with deaf people and deaf students that inspired them to pursue teaching deaf students. One stated, “I personally met some deaf students who were signing. They were signing and laughing, and you know, attracted me, and I decided to go do the course." The other also mentioned that he needed an additional language for his schooling and decided to pursue sign language after meeting a deaf person. The fifth participant mentioned a personal connection that inspired her to pursue teaching the deaf: "My father fell sick and couldn't talk and he was writing, so my passion developed from that, personally."

A thematic analysis of responses to interview questions was conducted to identify key themes and subthemes related to the general research question concerning their experiences in working with deaf children. Key themes that emerged included: Differences from hearing students, barriers to learning, barriers to teaching, and differences due to language background. Some utterances were unique to one theme, whereas others were applicable to more than one theme.

Barriers to teaching. The primary theme extracted from the transcribed interview was regarding barriers to teaching that the teachers experience. There were 12 utterances that were associated with this theme. Subthemes included conceptual learning, language skills, and quantity.

Conceptual learning. Several of the teachers mentioned that the deaf children had a particularly difficult time grasping abstract concepts. They stated that they very often had to have some concrete materials available to try to convey concepts, which was more difficult when the concept was something abstract. Teacher E stated: "They find it difficult to understand abstracts and concepts, so always need to use a lot of materials. So when they are not a good use of materials, it is very difficult." Later in the interview he went on: "They need a lot of materials, those materials can be quite simple… [inaudible]. So you can teach a whole lesson with the wrong materials, so you are always nervous."

The teachers also mentioned that teaching abstract concepts can be especially difficult due to the fact that "before you finish talking, they assume what you are going to say. They go and then do different thing" (Teacher C). This was highlighted in the video of the interview by Teacher A mimicking the students and repeatedly making the sign for KNOW to the laughter of the other teachers. Teacher B agreed that this makes it hard to get concepts across to the students and stated that "sometimes they get one concept out of what you are telling them and it gets totally confused."

Language skills. The language skills, or lack of skills, proved a great barrier to the teachers. This was partly due to inherent differences in English and the signed language. Teacher B illustrated this point when describing what makes teaching deaf children difficult: "Their language, what they write… grammar… grammar, we have past tense, we have present, we have past, but they don't have past in deaf language. So if it is yesterday that they do something, they still use the present tense. There is no past tense in their language."

Teacher D stated that because they cannot communicate at home prior to coming to the deaf school, this places a huge barrier to teaching the children. She said, "Very little language is applied at home. When they come here, they come to learn the language. So they have inadequate language and this is something we have to teach them." She went on: "At home, they don't learn. Most of them hardly anything at home. But with hearing children, they learn at home. Their parents teach them. Deaf children, all of… vocabulary – barrier, language – barrier, communication – barrier. Nothing is done at home." The fact that learning does not take place at home also makes the children underprepared for learning in the classroom each day. Regarding homework assignments, Teacher B stated: "They can't learn when they are home.

…And they have prayer time. They don't really come prepared. And you see them writing" during prayer time to prep at the last minute for class time.

Additionally, due to their lack of adequate language skill, the children suffer in terms of reading comprehension. Teacher B stated that they suffer "especially in English, the comprehension, the passage." She stated that in order to overcome this barrier, teachers will read passages "and then… give them the gists [*sic*]… in their language that they understand."

An additional barrier to teaching arose because some students came to the school at such a late age, it would not be worthwhile to try to educate them in traditional subjects because of their lack of language. Teacher A stated that children of "different ages. Some as old as 18 years" come to the school. Of these students who come to school so late in their life, Teacher B stated: "They are not starting school. So that person, you can't send that person into the classroom. What we normally do is if someone comes to school at 18… we send the person to the vocational side." In other words, those children who arrive at school so late that learning proper language and traditional subjects is not worthwhile tend to be taught vocational skills instead, to prepare them to be a contributing adult member of society despite their lack of education and language skills.

Quantity. Teachers reported that it is difficult to teach students due to limitations in terms of the quantity of material they can teach. Teacher C stated that "teaching them, you have to talk moooore [teacher's emphasis] before maybe one person will grab the concept." Teacher E stated that students "have a very short attention span." Teacher B expanded on this, saying that "you want to give them more… give them more at a time. But we can't, they get frustrated. So, something small, little at a time."

Barriers to learning. Many of the same issues that serve as barriers to teaching also serve as barriers for student learning. The majority of the barriers to learning mentioned have to do with students' poor language skills and lack of early language in the home. Teacher D stated: "the deaf, before they come to school, they are not taught language at home." She went on to further illustrate:

> There is no language, very little language is applied at home. When they come here, come to learning the language. So they have inadequate language and that is something we to teach them to [inaudible] to get their education. ... So with the deaf child, nothing [inaudible] so frustrating, unless the deaf child is really good. The deaf child, most of the time, depends on what the teacher teaches. I mean, at home, they don't learn. Most of them hardly anything at home. But with hearing children, they learn at home. Their parents teach them. Deaf children, all of… vocabulary – barrier, language – barrier, communication – barrier. Nothing is done at home.

Not having the opportunity to learn language early in life, as hearing children do, creates a huge barrier to learning for the children. The children are unable to take part in incidental learning and come to school with the disadvantage of first having to learn language before being able to learn their core competencies.

Just as the age at which children come to the school is a barrier to teaching, it is also a barrier to learning. The children who come to school too late in life to practically be taught language and core subjects are limited to vocational learning. As Teacher B said, (when one comes to school at age 18) "what is he coming to do already? So we send the person to the vocational side." These children will not learn to read or write or basic mathematics, which severely limits how they interact and contribute in society.

Even among children who come to school at a young age, the lack of early language input is clear when it comes to their reading comprehension. Teacher B stated that since their English skills and reading comprehension is so poor, teachers will read a passage themselves, and then give students the gist using language they can understand. This often results in them losing much detail, and simply being able to capture the big picture or portions of the concept.

Differences from hearing students. The teachers involved in the focus group provided some great insight on how deaf students differ from hearing students. As all of the teachers had experience in teaching hearing students, they were able to contrast key things that affected teaching and learning among deaf children. Teacher C stated:

> There is a big difference teaching the hearing and the deaf. The hearing, they can hear. So, when we teach them, we can… materials… maybe we can adapt so that people can understand. But the deaf is not like that. Teaching them, you have to talk mooooore [teacher emphasis] before maybe one person will grab the concept.

As previously discussed, Teacher B mentioned a key difference is seen in terms of grammar, likely due to inherent difference between spoken English and the sign language used at the school. She indicated that “there is no past tense in their language,” which causes grammar to be much more difficult to teach to deaf children than hearing children.

Teacher D made a very good point concerning the differences between deaf and hearing children. She stated that deaf children:

> don’t have incidental learning, like the hearing children. They hear people talking, they are able to pick a few things. They listen… listen to radio, listen to… I mean at the dining table, and things like that. They learn, they keep

> learning in their environment. …The deaf child, most of the time, depends on what the teacher teaches. I mean, at home, they don't learn. Most of them hardly anything at home. But with hearing children, they learn at home. Their parents teach them. Deaf children, all of… vocabulary – barrier, language – barrier, communication – barrier. Nothing is done at home.

This lack of incidental learning taking place in early age among deaf children no doubt manifests in barriers to teaching and learning that the teachers discussed.

Related to this incidental learning is self-teaching. Due to their poor language skills, the deaf children are very limited in their abilities to self-teach. Teacher E mentioned that "hearing people, when they are reading the textbook, they are going to assimilate that… talk about what they are reading." Regarding the deaf children, he said this is difficult, as "they use one vocabulary for too many options… so they always need somebody to guide them."

Differences due to language background. The teachers did mention that there are some differences in ability due to the language background of the students. For the majority of the students, prior to coming to school "they have their own language… home sign. It is different from the standard language that we teach here. Just like speaking Pidgin English. The deaf community, they have their own language."

However, some of the children have one or both parents who are deaf, which affects their ability in school. Teacher B said, "There's a girl. …The one that is the mother of the father, one of them [is deaf]. …There's a girl here." Teacher A volunteered: "Both parents are deaf." Of these children, Teacher D said, "They come with the sign language. …and they do better than the other children." Of the girl previously mentioned, Teacher A stated "that girl… she does very well." This does not appear to be the case for students with deaf siblings. In regards to students who had siblings who were also deaf, Teacher D stated “they are about the same” as the majority of students with no deaf parents.

Experiment 3B Discussion

The focus group with teachers from the school proved very insightful. These individuals work closely with the deaf children and are tasked with teaching them not only their core subjects, but also sufficient language skills so that they are prepared to learn. The teachers emphasised the difficulties they experienced in teaching the deaf children, and the barriers these children face in learning. The lack of exposure to early language appears to be the most impactful on these difficulties. The children do not experience incidental learning early in life, as hearing children do, and they are very limited in their abilities to self-teach due to their poor language skills. They have short attention spans and have extreme difficulty in conceptual learning, particularly in regards to abstract concepts. As sign language is a visual language, it lends itself well to concrete things. The teachers mentioned that using concrete materials aids them in their teaching of the children; however, when these materials are not available or are not able to convey an abstract concept, teaching is hindered and learning is severely limited.

The teachers also gave anecdotal evidence of the advantage for deaf children born of deaf parents. They stated that these children already know sign language when they come to school and are therefore better prepared to learn. These children therefore excel in comparison with their peers who were born to hearing parents. While it may be assumed that having a deaf sibling might provide a similar enhancement, this does not appear to be the case. Teachers stated that those children with deaf siblings, but not deaf parents, performed similarly as to those children without deaf siblings or parents. The results of this qualitative analysis provide additional, practical evidence for the benefit of early exposure to language for learning abstract concepts and performing well in school.

Experiment 3C Method

Setting. All participants for Experiment 3C were drawn from a school located within a close distance from Cape Coast School for the Deaf, Ghana National Basic School. The school is located in Cape Coast and serves children in grades KG 1 through JSS 2. The school also is involved with a program of inclusion in which blind pupils from the blind unit at the Cape Coast School for the Deaf walk up the hill to attend classes at Ghana National. None of the students included in the sample for Experiment 3C were blind.

Participants. Forty students (25 male, 15 female) from three classes at Ghana National Basic School in the Cape Coast region in Ghana served as participants. Students were in grades KG1, KG2, and P1, the rough equivalents of pre-school, kindergarten, and first grade at schools in the U.S. The teachers of the children informed the researcher that birthdates are not generally recorded or known to teachers, children, or even the children's parents. The teachers were able to give estimated ages in years for the majority of students, but specifics for establishing children's ages in months were only available for a few students. As such, ages included in the analyses are in years. Students for which age information was available ranged in age from 4 to 12 years (M = 6.43, SD = 1.97).

Design. Each child was tested in one private session with one task administered to the entire group at once. Three tasks were administered in the private testing session: the Puppet task, the Sally task, and the Mary task. Similarly as to in Experiments 2B and 3A, Sally and Mary tasks alternated as to revised and standard versions. The Draw a Man task was administered to the entire group of pupils within the classroom prior to initiating private sessions. Given the young age of the children and the limited amount of schooling they had had, the majority of students had limited understanding of English. The majority of students spoke Fanti, the local language of Cape Coast, so one of the teachers sat with the researcher and each student to act as an interpreter.

Materials and procedure. The materials for the four tasks were identical as for Experiment 3A. The procedures for the tasks were almost identical as for Experiment 3A. However, since the tasks were conducted with students individually, responses were recorded by the researcher rather than having the students circle their responses on a form.

Experiment 3C Results

Of the 40 participants, 21 (52.5%) passed all three FB tasks. Performance was best on the Puppet task, with 65% passing the task. One student failed the reality question and two students missed the memory question. Twenty-six children passed the belief question, each of whom also passed both control questions. One child missed the reality question and six missed the memory question on the Sally task. Fourteen children missed the belief question. Of the 26 children who correctly answered the belief question, 24 also answered both control questions correctly for a pass rate of 60%. The pass rate for the Mary task was 55%. Two children answered incorrectly on the reality question and four answered incorrectly on the memory question. While 26 children correctly answered the belief question, similarly as for the Sally task, four of those children missed one of the control questions. A summary of the response rates for the questions associated with the three tasks is presented in Table 4.6.

Table 4.6

Pass Rates for Experiment 3C

Task	Question			Passed
	Reality	Memory	Belief	
Puppet	97.5%	95.0%	65.0%	65.0%
Sally	97.5%	85.0%	65.0%	60.0%
Mary	95.0%	90.0%	65.0%	55.0%

Half each of the Sally and Mary trials were conducted with the standard order, in which the Belief question is asked first, and the other half were conducted with the revised order, in which the Belief question is asked last. Whether the standard or revised version was given made no significant effect for either the Sally (p = .520) or the Mary (p = .520) tasks.

Performance on the three FB tasks was strongly, significantly correlated. A reliability analysis revealed a Cronbach's alpha of .834, indicating that a scale made up of performance on the three tasks is reliable. Table 4.7 shows the correlation statistics between the three tasks.

Table 4.7

Correlations Among FB Tasks for Experiment 3C

	Sally	Mary
Puppet	.685***	.601***
Sally	-	.595***

***p < .001

Correlational analysis between the total number of FB tasks, age, and standard Draw a Man scores was conducted. No significant relationships were found between FB performance and the two other tasks. There was, however, a significant negative correlation between age and Draw a Man scores. Correlation statistics are presented in Table 4.8.

Table 4.8

Correlations Among FB, Age, and Draw a Man Scores for Experiment 3C

	Draw a Man	Total FB
Age	-.333*	-.028
Draw a Man	-	.229

*$p < .05$

Experiment 3C Discussion

With a mean age of approximately 6 and a half years, between 55% and 65% of children were able to pass each of the FB tasks. Slightly over half of the children were able to pass all three tasks. In their meta-analysis, Wellman et al. (2001) found that at about 44 months of age (3 years, 8 months), children are about 50% correct on the task. With the effects size for age of 2.94, this means that the pass rate for children a year older (4 years, 8 months) is 74.6%. Comparing the pass rates obtained in Experiment 3C with those found in the meta-analysis by Wellman et al., it appears that false belief understanding develops at a slightly later age in Ghanaian children from this region.

This finding runs counter to the finding of Avis and Harris (1991), who suggested that Baka children from the rain forests in Southeast Cameroon demonstrate false belief understanding at an age similar to Western children. This discrepancy may be due in part to the fact that Avis and Harris used a version of the task that included child participation and was acted out in person rather than by dolls or puppets. The salience of the situation, the fact that trickery was involved, and that the children met with the person that ultimately had the false belief may have increased performance over the children in the present study. This reasoning is consistent with the fact that similarly as to in Experiments 1B, 2A, and 3A, the Puppet task was the easiest task for the children. In the Sally and Mary tasks, the characters in the study did not intentionally trick another character. Additionally, the participants were not included in the task, as was done in stating that the group was going to play a trick on the frog in the Puppet task. As such, the advanced performance on the Puppet task in comparison with the other tasks seems likely due to child involvement and trickery being components of the task.

The apparent delay may also be due to the socioeconomic situation of the Ghanaian children. Previous findings have illustrated that children of poorer backgrounds in the U.S. and the U.K. tend to fail the false belief task until 5 years of age, which is less markedly different from the present finding. Doherty (2009) highlighted these differences by citing that "Holmes et al. [1996] found that disadvantaged children of mean age 4 years 3 months passed transfer and contents task between a quarter and half the time, and children of 5 years 3 months between 52% and 84% of the time" (p. 169).

Despite the higher mean age among the deaf children from Experiment 3A (M = 15;6 years) than those in Experiment 3C (M = 6;5 years), the younger children outperformed their older, deaf counterparts on all three tasks. The highest passing rate among the deaf children, 37.1% for the Puppet task, was still almost 20% lower than the lowest passing rate among the hearing children (55.0% for Mary task). Follow-up independent-samples t-tests confirmed that the sample of deaf children were significantly older than the hearing children, $t(104.977) = 15.892$, $p < .001$, yet the deaf children performed significantly poorer on the false belief tasks in aggregate, $t(65.725) = -3.645$, $p = .001$. These results provide strong evidence for the theory of mind delay in deaf children, regardless of country, in comparison with hearing children.

Study 3 General Discussion

The results of Study 3 provide further support for the delay in false belief reasoning among deaf children. Additionally, alternative naming and executive functioning skills were not delayed to the same extent, suggesting there is something specific about false belief understanding that proves particularly difficult for deaf children. Performance on false belief performance among hearing Ghanaian children appears slightly delayed in respect to Western children, but was significantly stronger than the performance by deaf Ghanaian children.

Results from the focus group conducted with teachers of the deaf children suggest that the deaf children have particular difficulty with learning concepts and abstract reasoning. It seems likely that this may be key to the difficulty on the false belief tasks, without a similarly impaired performance on the alternative naming task. The false belief tasks focus around an individual’s thoughts and beliefs, which cannot be physically seen. The alternative naming task, however, focuses on concrete objects, like cat, milk, and flower. These are objects that can be touched and seen, and therefore may be easier for the deaf children to grasp conceptually than “invisible” beliefs. This would also explain why the deaf children struggle with the false belief tasks than did the hearing children.

Chapter Five

Study 4: Bilingual Theory of Mind

Introduction

Most deaf people live within a larger society that is dominated by hearing people, with many deaf children having to learn to read and write the spoken language in school (Ann, 2001). Using Grosjean's (1982) definition of bilingualism, "the regular use of two or more languages" (p. 1), Ann thus argued that "most deaf people are bilingual to some extent in a spoken language in some form" (p. 41). While deaf children who use both a signed language and a spoken language may generally be considered bilingual, they represent a specific type of bilingual – bimodal bilingualism. Deaf people as a group tend to have their own (signed) language and culture, but live within a larger hearing culture with at least one dominant spoken language.

