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Theory of mind development: quality of sibling relationships and executive function

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Abstract

Previous research by McAlister and Peterson (2006) found the presence of child siblings aided theory of mind (TOM) development and executive function (EF) skills. They further found strong correlations between children's TOM and EF skills, controlling for language ability. The aim of the study was to replicate their findings. The study also aimed to examine whether there was a relationship between quality of sibling relationships and TOM. The final aim of this study was to examine the independent contributions of EF and language to TOM. Across two sessions, 21 children aged 3 to 5 years of age were given two TOM tasks, two EF tasks and a language ability test. Mothers completed questionnaires rating sibling relationship quality. Results revealed no sibling benefit to TOM. As expected, strong positive partial correlations were found between TOM and EF scores, controlling for language ability; this partial correlation was no longer significant when additionally controlling for age, though this was perhaps due to the small sample as the magnitude of the coefficient value was comparable. Sibling relationship quality did not predict TOM. Number of siblings did account for unique variance in EF scores over an above age and language, but this effect failed to reach significance. These findings suggest that child siblings in this sample do not benefit children's TOM development, however number of siblings may be of extra benefit to children's cognitive development.

KEY WORDS:	THEORY OF MIND	EXECUTIVE FUNCTION	LANGUAGE ABILITY	QUALITY OF SIBLING RELATIONSHIPS	FALSE BELIEF

Introduction

Theory of Mind Development

When children develop a theory of mind (TOM) they have the ability to attribute mental states, such as desires, intentions, and beliefs to themselves and others (Lang & Perner, 2002). That is, they have the ability to understand, explain, infer and predict behaviour (Baron-Cohen, 1994; Flavell, Miller & Miller, 2002). With TOM abilities children can actively acknowledge and evaluate different viewpoints, providing a knowledge framework for present and future circumstances. A conventional method used to measure ToM is the false belief task. It involves testing how one can take on the perspectives of others (Wimmer & Perner, 1983). Typically between the ages of 3-5 children have a rapid growth in the development of TOM. This highlights the importance in early preschool years in TOM development. At this age not only do children understand that a person may hold a different belief from their own, but one that is false (Wellman & Liu, 2004). The growth appears to be universal, according to a meta-analysis by Wellman, Cross & Watson (2001). Despite this, Hughes & Ensor (2005) found that in some cases children have the ability to understand mental states from as young as two years old. Jenkins & Astington (1996) however conclude that children do not acquire this type of cognitive ability until the age of five. Individual variability in findings suggests that there may be other variables involved in theory of mind development.

Siblings and TOM

A number of studies have investigated the effect that siblings have on TOM development. Findings show that simply having siblings leads to an earlier understanding of false belief (Jenkins & Astington, 1996; Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki & Berridge, 1996; Peterson, 2000). Children who have siblings have more opportunity to interact and share thoughts, emotions and beliefs. Children with siblings are also able to listen in on conversations, and may be exposed to discussions about mental states, which might aid TOM development (Wright-Cassidy, Fineberg, Brown & Perkins, 2005). Perner, Ruffman and Leekam (1994) found children with two or more siblings were almost twice as likely to pass the false belief task than children with only one sibling. This was further supported by a follow-up study by Ruffman, Perner, Naito, Parkin and Clements (1998) who found that specifically older siblings better cultivate an earlier false belief understanding.

Jenkins & Astington (1996) studied Canadian pre-schoolers and found children with more siblings scored higher on false belief understanding; furthermore they found this association continued to exist when age and language ability was controlled. However, they did not find any association with sibling position or sibling ages. They argue for the importance of number of siblings over sibling position and sibling ages for the development of children's understanding. Conversely, Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, and Berridge (1996) found middle children perform the best on false belief than those children born first and last. This implies sibling ages are just as important as sibling numbers in accomplishing TOM. Peterson (2000) pointed out that discrepancies amongst studies might be due to not fully considering sibling ages. For example siblings who are younger than 12 months and who cannot communicate through language cannot interact socially or play

effectively, and thus they are unable to aid any sort of false belief understanding. The same applies to siblings who are in their adolescence and young adulthood, who are passed the age of interacting socially on the same level as a young child. Essentially an older sibling might act in the same manner as a parent, which would not benefit the child in the same way as a sibling relationship. Instead TOM development might be of benefit if the child interacts with siblings in their own age range. To test this a longitudinal design by McAlister and Peterson (2007) was conducted. Their study supported the idea that children with two or more siblings have higher and earlier false belief understanding. Specifically children who have a sibling within their own age range (1-12 years) tended to perform better than only-children, or children with siblings outside their age range. Their study emphasised the importance of interaction with a child's own age group. However their results also showed that there was no difference in false belief understanding between children with one sibling, and children without any siblings. This suggests that siblings may not always have a bearing on advanced TOM understanding.

Conversely some studies have been unable to find any association between number of siblings (older, younger and both) and false belief understanding (Cole & Mitchell, 2000; Hughes & Ensor, 2005). It is more likely that quality of sibling relationships is a stronger predictor of TOM than number of siblings. Children that engage in shared positive and co-operative play with either siblings or friends have an enhanced understanding of TOM (Cutting and Dunn, 2006). Likewise, Hughes and Ensor (2005) found no association between TOM and number of siblings, but the quality of sibling relationships positively predicted TOM, even when age, language ability and executive function (EF) were controlled. They suggest that affectionate communication and play is what enhances TOM abilities.

Executive Functioning and TOM

It is evident that siblings have a significant role in understanding TOM, yet other important processes may also have a direct impact on TOM, such as executive functioning (EF). EF refers to a very complex cognitive structure; its primary role is to monitor and control thoughts and actions. Recent findings have shown that the three main components of EF are mental set shifting, working memory, and inhibitory control (Garon, Bryson & Smith, 2008). The main executive skill that appears to play a vital role in the performance of TOM is inhibition (Carlson, Moses & Claxton, 2004; Carlson, Moses & Hix, 1998; Hughes, 1998). In order to pass TOM tasks children must be able to supress irrelevant responses (inhibitory control). Inhibition as the primary component of EF and TOM is further supported by research such as Carlson and Moses (2001). They found inhibitory control remained strongly correlated to TOM, even when controlling for number of sibling, age, sex, and language ability.

There are two general explanations for the relationship between executive functioning and theory of mind. EF may affect either the expression of TOM, or the emergence of TOM, or both (Carlson & Moses, 2001). Expression accounts indicate that children may already have EF skills, but they are unable to use these skills effectively in false belief tasks. In this view it is not that children lack cognitive ability, but they are unable to express their knowledge into performance (Carlson, Moses & Hix, 1998). On the other hand, emergence accounts suggest that children need to obtain a certain level of skill in EF before they can develop representational mental

states (Perner, 1998). This has been demonstrated by Wimmer and Perner (1983) in unexpected location false belief tasks. Young children who have poor EF will assume that others take on the same perspective as they do. A child must disengage from misleading information and accurately apply their own mental state understanding to achieve certain tasks, for example conflict inhibition tasks (Carlson, Moses & Claxton, 2004). Longitudinal research predicts that EF skills are required for mental state understanding and not the other way around (Flynn, O'Malley & Wood, 2004; Hughes & Ensor, 2007).

Hughes and Ensor (2005) specifically looked at TOM and EF in two-year-olds, and found a strong correlation between the two even when controlling for language. A hierarchical regression analysis showed that age, language ability and TOM accounted for 40% variance in EF, with TOM uniquely accounting for 5% variance. Similarly, age, language ability and EF accounted for 34% variance in TOM, with EF uniquely accounting for 6% variance. Their study supports both expression and emergence theories as contributing factors on the relationship between EF and TOM.