'Bimodal' refers to the fact that one language is spoken and the other is signed, two modes of language – one that is perceived auditorily and one that is perceived visually (Emmorey, Borinstein, Thompson, & Gollan, 2008). In addition, bimodal bilinguals have the unique opportunity to produce and perceive their two languages at the same time, whereas unimodal bilinguals cannot simultaneously produce two spoken words or phrases because they are limited to a single output channel, the vocal tract (Emmorey et al., 2008). Additionally, although deaf signers are generally bilingual in a sign language and a spoken language, many deaf people prefer not to speak the spoken language (Emmorey et al., 2008). Comprehension of spoken language via lip reading is also quite difficult for deaf individuals (Emmorey et al., 2008). Given the unique set of circumstances for deaf bimodal bilinguals, it is reasonable that patterns of development of theory of mind and metalinguistic awareness among deaf bilinguals would not necessarily reflect the patterns of development among unimodal bilinguals.

Given that past researchers (e.g., Shatz, Martinez, Diesendruck, & Akar, 1995; deVilliers & Pyers, 1996) focused on the role of language in theory of mind acquisition, it is not surprising that there are multiple studies contrasting false-belief understanding between (unimodal) bilingual children and monolingual children. Goetz (2003), Kovács (2009), and Farhadian et al. (2010) all found evidence of superior performance by bilingual children on theory of mind related tasks than amongst their monolingual counterparts of similar age.

Goetz (2003) compared performance on appearance-reality, level 2 perspective-taking, and false-belief tasks between English monolinguals, Mandarin Chinese monolinguals, and Mandarin-English bilinguals. Thirty-two children comprised each monolingual group, with the bilingual group consisting of 40 children. Half of the children in each language group were 4-years-old and half were 3-years-old, which allowed Goetz to evaluate the effect of age as well as language group. Children were tested twice, one week apart; monolingual children were tested twice in their language, while bilinguals were tested once in each language with the order of languages counterbalanced.

In comparing the two monolingual groups Goetz (2003) found that 4-year-old children significantly outperformed 3-year old children and that children performed significantly better during the second testing session than in the first. No significant effect of language (English versus Mandarin) was found for any of the tasks. When including the bilingual children in the analysis, once again 4-year-olds performed significantly better than 3-year-olds and children performed significantly better at the second time-point than the first. Additionally, a main effect of language background (monolingual versus bilingual) was found, with bilinguals performing significantly better than monolinguals. When adjusting for language ability, as measured using

PPVT standard scores, bilinguals performed significantly better than monolinguals at time 1, but the effect was reduced to marginal non-significance at time 2. The examination of performance change from time 1 to time 2 showed that monolingual children improved significantly from the first to second testing time, whereas the bilingual children scored similarly at the two time points.

Goetz (2003) suggested three possible explanations for her evidence of a bilingual advantage on theory of mind task: a metalinguistic advantage, greater inhibitory control, and greater sociolinguistic awareness regarding conversational partners' linguistic knowledge. The first explanation is supported by research by Galambos and Goldin-Meadow (1990), which indicated that learning two languages increases the speed of development of certain metalinguistic skills in young children. Goetz (2003) reasoned than an increased metalinguistic awareness among bilingual children may lead to increased metarepresentation, as increased awareness of the representational nature of language may lead to increased understanding that objects (and in turn, situations) can be represented in different manners by different individuals.

Goetz's (2003) second explanation for her findings ties together research by Carlson and Moses (2001) that shows a relationship between inhibitory control and performance on false-belief tasks and by Bialystok's (1988, 1992, 1999) suggestion that bilinguals have greater control over their selective attention as necessary for resolving situations of ambiguity. This possibility is strengthened by the fact that Goetz found the bilingual advantage decreased on a version of the false-belief task that did not require a verbal response. Elicitation of verbal responses may have, as Goetz argued, increased their attention toward controlling their responses by making their language choice particularly salient.

Finally, Goetz (2003) suggested that perhaps performance was improved due to bilingual children's development of: a) awareness of the need to match their language with their partners, b) understanding their partner's knowledge of a language can differ from their own, and c) recognition that this difference in knowledge must be taken into account during communication. This explanation focuses on the impact of social experience on development, similar to past findings that highlight the impact of having an older sibling on theory of mind (e.g., Ruffman, Perner, Naito, Parkin, & Clements, 1998). That is, as bilingual children have increased exposure to and experience with people who differ from them in their linguistic knowledge, this increases the salience of others' knowledge, and ultimately, mental states.

Kovács (2009) similarly assessed theory of mind understanding among bilinguals, albeit among Romanian-Hungarian bilinguals versus Romanian monolinguals. Thirty-two bilinguals and thirty-two monolinguals were assessed on three tasks: the standard task created by Wimmer and Perner (1983), presented as coloured illustrations; a modified theory of mind task involving two dolls and illustrated cards; and a control task, the gizmo task, developed by Zaitchik (1990, as cited by Kovács, 2009). The modified task involved a language switch, in that one doll was bilingual and the other monolingual and they were told pertinent information in the language only the bilingual doll knew. The children had to therefore infer a false belief due to the monolingual not understanding the pertinent information and make a judgement on that doll's actions.

Despite being of similar ages (both groups mean age = 3.3, age range 2.10 – 3.6), the bilingual children in Kovács's (2009) study outperformed the monolingual children on both the standard and modified theory of mind tasks. The two groups performed similarly on the control task, which had significantly stronger performance than the theory of mind tasks. Approximately twice as many bilingual children passed each theory of mind task, a result that was statistically significant for both tasks (*p*s $\leq$ .03). Neither group performed significantly differently on the standard versus the modified task.

Kovács's (2009) results, similarly to Goetz's (2003), suggest bilingual children have an advantage over their monolingual peers in terms of false-belief task performance. Kovács also reasoned that this advantage may arise due to enhanced inhibitory control abilities in bilingual children, as Bialystok (1999) found. Kovács argued that her findings did not support Goetz's theory that social experience in terms of language-switch situations enhances or encourages earlier theory of mind development, as bilinguals did not exhibit better performance on the task modified to mimic a language-switch situation than on the standard task. Kovács cited Bialystok's research as making it likely that the advantage is due to the ability to suppress a prepotent response regarding object location. However, Kovács did also suggest that what may be driving this performance difference is the enhanced ability to label a concept with two verbal labels, which may help in maintaining alternative mental representations. This reasoning is consistent with the theory regarding development of metarepresentational ability as key to or underpinning theory of mind development.

Further evidence for the bilingual advantage comes from Farhadian et al. (2010). Farhadian et al. gave three false belief tasks to a group of 65 Persian monolingual and 98 Kurdish-Persian bilingual preschool children in order to determine to what extent bilingualism contributes to theory of mind development over and above age and verbal ability. Two unexpected transfer and one unexpected contents tasks were administered; children were awarded one point for a correct false belief response, and one point for correct memory check response for a total range of 0 to 6 on the three tasks. The McCarthy Scales of Children's Ability (McCarthy, 1972, as cited in Farhadian et al., 2010), a measure of verbal ability, was also administered.

A larger proportion of bilingual children (45%) passed all theory of mind tasks than did monolingual children (14%), with bilingual children also obtaining a significantly higher mean score on the tasks ($M_{Bilingual}$ = 4.76, $M_{Monolingual}$ = 3.53). A hierarchical regression analysis showed both age and verbal ability significantly predicted performance on the theory of mind tasks in step one; language status significantly predicted performance beyond age and verbal ability in step two. This indicates that language status significantly predicted theory of mind performance above and beyond the effects of age and verbal ability, consistent with findings from Goetz (2003) and Kovács (2009). Farhadian et al. (2010) also provided similar reasoning for this advantage: better metalinguistic abilities or advanced inhibitory control.

While these studies have shown better performance on theory of mind tasks and provided consistent explanations for this difference, they have not included measures of metalinguistic ability or executive functioning in an attempt to tease apart the nature of the relationship between bilingualism and theory of mind development. In order to address this deficit, tasks assessing theory of mind, metalinguistic awareness, and aspects of executive functioning were administered to Spanish-English bilingual and English monolingual preschool children.

Experiment 4 Method

Participants. Sixty-eight children (33 male, 35 female) in total took part in the experiment. Of these, 40 were monolingual English speakers and 28 were bilingual in English and Spanish. All participants were drawn from the Inland Empire in Southern California, U.S. The Inland Empire, consisting of San Bernardino and Riverside counties, is a metropolitan area within Southern California that is located directly east of the Los Angeles metropolitan area. The Inland Empire has a large Hispanic population, with Hispanics making up 49% of San Bernardino County and 46% of Riverside County according to the 2010 census (Inland Empire Center, 2014). The mean age of participants was 3 years, 10 months (*SD* = 9 months) and the mean verbal age, as assessed with the PPVT (Dunn & Dunn, 1997), was 3 years, 2 months (*SD* = 10 months).

Of the monolinguals, 20 were male and 20 were female. The mean age was 3 year, 10 months (*SD* = 11 months) and the mean verbal age was 3 years, 4 months (*SD* = 10.5 months). Of the bilingual participants, 13 were male (46.4%) and 15 were female (53.6%). The mean age of bilinguals was 3 years, 10 months (*SD* = 5 months) and the mean verbal age was 2 years, 10 months (*SD* = 8 months). Monolingual participants tested significantly higher for verbal mental age, $t(66) = 3.028$, $p = .004$, although chronological age did not differ significantly between the two groups ($p = .775$).

Table 5.1

Age Characteristics of Children Participating in Experiment 4

Age group	N	Mean (y;m)	SD (months)	Range (y;m)
Monolinguals	40	3;10 (3;4)*	11 (10)	2;8 – 4;1
Bilinguals	28	3;10 (2;10)	5 (8)	3;2-4;5 (2;1-4;1)

*verbal mental age, assessed with the PPVT, in parentheses

Design. Each child was tested individually by the primary researcher in two sessions that lasted approximately 10-15 minutes each. The two sessions took place one week apart and were conducted either in the child's home with a parent nearby, or in the corner of a preschool room in which the child attended preschool. Three or four tasks were administered in the first session, depending on language background. For all children, one false belief task, the CC task, and the DCCS were administered in this first session. For bilinguals, an additional task, the Bilingual task, was also administered. In session two, the second false belief task, the AN task, the DNS, and the PPVT were administered.

Materials and procedure. The materials and procedures for the FB, AN, CC, DCCS, and DNS tasks used in Experiment 4 were identical to those used in Experiment 1B.

Language switch task. This task was administered to children who were identified as both English and Spanish speaking by their preschool teacher. The preschool class is taught primarily in English, although teachers use some Spanish, particularly with those who they recognize as using Spanish in the home. The language switch task was structured similarly to the AN task and also comprised three phases: vocabulary check, practice, and test. The materials for the task were four A4 sized cards, each with four pictures on it for a total of 16 images. These images were of everyday items that preschool aged children were very likely to be familiar with, such as clothing, animals, and body parts. All images were named during the vocabulary check phase, two images were used during the practice phase, and the test phase consisted of four images. The images used for the practice phase and test phase were counterbalanced among participants.

The vocabulary check, similar to the AN, consisted of two passes: in the first pass items were named in either English or Spanish, and items were named in the other language during the second pass. The order of which language was presented first was counterbalanced. Trials were phrased as “Where is the [image name]?” in English, and “¿Dónde está el/la [image name]?” in Spanish.

Two images were used for practice and to familiarise the children with what was expected of them. During this phase the children were provided feedback and coached in order to produce the correct answer if necessary. The two practice trials were worded as follows.

Spanish to English:

Esta es una mano. ¿Cómo se dice en inglés?

Esta es una casa. ¿Cómo se dice en inglés?

English to Spanish:

This is a hand. How do you say it in Spanish?

This is a house. How do you say it in Spanish?

Trials were administered in both Spanish to English and English to Spanish. The order in which the two items (hand and house) were presented was counterbalanced, as was the order of first language presented. The test phase consisted of similarly structured scripting for four items. Each trial once again was conducted in both Spanish to English and English to Spanish, with order counterbalanced. Children received a total score out of eight: four English to Spanish and four Spanish to English; children were also scored in terms of number of items for which they successfully passed both language switches.

Experiment 4 Results

False belief tasks. A slightly higher percentage of bilingual children (32.1%, versus 25.0%) passed the Sally FB task, although this difference was not significant, $p = .588$, Fisher's exact test. However, monolinguals performed marginally significantly better than bilinguals on the Puppet FB task (Table 5.2), $p = .045$ by Fisher's exact test. As can be seen in Table 5.2, children appear to have had difficulty in correctly answering the memory question for each task. When aggregated, there was no significant difference in the number of children who passed both versus failed both tasks based on language status, $p = .748$, Fisher's exact test. When performance was split into three groups (failed both, passed one, passed both), again there was no significant difference between language groups, $\chi^2(2) = 1.084$, $p = .582$.

Table 5.2

Number and Percentage of Children Passing False Belief Tasks

		All Participants	**Monolinguals**	**Bilinguals**
Sally FB	Belief Question	23 (33.8%)	12 (30%)	11 (39.3%)
	Reality Question	62 (91.2%)	36 (90%)	26 (92.9%)
	Memory Question	51 (75%)	31 (77.5%)	20 (71.4%)
	Passed all three	**19 (27.9%)**	**10 (25.0%)**	**9 (32.1%)**
Puppet FB	Belief Question	17 (25%)	13 (32.5%)	4 (14.3%)
	Reality Question	63 (92.6%)	37 (92.5%)	26 (92.9%)
	Memory Question	46 (67.6%)	27 (67.5%)	19 (67.9%)
	Passed all three	**16 (23.5%)**	**13 (32.5%)**	**3 (10.7%)**

When assessing all children, the false belief tasks correlated positively with each other to a moderately-large degree ($r_\varphi = .504$, $p < .001$). Performance on the false belief tasks was significantly correlated with both chronological age and verbal mental age (Table 5.3). However, when disaggregated by language status it was revealed that the correlations with age were driven by the monolingual children; among bilingual children there was no correlation between false belief task performance and measures of age.

Table 5.3

Age and False Belief Correlations

	VM Age	FB Total	Sally FB	Puppet FB
Age (all)	.793**	.488**	.390**	.458**
Monolinguals	.853**	.654**	.634**	.535**
Bilinguals	.857**	-.068	-.201	.153
VM Age (all)		.381**	.181	.487**
Monolinguals		.628**	.463**	.648**
Bilinguals		-.195	-.185	-.174
FB Total Passed (all)			.875**	.859**
Monolinguals			.881**	.899**
Bilinguals			.919**	.803**
Sally FB Passed (all)				.504**
Monolinguals				.586**
Bilinguals				.503**

Ages in months, *$p < .05$, **$p \leq .001$

AN task. Children were near perfect in the vocabulary check, with 91.2% of total participants, 92.5% of monolinguals, and 89.3% of bilinguals missing no critical word checks. For monolinguals, this number seems consistent with the percent passing from Study 2 (50 typically-developing nursery children). Of the 40 monolinguals, 13 (32.5%) were able to produce at least three of the four item pairs. While all children had more difficulty when given the basic term and having to produce the superordinate term, bilingual children showed particularly poor performance on this aspect of the task (Table 5.4). As none of the bilingual children were able to produce at least three superordinate terms during these trials, this limited their overall performance, resulting in no passing scores among bilinguals. The monolinguals (M = 1.83) significantly outperformed the bilinguals (M = 0.71), $t(56.293) = 4.436$, $p < .001$. A paired-samples t-test confirms that the children's scores on basic-to-superordinate items (M = 1.49) were significantly lower than their scores on superordinate-to-basic items (M = 3.28),

$t(67) = -14.782$, $p < .001$. This remains true for both monolinguals ($t(39) = -9.837$, $p < .001$) and bilinguals ($t(27) = -12.042$, $p < .001$).

Table 5.4

Summary of Performance on AN Task

	All Participants	**Monolinguals**	**Bilinguals**
2+ pairs	24 (35.3%)	22 (55%)	2 (7.1%)
3+ pairs	13 (19.1%)	13 (32.5%)	0 (0%)
3+ Super – Basic	56 (82.4%)	37 (92.5%)	19 (67.8%)
3+ Basic – Super	13 (19.1%)	13 (32.5%)	0 (0%)

Chronological age was moderately and significantly correlated with passing the AN task with three or more pairs ($r = .477$, $p = .002$) among monolinguals. Verbal mental age also correlated moderately with AN task performance among monolinguals ($r = .401$, $p = .01$). As none of the bilingual children passed the AN task with three or more pairs correct, correlations were conducted between total pairs correct and each measure of age for this group. Chronological age correlated with the number of pairs correct for bilinguals ($r = .461$, $p = .014$), as did verbal mental age ($r = .527$, $p = .004$).

CC task. Children performed perfectly on the colour check (100%). Performance was also very strong on the experimental portion of the task with all 68 children (100%) passing the task by correctly answering at least three out of four trials. Only 4 (5.9%) of children did not achieve a perfect score on the test portion, and all four of these children were bilinguals.

DCCS. Children performed well on the DCCS, with 58 of 68 (85.3%) correctly sorting all five cards in the post-switch phase. Only one of the sixty-eight children (1.5%) was unable to correctly sort any of the five cards in the post-switch phase, and only five children (7.4%) sorted less than three cards correctly. Of monolinguals, 90%

correctly sorted all five cards. Of bilinguals, 78.6% correctly sorted all five cards, with a collective of 98.3% correctly sorting at least four cards.