Language and TOM

In order to understand the mind children must have the ability to reflect on their thoughts, beliefs and desires. This ability depends on language skills. Evidence from the literature suggests there is a strong positive correlation between language and false belief understanding. Studies by Dunn, Brown, Slomkowski, Telsa, and Youngblade (1991) support this claim along with many other studies. In some cases, a correlation as high as 0.60 or 0.70 has been found.

Milligan, Astington and Dack (2007) conducted a meta-analysis using 104 studies with a total of almost 9,000 children on the relationship between language ability and false-belief understanding. Specifically, they concluded that language ability accounts for 18% variance in TOM scores. In general those with high language abilities perform better on TOM tasks, whereas those with weak language abilities perform poorly (Schneider, Lockl & Fernandez 2005; Joseph & Tager-Flusbery, 2004). Jenkins and Astington (1991) found language was an effective predictor of performance in TOM, but a reverse trend was not present. This helps to validate the view that language is a paramount variable in the development of TOM. They also found that children with good language abilities with no siblings performed just as well on TOM tasks as children with poor language abilities with siblings. This suggests both factors are equally important in the development of TOM. Hughes and Ensor (2005) found a very strong correlation of .53 between TOM and language, as well as .50 between TOM and EF. However when controlling for language, although still significant the correlation between TOM and EF decreased to .29. This shows that language does contribute to the relationship between the two.

EF, Siblings and TOM

McAlister and Peterson (2006) studied TOM and EF in 124 typically developing children aged 3-5 years old. They found children with at least one sibling (aged between 1 and 12 years old) had better false belief understanding than children who did not have any siblings. However when looking specifically at the relationship

between having an older or younger sibling on TOM, they did not find any significant correlations. They also found children with siblings do better on EF tasks, and equally found no significant results when looking at sibling ages. Simply the presence of having a sibling aided children's false belief understanding and EF. Partial correlations confirmed ANOVA results. TOM and EF scores were positively correlated with presence of siblings when controlling for language, however they did not control for age. A hierarchical multiple regression analysis revealed that verbal ability, EF scores, and the presence of a child sibling were independent predictors of TOM. The presence of at least one sibling was a stronger predictor than number of siblings. Further analysis found number of siblings independently contributed to EF skills when controlling for age, however this was not the case once TOM scores had been controlled for.

The first aim of this study was to replicate McAlister and Petersons (2006) findings, who found the presence of at least one child sibling offers TOM and EF benefit. The second aim of this study was to replicate McAlister and Petersons (2006) partial correlation between TOM and EF, controlling for language ability. This study examined whether the correlation remained significant when additionally controlling for age. The third aim of this study was to examine whether there was a relationship between quality of sibling relationships and TOM. The final aim of this study was to examine the independent contributions of EF and language to TOM.

Method

Participants

The sample consisted of 28 typically developing children aged 2 to 5 years old. The primary carer (mother in all cases) had given written consent for their child to participate, and subsequently volunteered to complete the questionnaire. There were 22 girls and 6 boys. The children were recruited from two local nurseries and a dance school, with consent from the head teachers also given. Participants are predominantly from middle class backgrounds. For the purposes of the study, 7 children who were under three years old were excluded from the sample because these children were too young to fully engage with the tasks and answered none of the false belief questions correctly. The final sample consisted of 21 children (17 girls and 4 boys). In terms of sibling constellation, group 1 consisted of children with no siblings, including 4 children (19%). Group 2 consisted of 10 children (47.6%) who had at least one older sibling only. Group 3 consisted of 1 child (4.8%) who had both an older and younger sibling. Group 4 consisted of 6 children (28.6%) who had at least one younger sibling only. In terms of mother's education, 8 of the mothers (38.1%) had completed GCSE's, 5 of the mothers (23.8%) had also completed university and 4 had completed postgraduate degrees (19%). One mother failed to provide details of her education. Mother's age at birth ranged from 20-39 years.