Scores on the DCCS did not correlate significantly with either chronological age ($r = .082$, $p = .507$) or verbal mental age ($r = -.168$, $p = .171$). When split by language background, each group individually produced similarly non-significant correlations among these measures.

DNS task. Overall, children performed well on the DNS task, with 58.8% passing the task with at least 75% accuracy (12 of 16 trials). Nineteen of the children (27.9%) achieved a score of 8 or less. Monolinguals performed somewhat better than the bilingual children on this task; monolinguals had a passing rate of 70%, while 42.9% of bilinguals attained the same standard. An independent-samples *t*-test revealed that monolinguals ($M = 12.75$) significantly outperformed bilinguals ($M = 10.5$) on this task, $t(66) = 2.257$, $p = .027$.

DNS score correlated moderately with chronological age ($r = .329$, $p = .006$) and strongly with verbal mental age ($r = .614$, $p < .001$). Among bilinguals, DNS score correlated strongly with both chronological age ($r = .719$, $p < .001$) and verbal mental age ($r = .626$, $p < .001$); however, among monolinguals only verbal mental age correlated significantly with DNS score ($r = .559$, $p < .001$; chronological age – $r = .239$, $p = .137$).

Language Switch task. The Language Switch task proved to be difficult for the bilingual children. Only two (7.1%) children passed the task with three out of a possible four pairs correctly given. A total of nine children (32.1%) correctly answered two pairs out of four. Of the children, 14 (50%) were unable to correctly translate even one full pair from English to Spanish and Spanish to English. Translating from Spanish to English was slightly easier for the children: 39.3% of children correctly translated at least three of the four English words to Spanish; only 14.3% correctly translated at least three of the four Spanish words to English. Over one-third (35.7%) of children were unable to translate any of the words in either order.

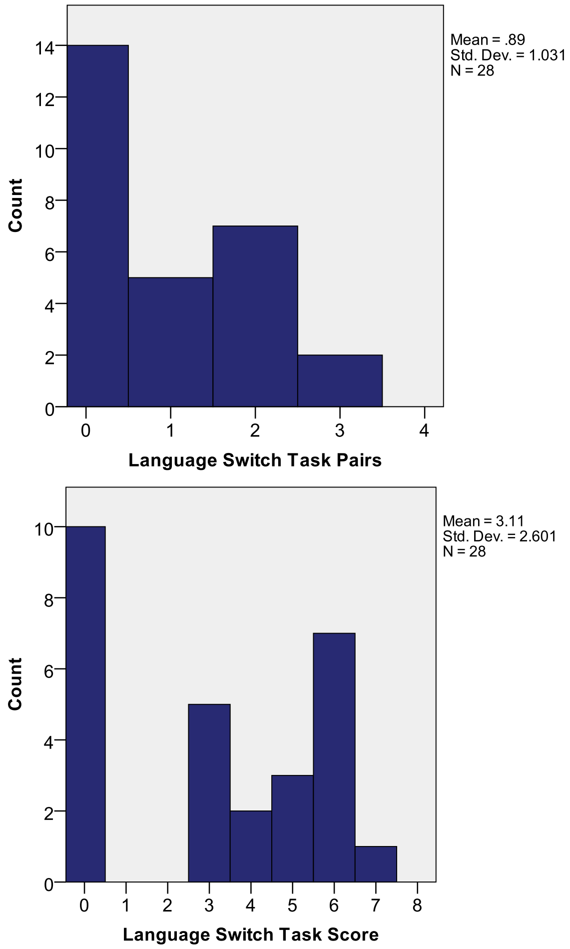

Figure 5.1. Performance by bilinguals on Language Switch task

Task relatedness. Chronological and verbal mental ages were partialled out to see if any relationships remained among tasks apart from those influenced by age.

All participants. A marginally non-significant correlation was found between passing scores on the AN task and DCCS performance (r = .241, p = .051). Performance on the DCCS also correlated moderately negatively with performance on the Puppet FB task (r = -.372, p = .002), but not with the Sally FB task (p = .666) or combined false belief performance (p = .164).

All three measures of false belief performance (Sally task, Puppet task, and aggregated) correlated moderately and significantly with performance on the AN task (r = .292, p = .017; r = .386, p = .001; r = .392, p = .001). These relationships remain when accounting for both measures of age and both measures of executive functioning (r = .288, p = .021; r = .540, p < .001; r = .458, p < .001).

Monolinguals only. There was a negative trend found between performance on the DCCS and aggregate false belief performance (r = -.301, p = .066), which is likely driven by the significant negative relationship between DCCS and performance on the Puppet Task (r = -.552, p < .001). Passing performance on the AN task was moderately and significantly related to the three measures of false belief performance (Sally task, r = .422, p = .008; Puppet task, r = .439, p = .006; aggregate, r = .494, p = .002). When additionally controlling for performance on both executive functions, these relationships were strengthened (r = .461, p = .005; r = .693, p < .001; r = .627, p < .001).

Bilinguals only. Among the bilingual children, score on the DCCS correlated moderately with score on the DNS task (r = .425, p = .03). DNS score also correlated moderately with each of the other tasks, as shown in the Table 5.5.

Table 5.5

Correlation Between DNS and Other Tasks for Bilingual Children

		FB Aggregate	Sally Task	Puppet Task	AN Task Pairs	Language Switch Pairs
DNS	*r*	.471	.477	.348	.472	.655
Score	*p*	.015	.014	.082	.015	.000

As no bilingual children passed the AN task with three or more pairs, the number of pairs correctly answered was used as the measure for the task. This measure correlated again with the Sally task, the Puppet task, and the aggregate (r = .676, p <

.001; $r = .612$, $p = .001$; $r = .715$, $p < .001$). Performance on the AN task also correlated moderately with the number of pairs produced in the Language Switch task. No measures of the Language Switch task correlated with any of the measures of false belief.

When controlling for executive functioning measures, Language Switch task performance no longer correlated with AN task performance. However, it then negatively correlated with performance on the Puppet task (pairs produced, $r = -.449$, $p = .028$). Performance on the AN task remained strongly correlated with false belief task performance after controlling for performance on the DCCS and DNS (Sally, $r = 589$, $p = .002$; Puppet, $r = .542$, $p = .006$; aggregate, $r = .637$, $p = .001$).

False Belief and AN task. A two-way between participants ANOVA conducted on performance on the AN task (as measured in pairs correct out of four) revealed a significant interaction between language background and total number of false belief tasks passed, $F(2, 62) = 3.756$, $p = .029$, $\eta^2 = .108$. The interaction was examined by simple effects and multiple comparison analyses. Among monolinguals, those that passed both false belief tasks scored significantly higher on the AN task than those that passed only one or neither false belief task ($p \leq .001$). Among bilinguals, those that passed both false belief tasks performed significantly better on the AN task than those that passed neither false belief task ($p = .025$).

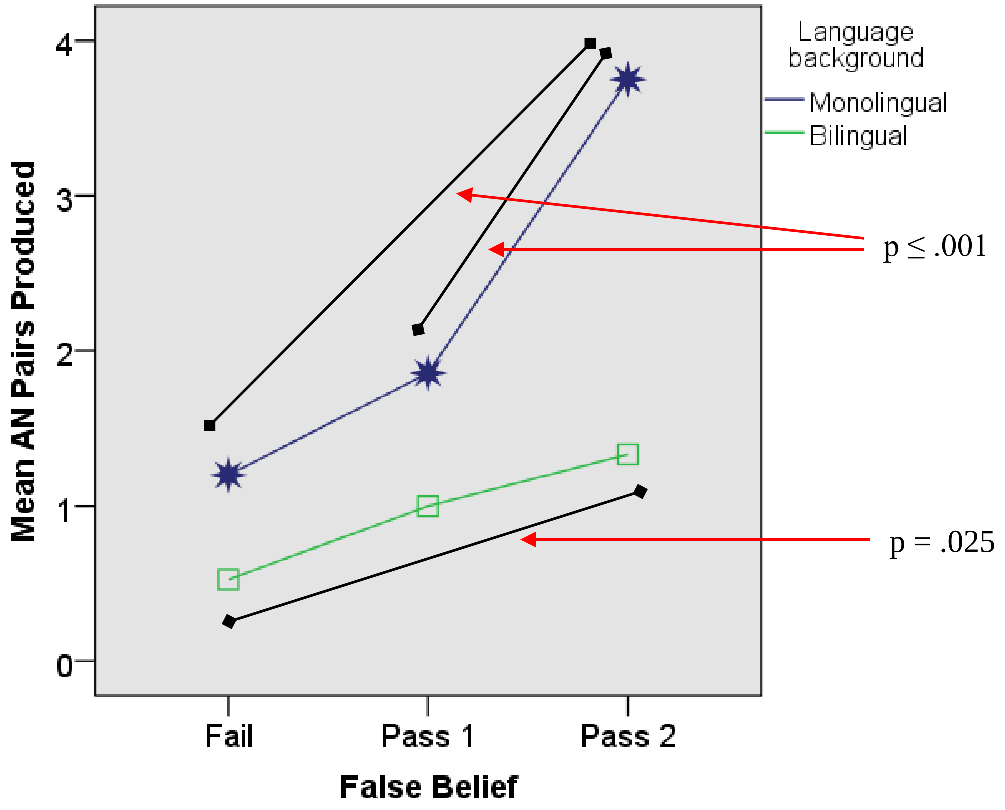

Figure 5.2. Interaction effect of language status and FB task performance on AN task performance

There was also a significant main effect of language background $F(2, 62) = 24.536$, $p < .001$, $\eta^2 = .284$. Simple effect analysis revealed that monolinguals outperformed bilinguals on the AN task at all levels of false belief performance.

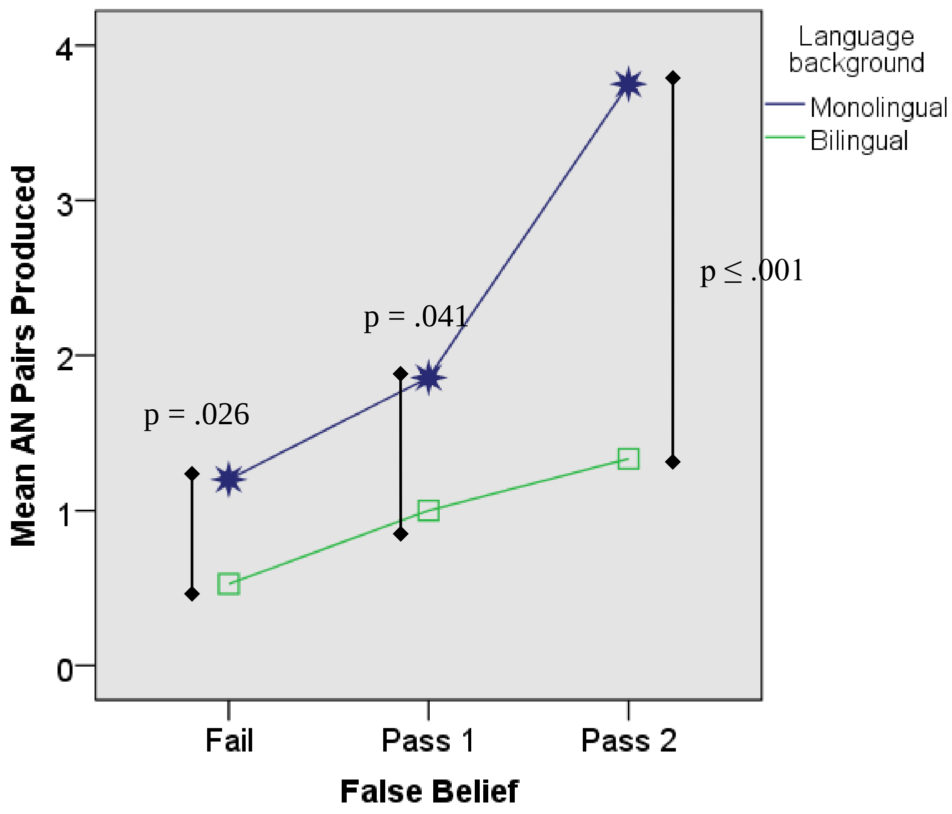

Figure 5.3. Main effect of language on AN task performance

Regression analyses. Three hierarchical regressions were conducted to assess whether performance on the FB tasks could be significantly predicted based on age factors and performance on the other tasks, both for monolinguals and bilinguals separately, and together. As the goal in this case was to identify predictors of false belief performance, FB tasks correct was the outcome variable. Chronological and verbal mental age were entered in step 1, along with CC task performance; these served as control variables. Both measures of executive functioning and number of AN pairs produced were included in step 2; evaluating the contributions of DNS, DCCS, and AN task performances on FB performance allowed for a direct comparison of impact on FB reasoning. In all three cases, evaluation of collinearity statistics indicated that the assumption of non-multicollinearity was met (all VIF < 10, T > .10).

All participants. A hierarchical multiple regression with number of FB tasks passed as the outcome variable showed that age, verbal mental age, and CC performance accounted for approximately 25.6% (unadjusted R^2) of the variability in FB tasks passed ($p < .001$). The addition of the two executive functioning tasks (DCCS and DNS) and AN pairs produced in step 2 significantly improved the model ($p < .001$). When evaluating the predictor variables independently, chronological age and AN pairs produced both made unique, significant contributions to the model (Table 5.6).

Table 5.6

Hierarchical Regression for Experiment 4 Data Predicting Total FB Score – All Children

Variable	*B*	*B*(SE)	Beta	*p*
Step 1[a]				
Age	.046	.015	.548	.004
PPVT	-.007	.014	-.094	.618
CC	.461	.369	.143	.217
Step 2[b]				
Age	.049	.015	.572	.002*
PPVT	-.031	.016	-.406	.055
CC	.262	.324	.082	.421
DCCS	-.138	.073	-.189	.064
DNS	-.013	.024	-.069	.599
AN	.342	.071	.569	.000**

[a] $R^2 = .256$, $p < .001$
[b] $\Delta R^2 = .229$, $p < .001$
[c] Model 2 significant, $F(6, 61) = 9.562$, $p < .001$
*$p < .01$; **$p < .001$

Monolinguals. Among monolinguals, neither chronological age nor verbal mental age made significant, unique contributions in step 1, although model 1 was significant as a whole ($p < .001$). The addition of the two executive functioning tasks (DCCS and DNS) and AN pairs produced in step 2 significantly improved the model ($p < .001$). When evaluating the predictor variables independently, verbal mental age showed a marginally significant effect, whereas performance on the DNS and AN tasks were strong, unique predictors of FB task performance (Table 5.7). The final model accounted for 73.7% (unadjusted R^2) of the variability in FB scores. The regression is highly significant, $F(5, 34) = 19.081$, $p < .001$.

Table 5.7

Hierarchical Regression for Experiment 4 Data Predicting Total FB Score – Monolinguals

Variable	*B*	*B*(SE)	Beta	*p*
Step 1[a]				
Age	.032	.017	.434	.072
PPVT	.020	.018	.258	.279
Step 2[b]				
Age	-.002	.018	-.026	.919
PPVT	.045	.021	.581	.038*
DCCS	-.126	.068	-.191	.073
DNS	-.100	.029	-.491	.002*
AN	.366	.067	.635	.000**

[a] $R^2 = .446$, $p < .001$
[b] $\Delta R^2 = .291$, $p < .001$
[c] Model 2 significant, $F(5, 34) = 19.081$, $p < .001$
*$p < .05$; **$p < .001$

Bilinguals. Among monolinguals, again neither chronological age nor verbal mental age made significant, unique contributions in step 1; model 1 containing these measures of age and CC performance did not significantly predict FB task performance ($p = .119$). Model 2 was significant ($p = .003$), and the addition of the two executive functioning tasks and AN pairs produced in step 2 significantly improved the model ($p = .004$). When evaluating the predictor variables independently, only verbal mental age and AN performance were significant, unique predictors of FB task performance (Table 5.8). The final model accounted for 58.1% (unadjusted R^2) of the variability in FB scores. The regression is highly significant, $F(5, 34) = 19.081$, $p < .001$.

Table 5.8

Hierarchical Regression for Experiment 4 Data Predicting Total FB Score – Bilinguals

Variable	*B*	*B*(SE)	Beta	*p*
Step 1[a]				
Age	.061	.049	.439	.225
PPVT	-.061	.037	-.715	.062
CC	.774	.378	.400	.051
Step 2[b]				
Age	.023	.047	.0163	.636
PPVT	-.079	.025	-.923	.005*
CC	.081	.364	.042	.826
DCCS	-.102	.165	-.107	.545
DNS	.048	.047	.284	.321
AN	.811	.223	.705	.002*

[a] $R^2 = .213$, $p = .119$
[b] $\Delta R^2 = .369$, $p < .004$
[c] Model 2 significant, $F(6, 21) = 4.861$, $p = .003$
* $p < .01$

Study 4 Discussion

The results of Experiment 4 in terms of false belief performance differences between bilingual and monolingual children did not reflect the findings from past research. While previous studies (e.g., Farhadian et al., 2010; Goetz, 2003; Kovacs, 2009) clearly showed better performance by bilingual children on false belief tasks, this was not the case for the present study. It is difficult to make any conclusions based on the non-difference found in the current study, however, due to the lower sample size and significantly lower verbal mental age among the bilingual children. It is therefore strongly recommended that further research be conducted with a larger bilingual sample and potentially matched subjects between groups based on age and verbal mental age.

Additionally, the inclusion of slightly older children in the sample may help to increase the low passing rates found among the present sample. As highlighted in Table 5.2, children in both groups struggled with the memory question, particularly on the Puppet FB task. Overall FB passing rates ranged from only 10.7% to 32.5%, much lower than what was witnessed in Studies 1 and 2. Ideally these passing scores would be around 50% in order to better differentiate children in terms of performance. Future researchers may consider tracking pass rates in order to aim for approximately half of a sample passing critical tasks for this reason.

Despite the fact that the general result regarding theory of mind performance and bilingualism is not consistent with past research, there is still information that helps to delve into the underlying influence of theory of mind development. Once again, performance on the FB and AN tasks were related, regardless of language status. As evidenced by the results of the multiple regressions, the number of pairs produced during the AN task was strongly related to performance on the FB tasks, even above and beyond effects of age and executive functioning. Inhibition does appear to play some part in the ability to pass the false belief tasks, as performance on the DNS was related to performance on the Language Switch task and FB tasks among bilinguals. Performance on the DNS was significantly, negatively related to FB task performance among monolinguals when controlling for all other variables. This runs counter to previous research and warrants further investigation to determine whether this is a reliable finding.

Regardless, it is clear from the results of the regression analyses that AN and FB task performances are strongly related, even when accounting for age, verbal mental age, and measures of executive functioning. This lends support for the claim for a general metarepresentational development as an explanation for stronger theory of mind performance among bilinguals that has been witnessed in past research, rather than simply being due to increased inhibition abilities.

Chapter Six

Summary, Implications, and Future Research

The field of theory of mind research has quickly grown since 1978, when Premack and Woodruff inquired into the chimpanzee's ability to understand human goals. While this seminal paper that sparked great interest in the "ability to impute mental states to oneself and to others" and "to make inferences about what other people believe to be the case in a given situation" (Baron-Cohen et al., 1985, p. 39) in order to predict that behaviour began focused on chimpanzees and grounded in animal psychology, it quickly became of interest within developmental psychology. By 1981, Bretherton, McNew, and Beeghly-Smith were asking a question that would lead to a field of study in developmental psychology that continues to be explored in great depth over 30 years later: When do infants acquire a "theory of mind"?

Through decades of research and debate, the present general consensus is that explicit false-belief reasoning is generally developed by around the preschool years, or 4 years of age, among typically developing children (Wellman & Peterson, 2013).

There are specific groups that show developmental delays in theory of mind reasoning, namely children on the autistic spectrum and deaf children of hearing parents who do not have early access to sign language. While the underlying mechanisms for children with ASD may differ somewhat, evidence suggests that access to language (spoken for hearing children, signed for deaf children) early in life plays a vital role in theory of mind development (Meristo et al., 2012; Moeller & Schick, 2006; Ruffman, Slade, & Crowe, 2002).

There are several other skills that have been found to develop around the same time as theory of mind; however, while many have theorised as to the role these skills play in theory of mind development, much remains somewhat unclear. These skills include metalinguistic awareness (e.g., Doherty, 2000; Doherty & Perner, 1998; Farrar & Ashwell, 2012; Perner et al., 2002) and aspects of executive functioning (e.g., Carlson & Moses, 2001).

Additionally, language background, including deafness and bilingualism, has been shown to affect the ages at which children develop these skills. While deaf children have been shown to experience delays in theory of mind development, bilingualism has been shown to be advantageous for this development (e.g., Goetz, 2003; Fahradian et al., 2010; Kovács, 2009; Rubio-Fernandez & Glucksberg, 2012). Bilingual children have also exhibited higher executive functioning skills than their monolingual peers, particularly in processes involving inhibition and set shifting (e.g., Bialystok, 1999; Carlson & Melzoff, 2008; Costa et al., 2008; Kovács & Mehler, 2009; Martin-Rhee & Bialystok, 2008). Degree of bilingualism has also been found to be related to degree of metalinguistic skill (e.g., Bialystok & Ryan, 1985; Cromdal, 1999; Galambos & Hakuta, 1988).

While executive functioning, metalinguistic awareness, and false belief understanding have been examined among typical hearing, deaf, and bilingual children in the past, there are a lack of studies that do so comprehensively. The links between these three areas of development among these groups of children has also yet to be investigated in depth, as are the causes for possible relationships among them. This study sought to undertaking an in-depth assessment of how language, including lack of early language input due to deafness and early input of multiple languages, affects the development of these skills to provide greater insight on the socio-cognitive developmental process. Additionally, the inclusion of a sample from the yet unstudied group of deaf and hearing children in Ghana adds to the body of knowledge regarding theory of mind development in different cultures around the world.

The purpose of this thesis was to investigate the development of theory of mind, metalinguistic awareness, and executive functioning, how these skills overlap in terms of development, and to examine the role of language in developing these skills. More specifically, these skills were assessed in several groups of children in order to tease apart the nature of the relationships between these areas of development. Typically developing, hearing, monolingual children served as somewhat of a baseline for the thesis by examining relationships between theory of mind, metalinguistic awareness, and executive functioning in Study 1. Study 2 sought to expand this line of investigation by examining performance among deaf children in the U.S. and the U.K. Given that many young deaf children in these developed countries use hearing aids or cochlear implants of some sort, it is difficult to isolate effects of delayed language exposure. As such, Study 3 was carried out in Ghana, where these technologies are not readily available to deaf children. A group of hearing Ghanaian children were evaluated to determine trends in the region regarding theory of mind development in order to provide a comparison group for the sample of deaf Ghanaian children. Finally, Study 4 expanded upon existing research into the role of bilingualism on theory of mind development, seeking to tease apart the reason for more advanced performance among bilinguals over monolinguals.

The aim of the thesis was to provide information for answering the following six research questions:

Research Question 1: Are there relationships among theory of mind, metalinguistic awareness, and executive functioning development? If so, what is the nature of those relationships?

Research Question 2: Does language background affect the development of theory of mind?

Research Question 3: Does language background affect the development of metalinguistic awareness?

Research Question 4: How do performance rates on a variety of theory-of-mind related tasks vary among deaf children?

Research Question 5: Does cultural background affect the development of theory of mind?

Research Question 6: Does cultural background affect the development of metalinguistic awareness?

The present chapter condenses and further evaluates the evidence from the four empirical chapters. Major findings from the four studies are discussed in terms of the thesis as a whole, as well as in the context of the existing literature in the field. Practical implications of the research are examined, and suggestions for expanding upon the information synthesised within this thesis are made.

Summary and Evaluation of Findings

The primary findings from each of the four empirical studies are compared and contrasted within this section. A table summarising details and main findings of the four studies is presented in Table 6.2. How the findings fit together to more fully tell the story of how language background plays a role in theory of mind and metalinguistic awareness development is discussed in terms of research questions.

Study 1. Study 1 consisted of two experiments, each with hearing children from Central Scotland between the ages of 2 and 5 years as participants. Experiment 1A involved assessing false belief understanding, metalinguistic awareness, and verbal mental age among a group of 31 nursery students. Performances on the false belief task and the metalinguistic task were significantly, positively related, even after partialling out age and verbal mental age at the time of testing, $r = .758$, $p < .001$.

These results were consistent with results obtained by Stummer (1997; 2001, both as cited by Perner, Stummer et al., 2002), showing a robust relationship between performance on an alternative naming metalinguistic awareness task and a false belief task, even when accounting for participants' ages and verbal mental ability. While Perner, Stummer et al. (2002) found that the relationship between these tasks did not remain when accounting for these additional factors, the present study supports Stummer's results, as do further findings from experiments conducted throughout this doctoral thesis. The fact that the difficulty experienced by the children on the metalinguistic task did not translate over to the similarly structured CC task support's Perner, Stummer et al.'s stance against the executive demand hypothesis. Additional support against executive functioning as mediating the relationship between metalinguistic awareness and false belief understanding was obtained in Experiment 1B.

Experiment 1B included the same false belief, metalinguistic awareness, and verbal mental age tasks, but also included a secondary false belief task and two measures of executive functioning. The purpose of Experiment 1B was to build upon the results of Experiment 1A and to assess whether executive functioning skills explain the relationship between metalinguistic awareness and false belief understanding. Performance on the false belief tasks, metalinguistic awareness task, and executive functioning tasks all correlated with age. After controlling for age and verbal mental age, performance on the false belief and metalinguistic awareness tasks remained positively correlated, $r = .465$, $p < .001$. A hierarchical regression showed that performance on the false belief tasks significantly predicted performance on the metalinguistic awareness task even after controlling for age, verbal mental age, and performance on the two executive functioning tasks ($\beta = .500$, $p = .002$).

The findings from both experiments in Study 1 support the notion that theory of mind understanding and metalinguistic awareness development are related, supporting previous work on the subject (e.g., Doherty, 2000; Doherty & Perner, 1998; Farrar & Ashwell, 2012; Perner, Stummer et al., 2002). The results argue against the executive demands hypothesis, as the relationships between metalinguistic awareness and false belief reasoning remained when accounting for not only age and verbal mental ability, but also performance on tasks explicitly designed to assess executive functioning skills believed to underpin performance on the standard false belief tasks. Rather, results from Study 1 support the theory that the two abilities may share a common core in understanding of representations, as proposed by Kloo et al. (2010). Given the findings of this study, the development of understanding of metarepresentation remains a strong hypothesis regarding why these skills develop somewhat concurrently.

Study 2. Study 2 similarly consisted of two experiments, both of which focused on performance among samples of deaf children and adolescents. The children in both experiments ranged in age from 5 to 15 years. The 18 children included in the sample for Experiment 2A were drawn from deaf populations in Southern California, U.S., and Central Scotland, U.K., whereas all 18 of the children in Experiment 2B lived in Central Scotland. Experiment 2A was very similar to Experiment 1B, using many of the same tasks, although they were modified for use with deaf children. The mean age of the children in Experiment 2A was 10 years, 2 months. No significant correlations were found among task performances after controlling for age. Performance on the two false belief tasks varied greatly, as 33.3% passed the traditional “Sally” unexpected transfer task, but 83.3% passed the “Puppet” task, which involved explicit trickery. Children performed well on all other tasks: alternative naming mean 3.56 out of 4, DCCS mean 4.44 out of 5, and DNS mean 15.8 out of 16.

Experiment 2A illustrated a very different pattern of development than was found among the hearing children included in Experiment 1B. While a clear relationship was found between performance on the metalinguistic awareness measure and measures of false belief among the hearing children in Study 1, no such relationship was found among participants in Experiment 2A. Results of Experiment 2A point toward a more specific delay in false belief development, without similar delays in metalinguistic awareness or executive functioning. These results support the vast amount of research that has suggested significant delays in theory of mind development among deaf children (Courtin, 2000; Moeller & Schick, 2006; Peterson & Siegal, 1995; Peterson & Siegal, 1999; Russell et al., 1998). Given that only standard forms of the false belief task were included in Experiment 2A, however, it begged the question as to whether alternative forms of false belief tasks or tasks that require precursory knowledge would prove more effective in use with deaf children.

As such, Experiment 2B involved a battery of tasks found to relate to theory of mind development, as well as the metalinguistic awareness task and two executive functioning tasks. The mean age of the children was 10 years, 6 months. The standard false belief unexpected contents task was also presented in two ways: one with the critical belief question asked first, and the other with it asked last. This was done in an attempt to determine if children were making assumptions about what the experimenter was asking prior to being asked the control questions. This alteration in the wording did not result in a significant difference in performance. Approximately two-thirds to three-quarters of children passed the false belief unexpected transfer tasks. Performance on the three tasks ranged from 66.7% to 77.8%, with 61.1% passing all three versions. The unexpected contents task appeared more difficult: 77.8% correctly answered the other's belief question, but only 50% correctly answered the own belief question. Performance on the other theory-of-mind related tasks was fairly consistent: 77.8% scored at least 3 out of 4 on the Tunnel task, 83.3% scored at least 4 out of 5 on the Lift/See task, and 72.2% correctly answered the Backward Explanation task. Performance remained high on the alternative naming task (mean 3.53 of 4), DCCS (mean 4.72 of 5), and DNS (mean 15.8 of 16).

Similarly as to the findings from Experiment 2A, results from Experiment 2B suggest that the delay witnessed among deaf children regarding false belief understanding does not directly translate over to delays in other areas of cognition. As such, it appears that deaf children may not experience a more widespread metarepresetation developmental delay, but that there is something specific to theory of mind understanding that is impacted by their deafness. The use of an alternative order of questions in the unexpected transfer tasks was designed to test the hypothesis that deaf children, who often receive distorted information or misinterpret information they receive (Mbaluka et al., 2013), may in essence be guessing at what information the experimenter is really after rather than simply answering the question presented in a straightforward manner. The fact that the alternate wording did not improve performance suggests that this is not the underlying reason for poor performance on false belief tasks by deaf children.

Regarding the other tests in the battery, results concerning performance on the Backward Explanation task are consistent with Perner, Lang, and Kloo's (2002) finding that an explanation task is not inherently easier or more useful than the typical unexpected transfer task. Errors made on the Tunnel task were consistent with those described by O'Neill et al. (1992); deaf children were more prone to feel an object than to look at it, despite the fact that feeling would provide no useful information in differentiating objects.

Study 3. Study three consisted of three separate portions. Experiment 3A involved assessing theory of mind, metalinguistic awareness, and executive functioning among 70 deaf students at a school for the deaf in Cape Coast, Ghana. Experiment 3B was a focus group involving five teachers of the deaf from the school. Experiment 3C involved assessing theory of mind abilities of 40 hearing children in Cape Coast, Ghana.

Experiment 3A was very similar to Experiment 2B. The 70 deaf children that were tested ranged in age from 8 years, 6 months to 24 years, 3 months, with a mean age of 15 years, 6 months. Performance on the majority of the tasks was somewhat lower than found among the deaf children in Experiment 2B. Performance on the unexpected transfer tasks ranged from 24.3% to 37.1%, with just 7.1% passing all three. Only 25.7% passed the other's belief on the unexpected contents task, and 18.6% passed the own belief question. Performance on the other theory of mind tasks were: 52.8% scored at least 3 out of 4 on the Tunnel task, 40.0% scored at least 4 out of 5 on the Lift/See task, and 27.1% correctly answered the Backward Explanation task. Children performed well on the measures of executive functioning: mean of 3.87 of 5 on the DCCS, and mean of 15.79 of 16 on DNS. Performance was lower than among the sample from Experiment 2B on the alternative naming task (mean 2.50 out of 4), although in terms of percent achieving a passing score of three out of four pairs (55.7%), the children performed better on this task than on the false belief tasks.

Once again, these findings are consistent with past research establishing delays in theory of mind development among deaf children (e.g., Peterson & Siegal, 1995; Peterson & Siegal, 1999; Russell et al., 1998). This group of children additionally did not have confounding effects of hearing aids and cochlear implants, perhaps providing a more "pure" sample of deaf children among which to assess theory of mind development. Performance on the more direct measures of false belief understanding (Smarties, Backward Explanation, and FB tasks) were the most difficult for individuals in this sample, as they were for the British sample in Experiment 2B. Contrastingly, measures of executive functioning skills (DNS, DCCS) were the easiest for the children, consistent with past research indicating that poor performance on false belief tasks by deaf children are not due to general problems with representation or executive functioning (Remine et al., 2008; Woolfe et al., 2002)

Experiment 3B involved a video-taped focus group with five of the teachers of the deaf. The teachers were queried regarding their experiences in working with the deaf children. Primary themes that arose from a qualitative analysis of the transcribed focus group were barriers to teaching, barriers to learning, differences from hearing students, and differences due to language background. Subthemes for barriers to teaching included conceptual learning, language skills, and quantity. Teachers expressed the great difficulties they had in teaching the children due to their poor language skills and struggle with abstract concepts.

The participants in Experiment 3C were 40 hearing children between the approximate ages of 4 and 12 years (mean age 6 years, 5 months). Children were tested on the three unexpected transfer false belief tasks that were also administered to the deaf children in Experiment 3A. Between 55.0% and 65.0% of children passed each of the tasks. Children were also tested using the alternative question order as described for Experiment 2B; this question order did not produce any significant differences in performance. Performance on the three tasks were highly related (rs $\geq .595$, ps $< .001$).

Findings from Experiment 3C suggest that the hearing children sampled in Ghana develop false belief understanding slightly later than among children included in Wellman et al. (2001)'s meta-analysis. Whereas Wellman et al. found that about 50%

of children at approximately 44 months of age (3 years, 8 months) are able to pass the false belief task, the children in the Ghanaian sample (mean age 6 years, 5 months) were only passing at slightly higher rates than this (55 – 65%). A major limitation to this conclusion, however, is the fact that the ages were approximate for children in the Ghanaian sample and the age range was quite large (8 years) compared to most studies of typically developing children; the higher ages of some Ghanaian children may have skewed the sample, making any potential delay seem more extreme than it truly is. This finding runs contrary to Avis and Harris's finding in their 1991 study of Baka children from Southeast Cameroon. However, given the low socioeconomic status of children in this area of Ghana in comparison to many Western studies of theory of mind, a finding of 55 – 65% passing rate is not entirely inconsistent with past research with children of poorer backgrounds in Western countries (Doherty, 2009).

Study 4. Study 4 consisted of a single experiment aimed at assessing differences in performance on theory of mind, metalinguistic awareness, and executive functioning among monolingual and bilingual children. Forty English-monolingual and twenty-eight English-Spanish bilingual preschoolers from Southern California were included in this experiment. The mean age of both groups was 3 years 10 months, although the group of monolinguals had a significantly higher mean verbal mental age than the bilinguals. The tasks used in the experiment were identical to those used in Experiments 1B and 2A, with the addition of a language-switching task for the bilingual children. Results were fairly consistent between monolingual and bilingual children. There was no significant difference in aggregate false-belief task performance or DCCS performance among the two groups. However, monolingual children did outperform their bilingual peers on the alternative naming task and the day/night Stroop task. Performance on measures of false belief, metalinguistic awareness, and executive functioning all correlated with age. False belief and metalinguistic task performances were significantly related for both groups, even after controlling for age and verbal mental age. Additionally, performance on the metalinguistic awareness task remained a significant predictor of false belief performance, even after accounting for the effects of age, verbal mental age, and executive functioning.