Materials and Measures

An experimental design was used. Measures included a language ability test, two tests of EF, two TOM tests, and a background questionnaire, as described in detail below.

Language

The British Picture Vocabulary Scale – Second Edition

(BPVS II; Dunn, Dunn, Whetton & Burley, 1997) was administered following the standard protocol. The child started with a training plate, and was asked to look at four different pictures on a page. They were told by the experimenter "I will say something, then I want you to put your finger on the picture of what I have said". If the child responded correctly, they continued to a second training plate. After completing the second training plate, the test items began. If the child responded incorrectly to either training plate a or b, they were corrected and asked to try again until the response was correct. Each set contained 12 items, if the child scored 8 or more responses incorrectly in a set of 12 items the test was stopped. Raw scores used for analysis were calculated subtracting the number of errors from the ceiling item.

Executive Function

Two executive functioning tasks were administered to measure inhibition;

Dimensional change card sort task (DCCS)

Following Frye, Zelazo & Palfai (1995). The experimenter presented the child with 3 boxes, on the front of each box there was picture of a red horse, a blue fish and a yellow bird. The child was told, "We are going to play a colour game. In this game, all the red ones go to the red box, all the blue ones go to the blue box and all the yellow ones go to the yellow box". They had to sort 9 cards into one of the 3 boxes. The cards to be sorted had different colour and animal combinations than the cards on the front of the boxes. If the child placed the cards incorrectly, they were corrected and told where the card should have gone. Following 9 colour trials, the child was then told, "Now we are going to play a new game, the animal game. The animal game is different: all the horses go to the horse box, all the fish go to the fish box and all the birds go to the bird box". The child then had to sort the cards according to the new rules. There were 9 test trials. The child was not told whether a card was placed correctly, however every time a card had been sorted incorrectly, the experimenter repeated the post-switch rules. The child received one point for each correct card in the post-switch trial (animal game) (max 9 points).

Day and Night task. (Gerstadt, Hong & Diamond, 1994).

The experimenter showed the child a picture of a sun and a moon. They were told the sun is 'day' and the moon is 'night'. They were then asked to say them the wrong way round, so when they saw a picture of the sun they should have answered 'night', and when they saw a picture of the moon they should have answered 'day'. The child was given two practice questions, if they answered incorrectly the rules and practice trials were repeated. If the child answered the practice trials correctly, the 16 test trials could begin. During the test trials, the experimenter was not allowed to correct the child if they gave an incorrect answer. They were scored one point for each correct response (max 16 points).

An EF composite was calculated by adding the DCCS task and the Day and Night task together; this final score was used for analysis. Total maximum score was 25.

Theory of Mind

Two TOM tasks were administered:

Unexpected Transfer Task

This was adapted from Wimmer & Perner's (1983) study. Two boxes were placed in front of the child in the middle of the table, and they were asked to put the lids on the boxes. The experimenter introduced a doll, and told the child, "This is Harry, and he is playing with the ball". The child was then told that Harry then got tired and put the ball in a red box and is then put into a small bag to sleep. The child was told, "He can't hear us and he can't see us". The experimenter then introduced a second doll called Tom; he found the ball in the red box and played with it. The child was then told that Tom then got tired and then put the ball away in the blue box and is then put in a different bag to sleep. Harry then woke up from his nap and wanted to play with the ball. The child was reminded that "Harry did not hear or see anything" The child was asked a belief question "Where will Harry look first?" and a justification question "Why will he look there first?" and two control questions. "Where did Harry put the ball in the beginning?" and "Where is the ball now?" Test scores were only credited if the control questions were answered correctly. The child scored one point for the belief question and if correct, one point for the justification question, thus the maximum they could have scored was 2. Correct justifications referred to the original location of the ball or to Harry thinking the ball had not moved or had not seen it moved.