Findings from Study 4 do not support findings from past research regarding false belief performance among bilingual children. While Farhadian et al. (2010), Goetz (2003); and Kovacs (2009) all found clearly advanced performance among bilingual children in comparison with their monolingual peers, the present findings showed no significant difference between monolingual and bilingual children in terms of false belief performance. However, as was previously acknowledged, there were some large limitations to this study, given that the two groups were not matched well on mental verbal age and unequal sample sizes, making it difficult to make claims from this study.

The evaluation of findings in regards to theoretical implications of the research conducted for this thesis will be considered relevant to the six research questions that guided the thesis.

Research Question 1. Research Question 1 concerned the relationships among theory of mind, metalinguistic awareness, and executive functioning development. Information relevant to answering this research question comes from all four studies. The general finding is that theory of mind and metalinguistic awareness appear to be strongly related among typically developing children, but not among deaf children. Executive functioning does not explain that relationship, although components of executive functioning were found to relate to theory of mind in some cases. As the findings between executive functioning and theory of mind were less robust, it appears that the link between theory of mind and metalinguistic awareness is stronger among hearing children than is the link between theory of mind and executive functioning.

Evidence from studies 1 and 4 show these relationships among hearing children most clearly. In Study 1, performance on the false belief tasks and metalinguistic awareness task were positively correlated, even after controlling for age and verbal mental age (*r*s $\geq$ .465). This was also the case in Study 4, both among monolingual and bilingual hearing children (*r*s $\geq$ .494). This indicates that there is a strong, positive relationship between theory of mind development and metalinguistic awareness development among hearing children. It is apparent from the fact that performance on the false belief and metalinguistic awareness tasks remained significantly, positively related even after accounting for scores on executive functioning tasks, as evidenced in the regression analyses conducted in studies 1 and 4, that this relationship cannot be explained merely by executive functioning skills. This lends strong support for the claim that there is an underlying developmental process driving the development of theory of mind and metalinguistic awareness.

There was not a similar, robust relationship found either between false belief performance and executive functioning or between metalinguistic awareness performance and executive functioning. There were some correlations found between individual measures of executive functioning and other task performances; however, these tended to become non-significant after controlling for age and verbal mental age, or they were not consistent between experiments, providing doubt as to the general strength of the relationships.

The relationships among the development of theory of mind, metalinguistic awareness, and executive functioning are not consistent between deaf and hearing children. The robust relationship found between theory of mind and metalinguistic awareness among hearing children was not witnessed at all with the deaf children in studies 2 or 3. Performance on the measures of theory of mind and metalinguistic awareness did not correlate at all, and performance was at least slightly higher on the metalinguistic task than on the false belief tasks. Rather, there is more evidence among the deaf children that executive functioning is playing a role in metalinguistic awareness and theory of mind development. Moderate correlations between the DCCS and the alternative naming, tunnel, and false belief tasks were witnessed among the deaf Ghanaian sample. This suggests that among deaf children who are severely limited in early language output due to the lack of hearing technology, set shifting ability supports metalinguistic and theory of mind development.

Research Question 2. Research Question 2 concerned whether language background affects the development of theory of mind. Information relevant to answering this research question again comes from all four studies. The general finding is that yes, language background, specifically the lack of early language input, affects the development of theory of mind. This can particularly be seen when contrasting the performance on false belief tasks between the hearing children in studies 1 and 4 with the deaf children in studies 2 and 3.

It appears that lack of early language input delays theory of mind development. Although the deaf children in the studies generally performed better than the hearing children in terms of percent passing tasks, it is important to keep in mind the age differences between the deaf and hearing groups. The deaf groups were all quite a bit older than the hearing groups, yet they still struggled to pass the false belief unexpected transfer tasks at a rate of more than 80%. In most cases, over 25% of the deaf children were failing the false belief task, despite none of the children being younger than 5 years of age.

Figure 6.1 shows the breakdown of percent of children passing each false belief unexpected transfer task in each of the experiments, as well as the hearing status and mean age of the group being tested. Figure 6.2 shows the average percent of children passing across the false belief tasks. Although the lowest performing group was a hearing group and the highest performing group was a deaf group, there is a difference of almost 7 years in terms of mean age of the groups. In directly comparing the hearing Ghanaian sample (3C) with the deaf Ghanaian sample (3A), it is clear that the hearing sample outperformed their deaf counterparts, despite the significantly lower mean age of the sample. These two groups may show the most pure comparison regarding early language input, as none of the deaf Ghanaian children had hearing aids or cochlear implants, and the two groups were growing up in the same region under similar conditions, apart from hearing status.

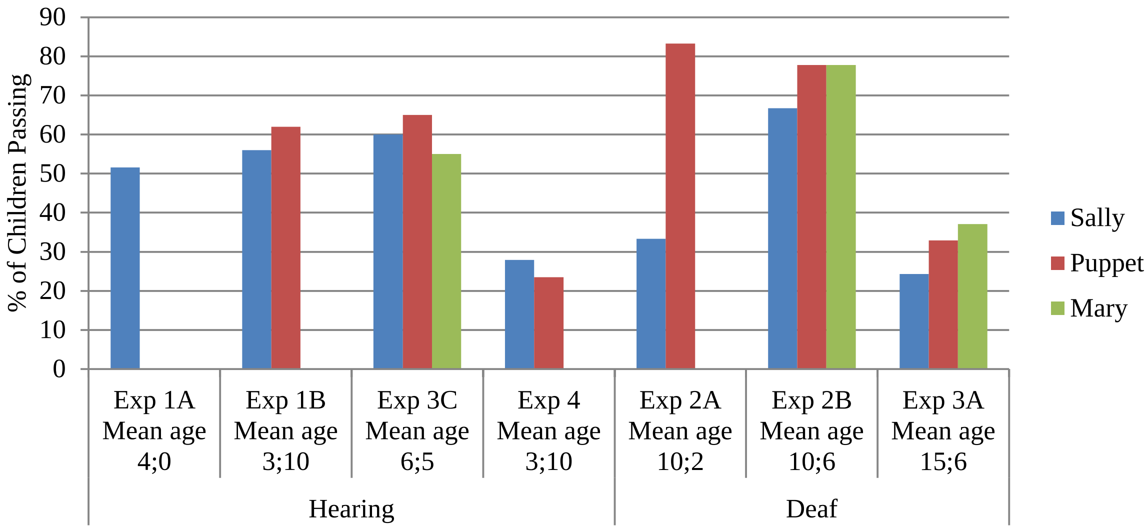

Figure 6.1. Percentage of children passing false belief tasks by experiment and task

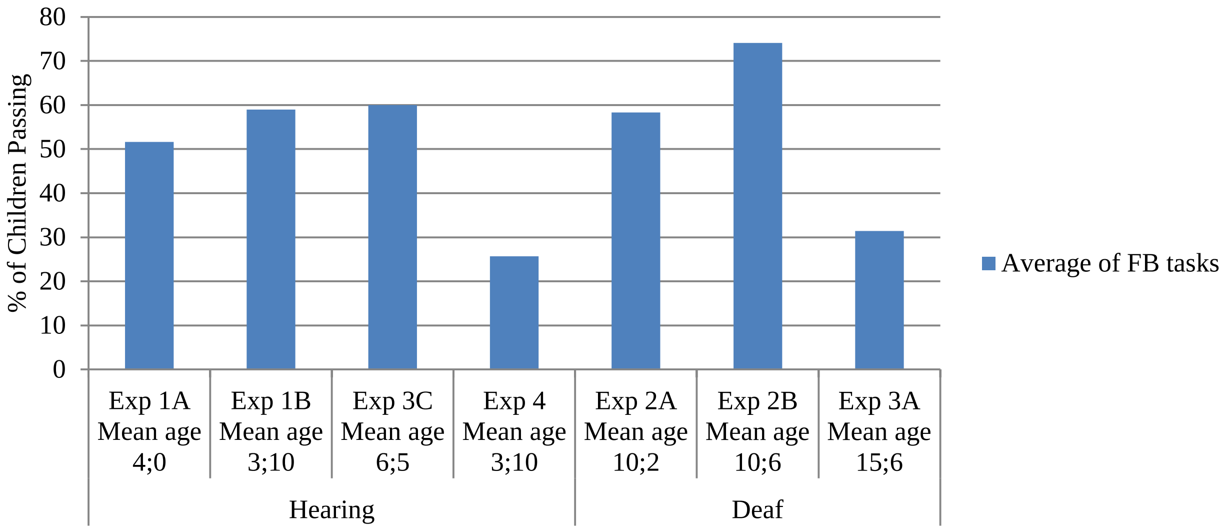

Figure 6.2. Percentage of children passing false belief tasks by experiment, averaged across tasks

In terms of the effect of early input of multiple languages, the bilingual children in Study 4 did not outperform their hearing counterparts, contrary to past findings. Despite the fairly consistent finding that bilingual children outperform their monolingual peers (e.g., Goetz, 2003; Kovács, 2009; Farhadian et al., 2010), no significant difference was found in aggregate false belief performance between the two language groups in Study 4. One possible explanation for this anomaly, as well as for the fact that the bilinguals did not outperform their peers on measures of executive functioning, is that the bilingual sample in Study 4 had a significantly lower verbal mental age than the monolinguals, despite the same mean chronological age. It may have been the case that the bilingual children were not as advanced in their English skills, as shown by PPVT scores, as the PPVT was administered in English. If the bilingual children had lower English vocabularies than their monolingual peers, this may have hindered their performance on all tasks, limiting the potential to see a bilingual advantage on these skills.

Research Question 3. Research Question 3 concerned whether language background affects the development of metalinguistic awareness. The answer to this question is less clear than those previously discussed. It may be that deafness increases metalinguistic awareness, or the fact that the deaf children outperformed the hearing children on the metalinguistic task may be an artefact of age. Bilingualism did not appear to provide any advantage on the metalinguistic task, as the bilingual children in Study 4 actually performed significantly lower than their monolingual peers. Figure 6.3 shows the mean score for each experimental group on the alternative naming task.

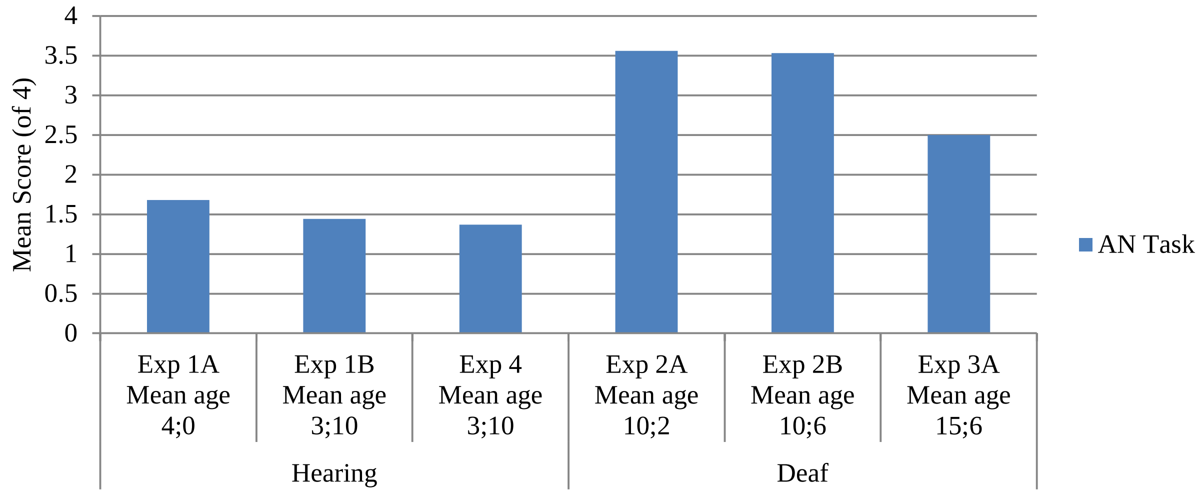

Figure 6.3. Performance on alternative naming task, by experimental group

When considering that the false belief task appears more difficult for deaf children than hearing, yet the metalinguistic task appears more difficult for hearing children than for deaf, this allows for theoretical speculation regarding the relationship between theory of mind and metalinguistic awareness development and the nature of the delay in theory of mind among deaf children. One potential explanation for this difference in apparent task difficulty is that there is an underlying mechanism that allows or promotes for theory of mind and metalinguistic development to occur.

However, there is something unique about theory of mind that stops developing in deaf children while metalinguistic awareness continues to develop. This could potentially also explain why hearing children tended to perform better on measures of false belief than metalinguistic awareness, but deaf children tended to perform better on the measure of metalinguistic awareness than on measures of false belief understanding.

After considering the findings of the present thesis in light of past literature, it is proposed that false belief understanding and metalinguistic awareness develop in tandem due to an underlying mechanism that is grounded in perspective shifting ability. It appears that metalinguistic awareness develops slightly later than theory of mind, as hearing children tend to have more difficulty with metalinguistic awareness than explicit displays of false belief understanding, potentially due to lack of exposure to written language.

However, among deaf children, they are able to continue development of metalinguistic awareness as it grows with age, but get "stuck" on theory of mind due to the abstract nature of the concepts of belief. As was illustrated by the teachers of the deaf who took part in the focus group in Experiment 3B, deaf children appear to struggle greatly with abstract concepts. The teachers stated that they needed concrete materials to illustrate concepts to the children and to aid in their learning of those concepts. It is difficult to convey thoughts or beliefs visually, which may be where the difficulty with theory of mind arises for deaf children. This would not be the case with metalinguistic awareness. Deaf children learn language in regards to concrete items, whether they be signs, words, or the objects and things they represent. This provides them with the visual material for associating language with things, and potentially different words or signs for the same thing, developing their metalinguistic abilities.

However, they do not have anything concrete to attach to what an individual is thinking or believes – this remains an abstract concept that they struggle with.

Research Question 4. Research Question 4 concerned how performance rates on a variety of theory-of-mind related tasks vary among deaf children. In order to answer this question, a battery of theory-of-mind related tasks were administered to deaf children in Central Scotland (Experiment 2B) and in Cape Coast, Ghana (Experiment 3A). This battery of tasks was used to scale performance by deaf children in order to provide some background for further investigation into scaling of developments.

Table 4.5, reprinted below, illustrates the performance of the deaf children in Experiments 2B and 3A. Below it has been condensed only to show performance on theory-of-mind related tasks.

Table 6.1

Comparison of UK and Ghanaian Pass Rates

Task	UK Pass Rate		Ghana Pass Rate	Task
Smarties	50%	Most difficult	10.0%	Smarties
Backward Explanation	72.2%		27.1%	Backward Explanation
FB	72.2%		31.4%	FB
Tunnel	77.8%		40.0%	Lift/See
Lift/See	83.3%	Least difficult	52.9%	Tunnel

As illustrated in the table, the Ghanaian sample performed lower on all tasks than did the Scottish sample, presumably due to longer amount of time without language input prior to joining school, no availability of cochlear implants and hearing aids, and less technology available for aiding in development both prior-to and after joining school. However, despite the differences in pass rates between the two groups, their performance follows similar patterns. The deaf children performed poorest on tasks that involved prediction or explanation based on another's thoughts or beliefs. Alternatively, they performed better on the two tasks related to understanding the seeing leads to knowing or understanding which senses can reliably be used for understanding characteristics of an object. The order of the Tunnel task and the Lift/See task were opposite between the two groups, but they still were the two most-passed tasks.

This again seems to relate to the comments made by the deaf teachers in Experiment 3B that deaf children have trouble with abstract concepts. While the Lift/See task and the Tunnel task are somewhat related to theory of mind and understanding of how people know things, they are more concrete than the other three tasks. The children appear better able to understand the concepts of seeing and feeling objects, and how that leads to knowing something about that object, better than they understand how seeing (or not seeing) something can change what another person believes. It is therefore proposed that as scenarios and concepts become more abstract, the more difficult they become for deaf children. The more salient the concept, including concepts regarding mind, the more easily they will understand. While this does not get to the reason that undergirds this abstract difficulty, it is information that can be valuable in practical terms, such as in deaf education.

Research Question 5. Research Question 5 concerned whether cultural background affects the development of theory of mind. Evidence for answering this research question is drawn from studies 1 and 3. While there appears to be some potential effect of culture on theory of mind development, it is slight. False belief task passing rates for the Scottish children in Experiments 1A and 1B ranged from 51.6% to 62.0%; the false belief task passing rates for Ghanaian children in Experiment 3C ranged from 55.0% to 65.0%. The Ghanaian children were notably older than their Scottish counterparts (*M* = 6;5 versus *M* = 4;0 and 3;10); however, the passing rates for the Ghanaian sample are slightly higher than those for the Scottish sample. In comparison to past findings by Wellman et al. (2001), who found that at about 44 months of age (3 years, 8 months), children are about 50% correct on the task, the Ghanaian sample appears slightly delayed. However, this could also be due to socioeconomic, rather than purely cultural, factors, as researchers (e.g., Holmes, Black, & Miller, 1996; Hughes et al., 2005) suggest that children from lower socioeconomic backgrounds tend to develop theory of mind at a slightly later age.