Unexpected Contents Task

In this task from Perner, Leekam & Wimmer (1987). The experimenter introduced the child to a doll called Sally. Sally was then put into a bag, the child was told "Sally cannot see or hear anything" The experimenter then showed the child a 'smarties' box and then asked them what they thought was inside (The child must have correctly guessed smarties, and if they were unable to answer smarties or sweets then the test was abandoned). After the child guessed smarties the child was then shown that in fact there were pencils inside the smarties box. The box was then closed. The child was then asked "So do you remember what's in here?" (If the child answered incorrectly, after the box was opened again and showing them what was inside, the test was abandoned). The child was then asked a 'self belief' question "When I first showed you this box, all closed up like this, what did you first think was in there?" Then the experimenter took Sally out from the bag. The child was reminded that Sally did not hear or see anything, and was then asked another belief question "What does Sally think is inside the box?" (If the child did not answer, the experimenter gave a forced choice and asked "Will Sally say there are smarties or pencils in the box?"). Finally, the child was asked "Why does Sally think there are smarties/pencils in there?" The child received one point for 'self belief' question and one point for 'other belief' question. Plus one point for a correct answer to the justification question if the 'other belief' question was correct. The maximum total score was 3. Correct justifications referred to the box's misleading appearance.

A TOM composite was calculated by adding the unexpected transfer task and the unexpected contents task together; this final score was used for analysis. Total maximum score was 5.

Family background

A questionnaire was given to each of the child's parent to collect information about the child's family background. Questions about the child's siblings included: number of siblings, age of siblings and quality of their relationships. Mothers had to rate the quality of sibling relationships on a 10-point scale, ranging from 1 (never) to 10 (always). Mothers were asked "How often in general does he/she play with each sibling?" and "How often in general does he/she argue with each sibling?" The questionnaire also contained questions relating to social economic status, such as parents education and occupations.

Procedure

The child assessments took place in either a quiet part in of the nursery school or hall. Every child was tested individually. The 7 practical tests were divided into two sessions, to ensure the sessions were not tiring for the children. Two groups were manufactured so that one group completed Session A tasks first, and the other group completed Session B tasks first. Within each group half of the children completed the tasks in one order, and the other half of the children completed the tasks in the opposite order. Both sessions took no longer than 9 minutes to complete.

All of the children had a familiar face present so they did not feel uncomfortable during any point of the study; this was usually one of the nursery workers. The children only took part if they wished to; they were not forced to do so. Each child received a sticker as a reward for participating. No deception occurred in this study; all of the information about the study was included in consent form. Initially the data was not made anonymous, as testing involved two test sessions so it was necessary to identify children. However, data was handled confidentially, with each child allocated an ID number. The names of the children were never stored alongside the scores on the tasks; they were kept on an electronic spread sheet, which could only be identifiable by ID number. A separate, password protected document contained the list participants' names alongside their ID numbers. The consent letter informed parents that they were allowed to withdraw their consent from the study at any time without a given reason; and they could do so by contacting the experimenter or the supervisor.

The psychological risks were low because the tasks undertaken by the children were not invasive in anyway. All of the children enjoyed the tasks and are typical of the types of tasks the children undertake at nursery. If the child seemed to be under any stress at all during the tasks the study would have been stop immediately, however this was not the case for any of the children in this sample.

Results

Descriptive information and preliminary analysis

Table 1
Children's Performance on TOM, EF and BPVS

	All ages	2 years old	3 years old	4 years old	5 years old
N	N = 28	N = 7	N =13	N = 6	N = 2
Mean age years (SD)	3.46(0.90)	2.49(0.33)	3.31 (0.19)	4.23 (0.28)	5.60 (0.42)
Mean TOM (SD)	1.79(1.52)	0.14(.38)	1 (1.08)	2.17 (1.94)	3 (2.83)
Mean EF (SD)	11.54(9.25)	6.14(9.20)	10.31 (7.31)	16 (9.55)	25 (.00)
Mean BVPS (SD)	38.29(14.34)	25.90(8.50)	35.77 (7.13)	53 (17.44)	54 (5.66)

Note: TOM = Theory of Mind; EF = Executive Function; BPVS = British Picture Vocabulary Scale.