Research Question 6. Research Question 6 concerned whether cultural background affects the development of metalinguistic awareness. This question has the least amount of evidence available from the studies conducted for this thesis. Due to time and practicality constraints including translating the task into Fanti, the alternative naming task was not administered to the group of hearing Ghanaian children. Therefore, the only comparison of metalinguistic ability due to culture than can be done is between the deaf Scottish children in Experiments 2A and 2B and the deaf Ghanaian children from Experiment 3A.

However, this comparison is very limited as well, as there are significant differences in the early lives of the two groups apart from merely cultural differences. The children in the sample from the U.K. were likely identified as deaf fairly early on in childhood, at least by the age of 5 when they entered school, if not much earlier. In contrast, the children in the Ghanaian sample may or may not be identified as deaf until later in childhood, and even then, resources are very limited for parents of deaf children. These children do not necessarily begin school at the age of 5, and as the teachers in the focus group stated, sometimes they do not join school until as late as 17 or 18 years of age (Appendix C). Due to the limited resources available to them, children tend to have no language skills, apart from some home signs used with family, when they begin school. This is not likely the case with deaf children in the U.K., as there are organizations and support for parents so they can begin exposing their children to sign language or potentially using hearing aids or cochlear implants prior to enrollment in school.

Having said that, the performance on the alternative naming task among the deaf children in Ghana was noticeably lower than among the Scottish children (see Figure 6.3). The samples from Experiments 2A and 2B performed almost identically on the task, despite the group in Experiment 2A including children from both America and the United Kingdom. However, as both the U.S. and the U.K. are developed, English-speaking, Western countries, cultural differences would be slight, and unlikely to provide a good contrast for evaluating effects of culture. The fact that the Ghanaian children performed to a lower degree on the task than did the Western children may point to an effect of culture on metalinguistic ability; however, without additional investigation it is impossible to determine whether the difference is due to cultural differences or to more extreme language deficiencies among the Ghanaian sample.

Practical Implications of the Research

The most profound practical implication arising from this thesis is likely that which comes from the suggestion that deaf children struggle with abstract reasoning. It is argued that this problem with abstract concepts is what undergirds the struggle deaf children have with theory of mind tasks, which was particularly highlighted among the sample of deaf Ghanaian children. The scaling of performance on theory-of-mind related tasks among the groups from Experiments 2B and 3A appears to highlight the impact of having something tangible to see or feel in regards to gaining a theory of mind. Children struggled the most with tasks that were reliant on purely abstract concepts of others' beliefs, as it is difficult to make these ideas salient without concrete materials.

As the teachers pointed out, the deaf children's struggle with abstract thinking affects their ability to learn in class, particularly without visual or tactile materials. This highlights the need for creation of materials and availability of materials that can ground abstract concepts in concrete items. This is something that potentially can be undertaken by researchers specialising in deaf education.

This outcome of this thesis may also serve to motivate further research into designing and testing interventions for deaf children aimed at increasing theory of mind understanding. Wellman and Peterson (2013) recently conducted such an intervention with deaf children in Australia. The study made use of concrete materials, including cutout dolls, thought bubbles, and containers and rooms with opening paper flaps, to conduct an intervention program aimed at increasing false-belief understanding and progress on a broader theory-of-mind scale, an intervention that was found to be effective. Information gained from this new study teamed with information from this thesis may serve as a solid framework for developing interventions for use with deaf children.

Suggestions for Future Research

This thesis was aimed at addressing gaps in the existing literature on the interplay between theory of mind, language, and metalinguistic awareness, whilst also evaluating claims and theories presented by previous research through additional empirical testing. While some questions have been answered in this regard, the field can only be further strengthened by additional research. This is particularly true given some of the limitations that were encountered during the process of completing this thesis, particularly with access to participants.

As with any special population, gaining access to deaf children to take part in this research proved difficult. The existing knowledge can only be strengthened by replicating the studies presented in this thesis with larger sample sizes, particularly in regards to the deaf children.

Bilingual participants also proved difficult to obtain, and as a result the analysis presented in Study 4 is not as strong as it could have been. The bilingual children who did take part had notably lower verbal mental skills than their monolingual peers, which may have impacted results. It is therefore recommended that future researchers seek to match bilingual and monolingual children not only on chronological age, but on verbal mental age as well, to ensure a fair comparison between groups.

The evidence regarding Research Questions 5 and 6, those having to do with effects of culture on theory of mind and metalinguistic awareness development, was somewhat weak in the present thesis. It is recommended that future researchers seek to expand upon this and existing research on theory of mind and culture in order to give a more complete view of how these skills develop in cultures around the world. This should definitely entail more research being conducted in Africa, as there is a severe lack of studies investigating sociocognitive development of children in African countries.

As previously mentioned, the opportunity for interventions for deaf children aimed at increasing theory of mind abilities should be considered. In line with this, further investigation should be conducted into the theory that deaf children experience trouble with theory of mind due to the extreme abstractness of the concept of other people's beliefs. Future research should be aimed at testing this hypothesis by including measures of abstract reasoning alongside measures of theory of mind.

Conclusions

The aim of this doctoral thesis was to conduct research into the effects of language and culture on the development of theory of mind, metalinguistic awareness, and executive functioning. While relevant evidence regarding the effects of language was somewhat lacking, some important findings have nonetheless been noted. Results show that there is a strong relationship among hearing children between theory of mind and metalinguistic awareness, which is likely due to the underlying ability to confront and shift between multiple representations or perspectives. This relationship is not due to issues of executive functioning. However, this relationship does not exist among deaf children. It is proposed that while these skills may begin developing at the same rate in all children, deaf children are halted in their theory of mind development by the inability to understand abstract concepts, such as thoughts and beliefs. It was recommended that future researchers aim to test this hypothesis by further evaluating abstract reasoning among deaf children and determining whether there is a correlation with theory of mind understanding.

Table 6.2

Summary of Four Studies

	Study 1		Study 2	
	Experiment 1A	**Experiment 1B**	**Experiment 2A**	**Experiment 2B**
Location	Central Scotland	Central Scotland	Southern California & Central Scotland	Central Scotland
Participants	31 hearing children	50 hearing children	18 deaf children	18 deaf children
Ages	2;8 – 4;9 (*M* = 4;0)	2;10 – 5;1 (*M* = 3;10)	5;7 – 15;9 (*M* = 10;2)	5;0 – 15;7 (*M* = 10;6)
Tasks	FB, AN, CC, BPVS	2 FB, AN, CC, BPVS, DCCS, DNS	2 FB, AN, CC, DCCS, DNS	3 FB, AN, CC, DCCS, DNS Smarties, Tunnel, Backward Explanation, Lift/See, Draw a Man
Main Findings	51.6% pass FB AN *M* pairs correct (of 4) = 1.68 CC mean correct 3.19 (of 4) FB and AN significantly related to age FB and AN after controlling for age and VMA (r = .758, p < .001)	56% pass Sally FB 62% pass Puppet FB AN *M* pairs correct (of 4) = 1.44 CC mean correct 3.74 (of 4) DCCS mean correct 3.78 (of 5) DNS mean correct 12.08 (of 16) FB, AN, DCCS, DNS all related to age FB and AN after controlling for age and VMA (r = .465, p < .001) FB significantly predicted number of AN pairs produced after controlling for age, VMA, DCCS, and DNS (β = .500, p = .002)	33.3% pass Sally FB 83.3% pass Puppet FB AN *M* pairs correct (of 4) = 3.56 CC mean correct 4.0 (of 4) DCCS mean correct 4.44 (of 5) DNS mean correct 15.8 (of 16) No sig. correlations after controlling for age	FB pass rates 66.7% - 77.8% 66.7% pass all three FB AN *M* pairs correct (of 4) = 3.53 CC mean correct 4.0 (of 4) DCCS mean correct 4.72 (of 5) DNS mean correct 15.8 (of 16) Smarties: 77.8% other belief 50.0% own belief Tunnel mean 3.22 (of 4) Backwards Explanation 72.2% correct Lift/See mean correct 4.39 (of 5) AN & Lift/See after controlling for age & Draw a Man (r = .628, p < .05)

	Study 3		Study 4	
	Experiment 3A	**Experiment 3C**	**Monolinguals**	**Bilinguals**
Location	Cape Coast, Ghana	Cape Coast, Ghana	Southern California	Southern California
Participants	70 deaf children	40 hearing children	40 monolingual English	28 bilingual English-Spanish
Ages	8;6 – 24;3 (*M* = 15;6)	4;0 – 12;0 (*M* = 6;5)	2;8 – 4;1 (*M* = 3;10)	3;2 – 4;5 (*M* = 3;10)
Tasks	3 FB, AN, CC, DCCS, DNS Smarties, Tunnel, Backward Explanation, Lift/See, Draw a Man	3 FB, Draw a Man	2 FB, AN, CC, PPVT, DCCS, DNS	2 FB, AN, CC, PPVT, DCCS, DNS, Language Switch
Main Findings	FB pass rates 24.3% - 37.1% 7.1% pass all three FB AN *M* pairs correct (of 4) = 2.50 CC mean correct 3.99 (of 4) DCCS mean correct 3.87 (of 5) DNS mean correct 15.8 (of 16) Smarties: 25.7% other belief 18.6% own belief Tunnel mean 2.64 (of 4) Backwards Explanation 27.1% correct Lift/See mean correct 3.29 (of 5) DCCS and… Tunnel ($r = .316$, $p < .01$) AN ($r = .376$, $p < .01$) FB ($r = .242$, $p < .05$) AN and CC ($r = .261$, $p < .05$)	65% pass Puppet FB 60% pass Sally FB 55% pass Mary FB FB tasks highly related (rs $\geq .595$, ps $< .001$)	25.0% pass Sally FB 32.5% pass Puppet FB AN *M* pairs correct (of 4) = 1.83 CC mean correct 4.00 (of 4) DCCS mean correct 4.60 (of 5) DNS mean correct 12.75 (of 16) FB, AN, DCCS, DNS all related to age FB and AN after controlling for age and VMA ($r = .494$, $p = .002$) AN significantly predicted FB score after controlling for age, VMA, DCCS, and DNS ($\beta = .635$, $p < .001$) DNS negatively predicted FB score ($\beta = -.491$, $p = .002$)	32.1% pass Sally FB 10.7% pass Puppet FB AN *M* pairs correct (of 4) = 0.71 CC mean correct 3.86 (of 4) DCCS mean correct 4.68 (of 5) DNS mean correct 10.50 (of 16) FB, AN, DCCS, DNS all related to age FB and AN after controlling for age and VMA ($r = .715$, $p < .001$) AN significantly predicted FB score after controlling for age, VMA, DCCS, and DNS ($\beta = .705$, $p = .002$)

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Appendix A

Task Scripts

*Note: references to signing were replaced with references to saying when working with hearing children

Introduction

Hi, my name is Danielle. What's your name?

Hi ______. Today I have a few games I want to play. Will you play them with me?

Colour/Colour Game

Ok, the first game is about colours. You know your colours? Good!
Show me, where is blue? Where is brown? Where is yellow? Where is green? Where is red? Where is orange?
Very good! Now, I have some pictures. Each picture has 2 colours. I'll sign the first colour, then you sign the other colour. Ok? Let's give it a try.
This picture is red (/yellow). What other colour is it?
This picture is brown (/blue). What other colour is it?
This ball is red (/blue). What other colour is it?
This turtle is brown (/green). What other colour is it?
This butterfly is blue (/yellow). What other colour is it?
This present is yellow (/red). What other colour is it?
Good job!

DCCS

Now, a new game. In this game, we have 2 boxes. This one has a blue apple. This one has a red dog. See the holes on the top? We can put things inside. First we'll play the shape game. In the shape game, all the dogs go in the dog box and all the apples go in the apple box. I'll try first. Here is an apple. It goes in the apple box. Here is a dog. It goes in the dog box. Now you try.
Here's an apple. Where does it go in the shape game?
Here's a dog. Where does it go in the shape game?
...
Ok now let's play a new game. It's called the colour game. All the red pictures go in the red box and all the blue pictures go in the blue box. Understand? Ok you try.
Here's a blue one. Where does it go?
Here's a red one. Where does it go?
...
Good job!

False Belief Sally Task

In our next game we have a box, a jar, and two dolls. This is a little girl, her name is Sally. What's her name? Right, Sally! This is a little boy, his name is Tony. What's his name? Right, Tony!
Now, Sally has a marble. Sally puts her marble into the box. Now Sally goes out to play. What does Tony do while she's gone?

He takes the marble out of the box and puts it in the jar, like this. Now Tony goes out to play.
Here comes Sally back in.
Where will Sally first look for her marble?
Where is the marble really?
Where did Sally put the marble in the beginning?
Great job! Now Sally and Tony are going to go away and play together.

AN Task

Ok now in this game we're going to look at some pictures. When I sign a word, you show me which picture it is. Ok let's give it a try.

Point to the apple.	Point to the fruit.
Point to the dog.	Point to the books.
Point to the drink.	Point to the milk.
Point to the rose.	Point to the flower.
Point to the plane.	Point to the shoe.
Point to the animal.	Point to the cat.
Point to the burger.	Point to the food.
Point to the chair.	Point to the bear.
Point to the bear.	Point to the sun.
Point to the bird.	Point to the owl.
Point to the ring.	Point to the house.
Point to the carrot.	Point to the ring.

Very good! Now, I have some pictures. Each picture has 2 names. I'll sign the first name, then you sign the other name. Ok? Let's give it a try.

This is a fruit. What else is it?	This is a rose. What else is it?
This is a drink (/milk). What else is it?	This is milk. What else is it?
This is a cat (/an animal). What else is it?	This is an animal. What else is it?
This is food (/a burger). What else is it?	This is a burger. What else is it?
This is an owl (/a bird). What else is it?	This is a bird. What else is it?

Great job!

Day Night Game

Now let's have a look at our next game.
Whenever you see this picture, I want you to sign "Day". What do you sign?
Whenever you see this picture, I want you to sign "Night". What do you sign?
Right, now let's give it a try.
(If wrong in first 2, repeat and say - What do you sign to this picture?)
Good job, you did very well!

False Belief Puppet

Oh! I hear something! It's Puppet! What's that you've got Puppet?
What does Puppet have?
Right, a key! Is that your house key Puppet?
You don't want to lose that, do you?
Where will you put it?
Good idea.
Are you tired Puppet? Are you going for a nap?
Night night Puppet!

Let’s play a trick on Puppet. I’m going to move his key from the box to…let’s see, where should we put it? Under this paper? Good – let’s hide it here.
I hear Puppet waking up!
Where will Puppet first look for his key?
Where is the key really?
Where did Puppet put his key in the beginning?
Oh here it is, Puppet! See you later!

BPVS

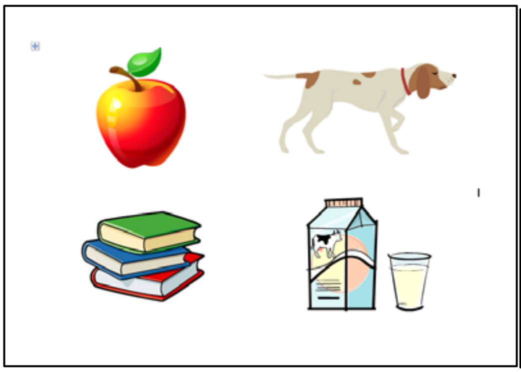
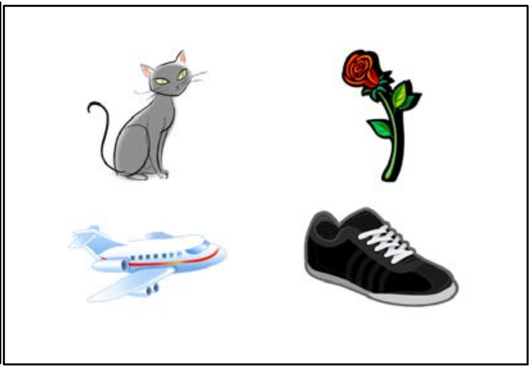
Okay we have 1 more game today. I’m going to sign a word and you point to the right picture. Ok? Let’s give it a try.

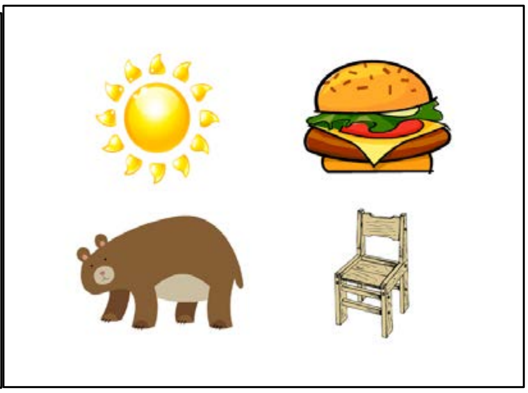
That’s us all finished! Thank you so much for helping me today, I had fun. Do you have any questions? Thank you!

Appendix B

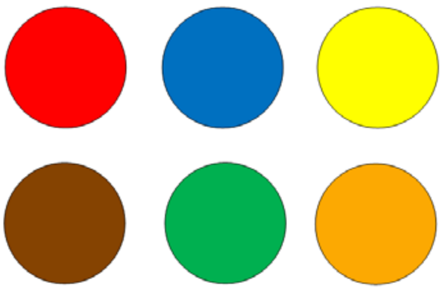
General Study Physical Materials

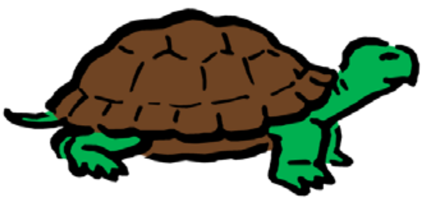
Alternative Naming Task Materials



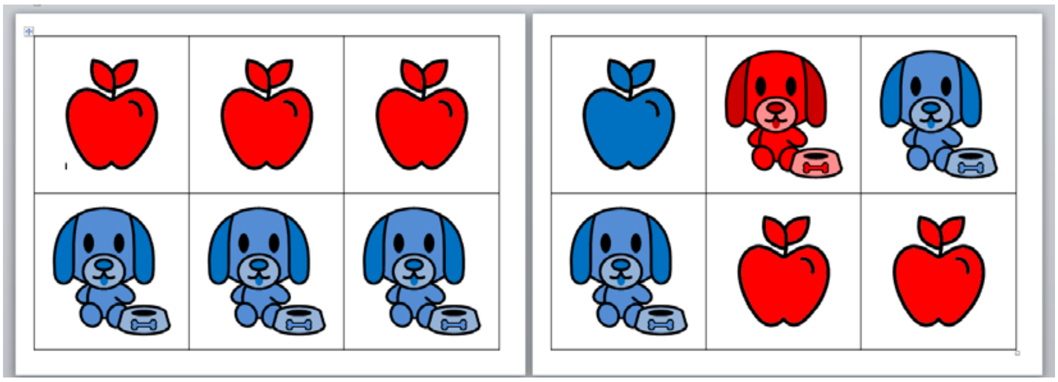
Colour/Colour Task Materials



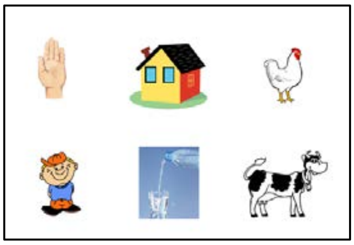


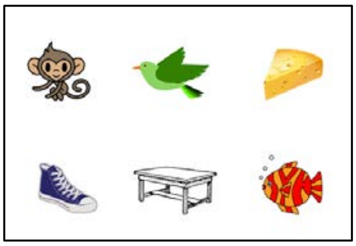
Day/Night Stroop Task Materials

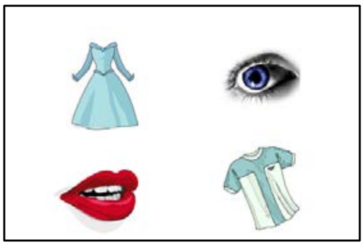
Dimensional Change Card Sort Task Materials



Language-Switch Task Materials







Appendix C

Study 3 Physical Materials

Figure C.1. Modified Smarties task used in Experiment 3A

Figure C.2. Modified Smarties task used in Experiment 3A

Figure C.3. Tunnel task practice items used in Experiment 3A

Figure C.4. Tunnel task *see* items used in Experiment 3A

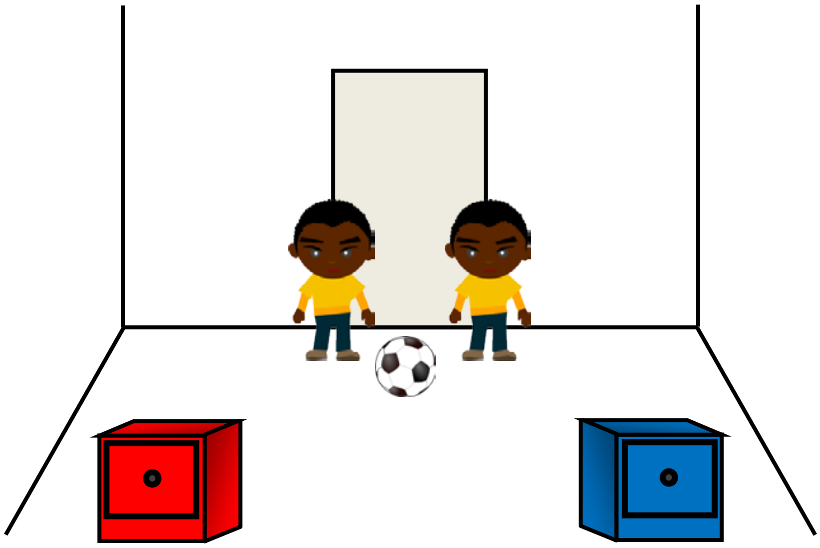
Figure C.4. Tunnel task *feel* items used in Experiment 3A

Figure C.5. Mary False Belief task items used in Study 3

Figure C.6. Sally False Belief task items used in Study 3

Figure C.7. Puppet False Belief task items used in Study 3 (also used in all other studies with Puppet task)

Study 3 Backward Explanation Task



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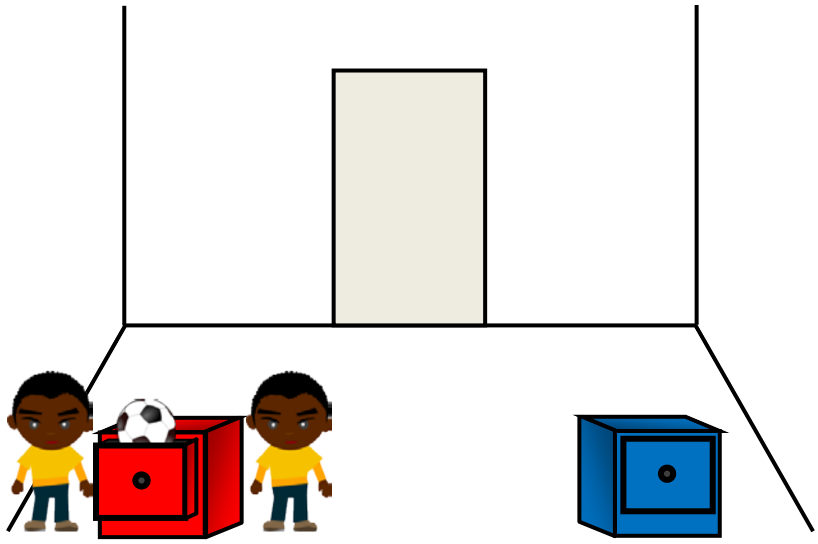

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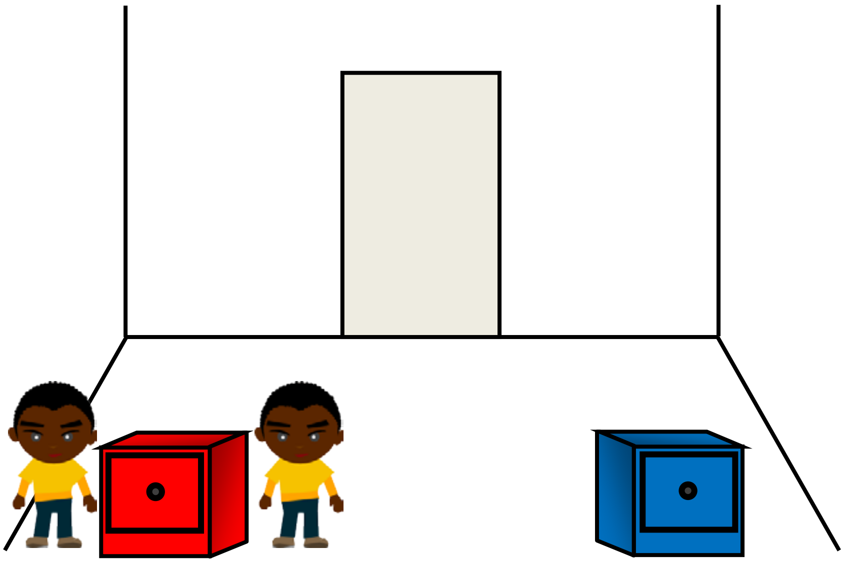

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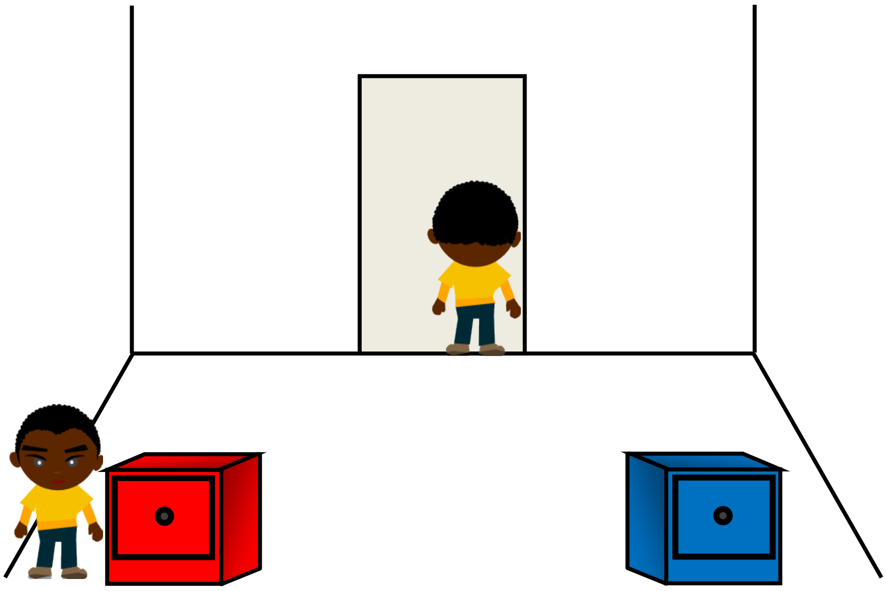

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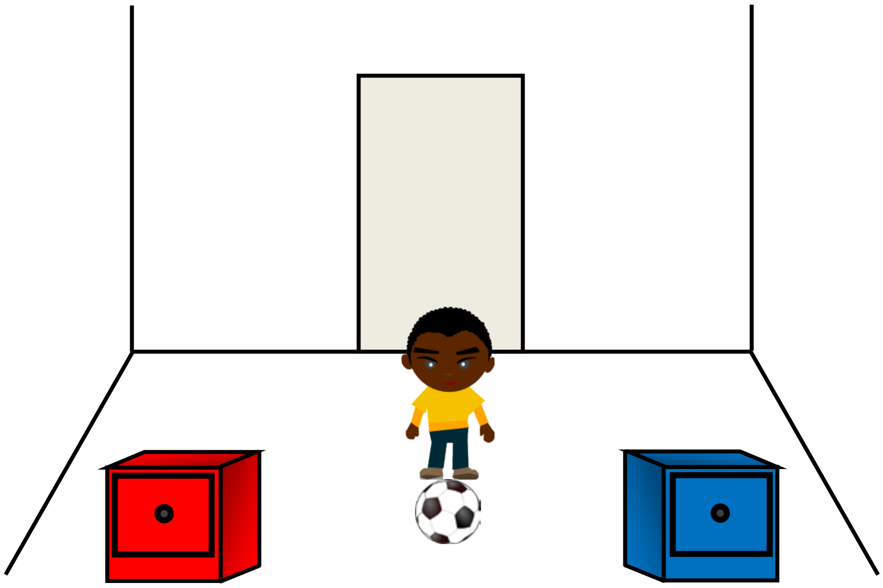

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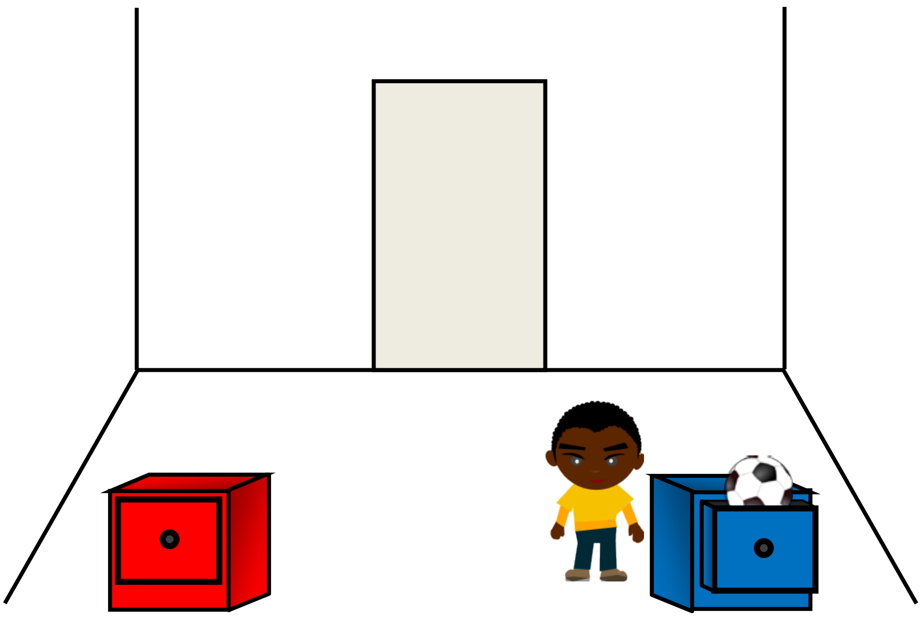

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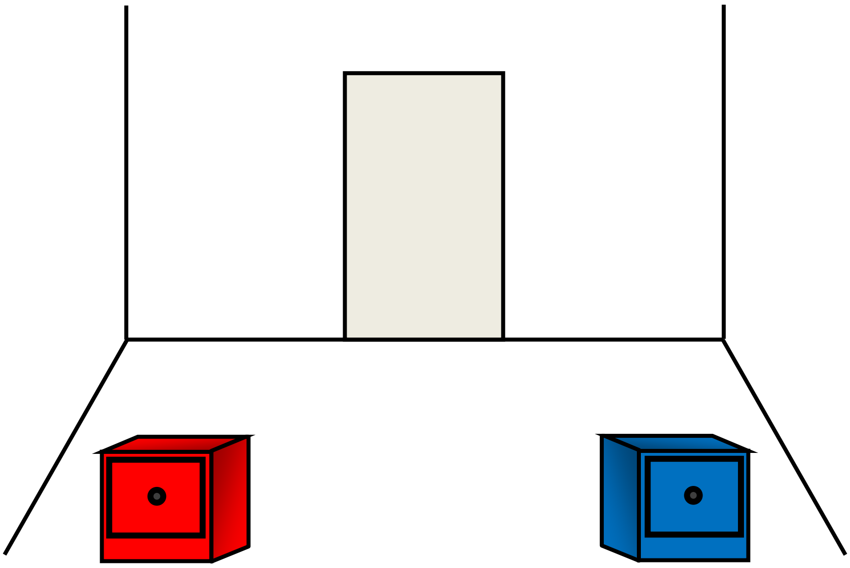

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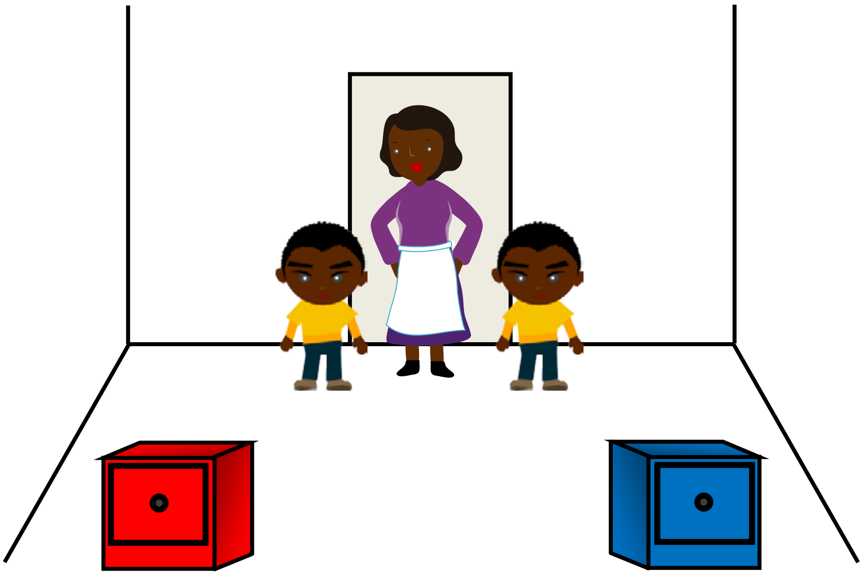