Table 1 shows all the children's mean scores on TOM, EF and language tasks. As expected from previous findings, TOM scores are strongly correlated with age, r (28) = .613, p < .001. This shows that the children in this sample are developing their false belief understanding with age. Children who were younger than three years old were excluded from further analysis because they failed to pass TOM tasks. Before testing the hypothesis the siblings were split into four groups: Group 1 consisted of children who do not have any siblings; Group 2 consisted of children with older siblings only; Group 3 consisted of children with both younger and older siblings; and group 4 consisted of children with younger siblings only. Replicating McAlister and Petersons (2006) analysis, the four sibling groups were tested to see if any variables would co-found the analysis of sibling effects on TOM and EF. Results showed no significant differences among the sibling constellation groups in age, F (3, 17) = 1.49, p > .05, in language, F (3, 17) = .64, p > .05, nor SES composite, F (3, 17) = 1.99, p > .05. Thus any differences found in TOM and EF scores would not be directly affected by these variables when specifically looking at sibling groups. However the sample sizes varied greatly in the different sibling constellation groups, therefore ANCOVAs were carried out with age in months entered as a covariate.

TOM scores and siblings

To test whether child siblings benefit TOM development, one-way ANCOVAs were conducted. The analysis directly replicated McAlister and Peterson's (2006) study, however they fail to report the exact method of statistical analysis they used. Therefore even though some of the tests differ they serve the same purpose. In all of

the ANCOVA tests, age in months was entered as a covariate to control the varied age ranges in the different sibling constellation groups. Firstly, we tested Peterson's (2000) hypothesis that children with at least one sibling have more advanced TOM than children without siblings. This was tested by a one-way ANCOVA helmert contrast comparing group 1's scores with the rest of the sample. The result was non significant (M^{diff} = -.25, p = .76). The overall contrast was also non significant, f (3, 23) = 5.13, p = .67. This suggests children in this sample with no siblings were not worse off in their TOM development than children with at least one sibling. To test the next hypothesis the groups were re-coded. Ruffman et al. (1998) suggest that those children with older siblings have earlier false belief understanding than children with younger siblings. To test this, a one-way ANCOVA helmert contrast was conducted between groups 2 and 3 combined (children with older siblings) versus groups 1 and 4 (children without older siblings). Age in months was entered as a covariate. The result was non-significant, (M^{diff} = -.21, p = .67). The overall contrast was also non significant, f (1, 25) = 1.83, p = .67. Lastly, we tested Perner et al.'s (1994) hypothesis that children with two or more siblings were twice as likely to pass false belief tasks than children with only one sibling. After re-coding the groups, this was also tested by a one-way ANCOVA helmert contrast comparing group 3 with group 2 and 4 combined. The result was non significant (M^{diff} = -.98, p = .46). The overall contrast was non significant, f (3, 25) = 5.13, p = .68.

Overall, children in this sample who did not have any siblings did not differ on TOM scores compared to children with siblings. Furthermore there were no significant differences between the different sibling constellation groups in TOM development. These findings do not support the previous literature, more importantly they do not replicate McAlister and Petersons (2006) findings that children without siblings were less advanced in TOM development compared to children with siblings.

Table 2
Children's Performance on TOM, EF and Language in Different Sibling Constellation Groups, and Parent SES Composite

Group	1. No child siblings	2. Has old child sibling(s) only	3. Has younger and older child siblings	4. Has younger child sibling(s) only
Group size	4	10	1	6
Mean age (SD)	3.40 (0.12)	4.13 (0.95)	3.10	3.60 (0.49)
Mean SES (SD)	2.06 (1.13)	3.63 (1.38)	5	3.67 (1.38)
Mean TOM (SD)	0.75 (0.96)	1.80 (1.99)	.0	1.83 (1.17)
Mean EF (SD)	8.25 (9.50)	16.2 (9.16)	8	12.83 (7.60)
Mean BPVS(SD)	35.5 (9.26)	45.3 (16.06)	33	43.83 (12.04)

Note: SES = Social Economic Status; TOM = Theory of Mind; EF = Executive Function; BPVS = British Picture Vocabulary Scale.