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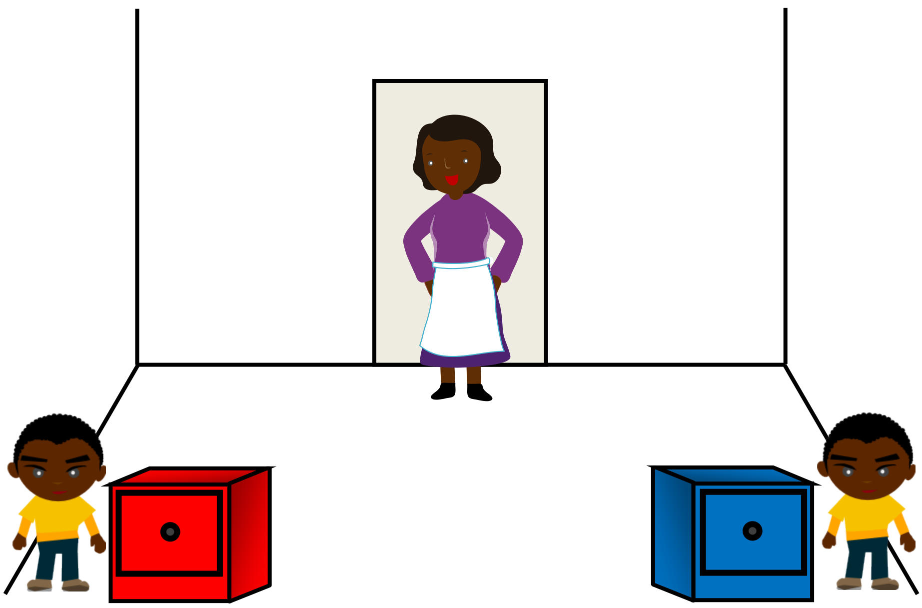
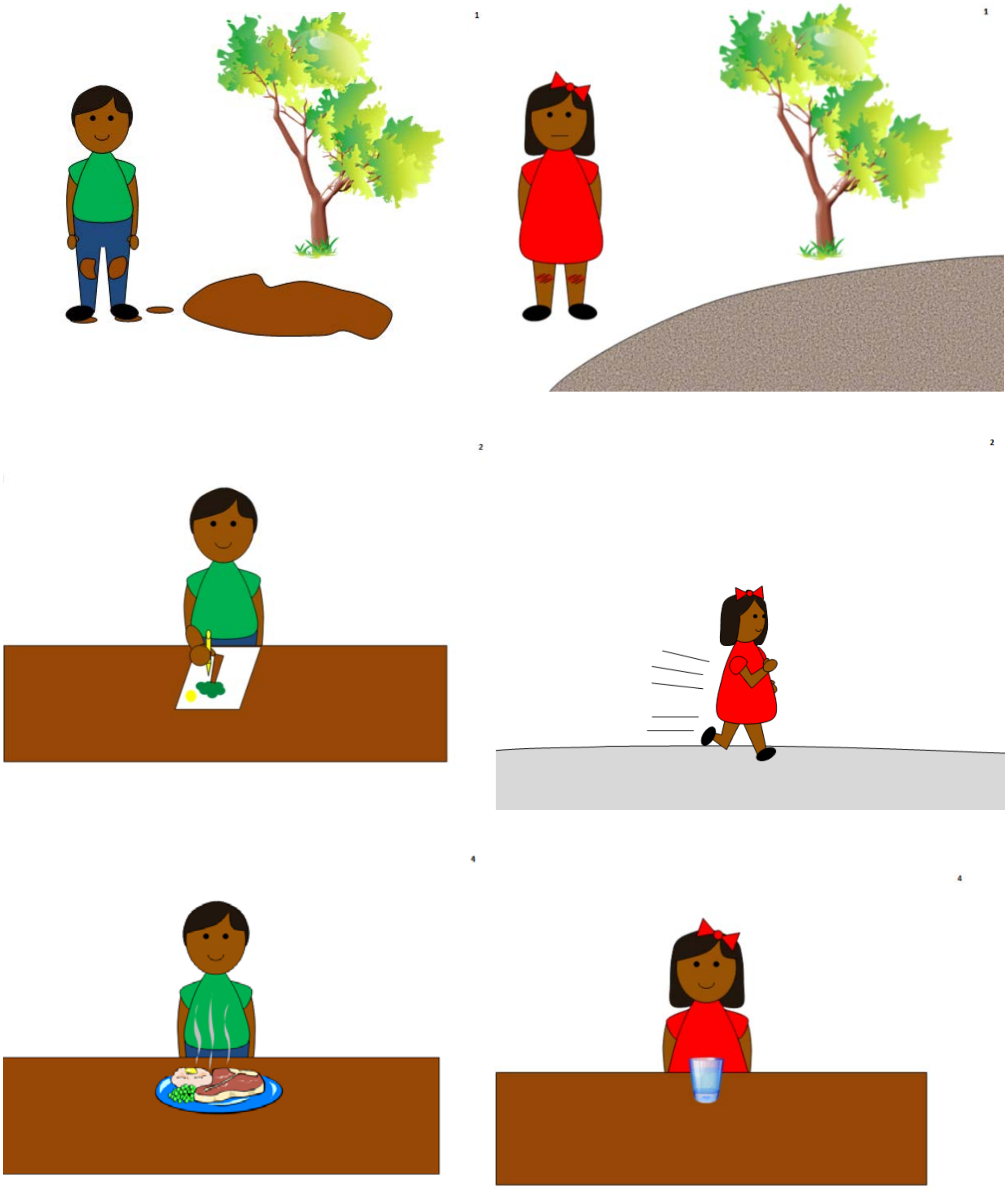
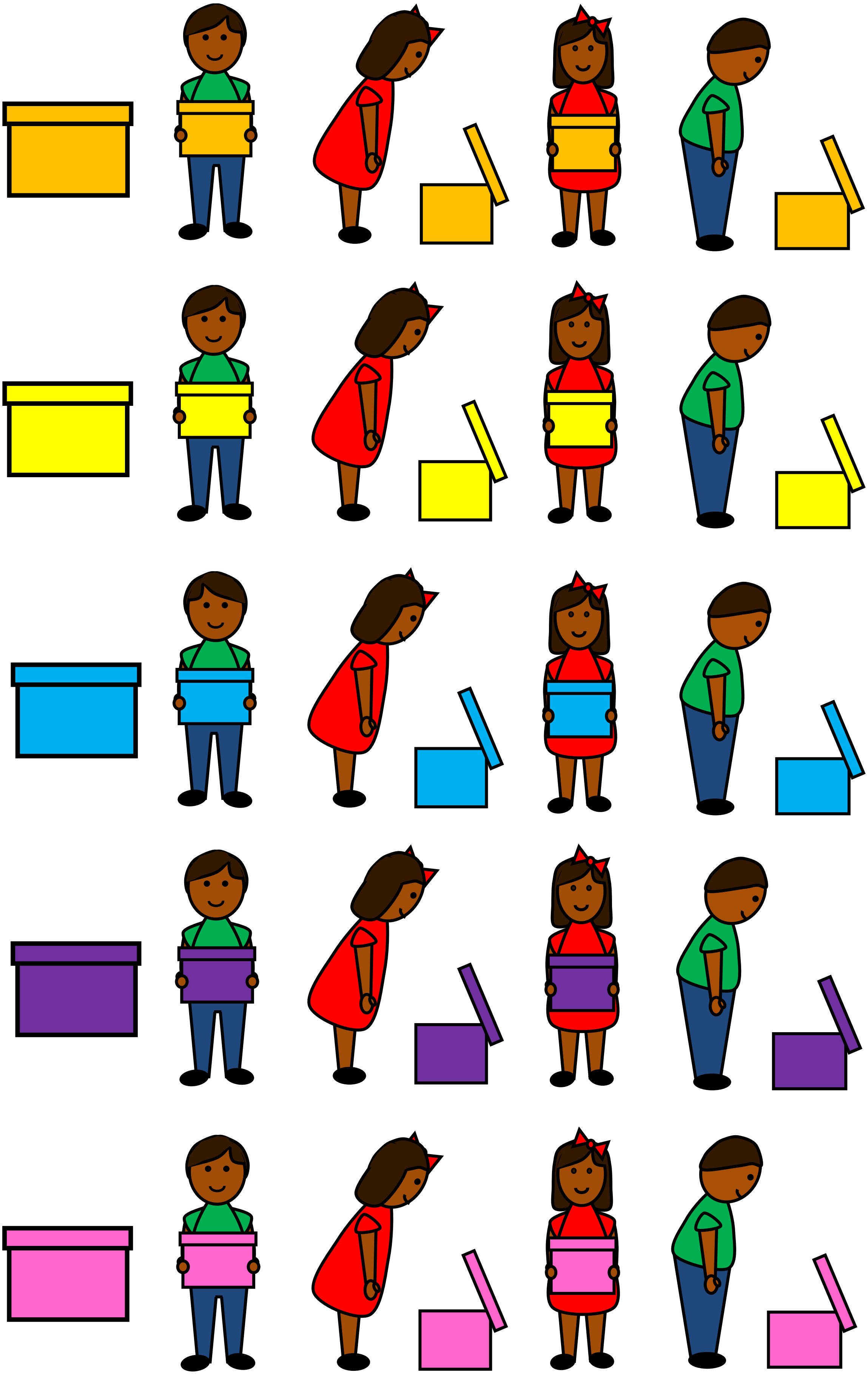


9

Study 3 Lift/See Task





Appendix D

Study 3B Transcript

Focus Group Transcript

Participants, from left to right as video opens:

Danielle: Blue Dress

A: Gent, Blue Hawaii-style shirt

B: Lady, pale yellow top

C: Lady, Blue Vest

D: Lady, Dark Striped top

E: Gent, white polo shirt

0:00

> Danielle: I'd like to ask some questions about what working at the deaf school is like. So how about we start, if everyone says their name, and how long you've been here
>
> E: My name is [name]. I've been...I'm teaching the science and geo [inaudible]. I've been teaching for five years now.
>
> D: I'm [name] and I teach kindergarten. I have been teaching here for seven weeks.
>
> Danielle: Seven weeks?
>
> D: Yes.
>
> C: My name is [name]. I have been here for six weeks.
>
> Danielle: What do you teach?
>
> C: I teach English language.
>
> B: [Name]
>
> Danielle: Sorry?
>
> B: [Name]. I've been teaching for seven years. [inaudible]. English.
>
> A: I'm [name]. I teach English language to the kids. I've been here for 17 years.
>
> Danielle: Wow. So you've been here for a long time.

1:26

Danielle: So what kind of training do you normally do in order to teach at the deaf school? Is there additional training besides regular teacher training?

1:40

E: Yes. As I said before, when I teach [inaudible] you have to go to university for education, and you have to focus on special education…as a focus. And study mathematics, or …when I was there you had to… disci- discipline. Educational behaviour, human behaviour, mental, … eh… [D says something inaudible, others chime in – inaudible] … so these three things. You study them [inaudible]. You study them in specialised courses.

2:24

Danielle: So everybody does? [agreement from participants] So why do you choose to go into special education? Do you get to choose whether you work with deaf or blind or…?

D: [inaudible]. Em, some of us had mentors. [inaudible] …the residents, the discipline [inaudible]; I personally had a mentor. Yes. [inaudible] So this was good, and I came to this school.

3:06

B: It was [inaudible] when I was in training, so I had a class [inaudible] so that's why I came into special education.

A: Well I personally met some deaf students... who were signing. They were signing and laughing, and you know, attracted me, and I decided to go do the course.

3:45

C: [inaudible] …my father. My father fell sick and he couldn't talk and he was writing, so my passion developed from that, personally.

3:56

E: For me, I once met a deaf person who [inaudible]. And besides that, I needed an additional language so when I saw him, I decided to [inaudible] and I went on a course for that. And I knew that was what I want to teach.

4:28

Danielle: So have you all always taught deaf children or at deaf schools, or have you also taught hearing children? [asked to repeat] Have you also taught hearing children, or only deaf children?

A: I taught hearing children for the teaching course, yet.

Danielle: Anybody else?

[All gesture to say they have taught hearing children]

Danielle: You all taught hearing children before? [show agreement]

E: Before we went from [inaudible] we were teaching in a regular school

Danielle: So you have experience of both here and elsewhere? [agreement]

5:06

Danielle: Are there any big differences that, you know, what are the traditional difficulties of teaching the deaf children versus the hearing children? Or are they about the same?

D: Yeah...

C: There is a big difference teaching the hearing and the deaf. The hearing, they can hear. So, when we teach them, we can...materials…maybe we can adapt so that people can understand. But the deaf is not like that. Teaching them, you have to talk moooore before maybe one person will grab the concept.

Danielle: So it's slower?

All: Yes

E: In addition to that, they find it difficult to understand abstracts and concepts, so always need to use a lot of materials. So when they are not a good use of materials, it is very difficult [inaudible]. And then, we also write their sentences [inaudible].

6:28

B: Their language, what they write...grammar...grammar, we have past tense, we have present, we have past, but they don't have past in deaf language. So if it is yesterday that they do something, they still use the present tense. There is no past tense in their language.

Danielle: So it makes it harder to teach? [B agrees]

7:03

D: In addition to that, the deaf, before they come to school, they are not taught language at home.

Danielle: So how do they communicate?

D: There is no language, very little language is applied at home. When they come here, they come to learn the language. So they have inadequate language and that is something we to teach them to [inaudible] to get their education. And they don't have incidental learning, like the hearing children, they hear people talking, they are able to pick a few things. They listen...listen to radio...listen to...I mean at the dining table, and things like that. They learn, they keep learning in their environment. So with the deaf child, nothing [inaudible] so frustrating, unless the deaf child is really good. The deaf child, most of the time, depends on what the teacher teaches. I mean, at home, they don't learn. Most of the them hardly anything at home. But with hearing children, they learn at home. Their parents teach them. Deaf children, all of...vocabulary – barrier, language - barrier, communication - barrier. Nothing is done at home.

8:46

Danielle: About how old are the children when they first come, most of them? Are they all different ages?

A: Different ages. Some as old as 18 years.

B: They are not starting school. So that person, you can't send that person into the classroom. What we normally do is if someone comes to school at 18 [inaudible] what is he coming to do already? So we send the person to the vocational side.

9:20

E: Just last week, I went to P2. P2. And there is a boy of nineteen years in P2.

D: There's a boy in my class of 17.

E: KG?

D: KG1. Kindergarten.

E: Kindergarten. 17.

Danielle: So are their language skills, are they – are they very poor still, even though they're older, when they come? [no response]

Danielle: The one who is 17 in your class, is he able to communicate much, or is he at the same level as the very little ones?

D: He didn't have the normal functioning as the younger kids. His functioning level is very poor.

10:04

Danielle: Do you think that's something that ... you think that he was born or because he hasn't had the language?

D: Um, I think he has the brain...

E: [asks something of D, inaudible]

D: That is why he isn't able to function very well. [Danielle: lower?] Yes, his functioning level is lower than even the children in the class.

E: he is multiple handicapped

10:37

Danielle: So before they come, how do they communicate at home? They gesture, or...?

E: They have their own language...home sign. It is different from the standard language that we teach here. Just like speaking Pidgin English. The deaf community, they have their own language. [inaudible].

11:10

Danielle: I remember before you were saying something about with the children, that they guess what you are trying to say before you finish saying it? So they assume… assume before you finish talking?

C: Yes.

[Inaudible]

11:28

C: Before you finish talking, they assume what you are going to say. They go and then do different thing.

Danielle: So they don't wait for you to...

[all smile – "yes". A makes "know" gesture several times (mimicking students) and all laugh and agree]

11:42

B: Sometimes they get one concept out of what you are telling them, and it gets totally confused.

Danielle: I guess it's difficult to teach the full...

A: And I remember, because I teach English [inaudible] I want to go to Accra, or I'm going to Accra [makes NAME sign]

12:11

Danielle: Is there anything else that you notice that is particular to the deaf children? That makes things complicated?

[B asks C something] C: She is asking if there is anything particular to deaf children [inaudible]

E: [to Danielle] Go on.

Danielle: That's mainly what I was most interested in, was… was how you feel about [inaudible] how you teach them, how are they learning, what is different between them and hearing children, [inaudible] any other points?

13:00

E: So for them, I like...they need a lot of materials, those materials can be quite simple [inaudible]. So you can teach a whole lesson with the wrong materials, so you are always nervous.

Danielle: And as far as their attention, is it similar to hearing children...is it harder to keep their attention than hearing children? Or…?

[all agree yes]

E: They have a very short attention span.

B: You want to give them more...give them more at a time... but we can’t, they get frustrated... So, something small, little at a time.

E: And also the hearing people, when they are reading the textbook, they are going to assimilate that [inaudible] talk about what they are reading. [inaudible] they use one vocabulary for too many options [inaudible] so they always need somebody to guide them.

14:27

Danielle: So they can't really learn on their own like the hearing children who could read and learn on their own... they need the extra help?

B: Especially in English, the comprehension, the passage...They read...we understand what's there...[inaudible] and then we give them the gists... in their language that they understand.

E: For example, if say something is lying here, or something is white elephant, white elephant and they won't understand because I am not [others contribute: inaudible] …white. Just it’s white. [inaudible]

15:13

Danielle: So maybe the details, they lose...they just remember the big

E: Yes.

C: You were asking whether they can learn when they are home. They can’t learn when they are home. Unless [inaudible] … And they have prayer time. They don’t really come prepared. And you see them writing about [inaudible]. If the teacher is not in the class that is [inaudible]

A: Confidence [inaudible]

C: And their comprehension is more good.

16:05

Danielle: So you do get some who understand…

All: Yes [inaudible conversation]

Danielle: Do any of the children come, do they have deaf parents? Do they generally have deaf parents?

A: Deaf parents, oh yes.

B: There’s a girl. [inaudible]. The one that is the mother or the father, one of them. [A asks B something]. There’s a girl here. [inaudible conversation between A and B] Both parents.

A: Both parents are deaf.

Danielle: So do you see differences in how they perform if they have the deaf parents or if they have hearing parents?

D: They come with the sign language.

Danielle: So they are ready to learn?

D: Yes, and they do better than the other children

A: That girl [inaudible] she does very well. The sign was [inaudible]

B: [inaudible]

17:17

Danielle: I noticed some of them, there are a couple of twins or ones who have brothers and sisters, are they any different because they've had someone to talk to when they were younger...can you see any difference with them?

D: I have not had an experience

C: [inaudible] mother! And they are also sign [inaudible]. Those boys, the one.

E: Ah, Seth, he is in my class.

C: They are all deaf. All boys.

E: [inaudible] The one in the town. [inaudible with gesture]

18:08

B: Ah yeah yeah, that boy, yes, and the sister.

E: [inaudible]

C: There are twins in P5. [inaudible]

Danielle: I was wondering since they have another deaf person to communicate with when they are smaller, if that shows through at all when they come here or are they the same [no answer] You would say they are about the same?

D: They are about the same.

Danielle: Where do they leave the older person, the parent…

D: [inaudible]

18:57

E: [inaudible] private language

C: [inaudible]

E: [inaudible]

Danielle: So they were later in becoming [inaudible]

E: [inaudible] yes

B: [inaudible]

Danielle: Is there anything else that...Probably it is difficult, since you are always [inaudible]. Maybe if you want to tell me a bit about the school.

[video ends].