EF scores and siblings

Table 2 summarizes children's TOM, EF and language ability scores in their different sibling constellation groups. McAlister and Peterson (2006) also tested whether having a child sibling would influence EF scores. Firstly following their procedure, a

one-way ANCOVA helmert contrast was tested between group 1 (children without siblings) versus group 2, 3 and 4 (children who had at least one sibling) combined. Age in months was entered as a covariate. The result was non significant (M^{diff} = -3.38, p = .49). The overall contrast was also non significant, f (3, 23) = .48, p = .70.), hence children with siblings do not perform any better on EF tasks than children without siblings. McAlister and Peterson (2006) also looked at the presence of an older sibling. This was tested on re-coded groups using a one-way ANCOVA helmert contrast, comparing group 1 and 4 (children with none or younger siblings only) versus group 2 and 3 (children with at least one older sibling). Age in months was entered as a covariate. Likewise, this was non-significant, (M^{diff} = -.92, p = .76). The overall contrast was non significant, f (1, 25) = .10, p = .76.

For the children in this sample, sibling constellation groups did not have higher EF scores than children without siblings. This did not replicate McAlister and Petersons (2006) findings that children with at least one sibling had higher EF scores. Although the different sibling constellation groups were unequal in sample sizes, age was entered as a covariate as a control.

Correlations of TOM and EF with sibling variables

Table 3 shows simple bivariate correlations between TOM, EF and other key variables. As expected, results supported previous findings of strong positive correlations between children's false belief understanding, EF, age and language ability. There were very high correlations between TOM and EF, r (21) = .68, p < .001, and between TOM and language ability, r (21) = .70, p < .001. Like McAlister and Peterson (2006), when controlling for language ability there was still a significant partial correlation between TOM and EF, r (18) = .45, p < .05. When additionally controlling for age the relationship between EF and TOM was marginally significant, p = .06. Interestingly the partial correlation coefficient is still very nearly as large (r = .44), so the addition of age as a control did not make a difference to the magnitude of the correlation. Further analysis investigated the relationship between TOM and language ability when controlling for EF. Results show a marginally significant yet positive partial correlation, r (17) = .44, p = .06, between TOM and language ability, controlling for EF. This shows that both EF and language ability contribute to TOM development. The correlation coefficient is comparable in magnitude to that found by other investigators in research with a bigger sample, therefore the lack of significant findings is most likely due to statistical power. Although some findings were non significant, they must be taken with caution due to the small sample in this study.

Table 3
Correlations among children's TOM scores, EF scores, language ability and sibling measures

Variable	1	2	3	4	5	6	7	8
1. TOM composite	-	.51*	.68**	.70**	.22	.24	.29	-.09
2. Age		-	.57**	.66**	.33	.24	.22	.09
3. EF composite			-	.62**	.39	.29	.15	-.19
4. BPVS				-	.13	.25	.20	-.13
5. No of siblings					-	.78**	.16	.11
6. Presence of sibling						-	-	-
7. Play frequency							-	.24
8. Argue frequency								-

Note: TOM = Theory of Mind; EF = Executive Function; BPVS = British Picture Vocabulary Scale * denotes significant at p < .05 (two-tailed), ** at p <. 01 (two-tailed).

In line with ANOVA results, TOM scores were not significantly correlated with number of siblings, r (21) = .22, p > .05, or the presence of at least one sibling, r (21) = .24, p > .05. This was still true when controlling for language ability and age. Similarly, EF scores were not significantly correlated with the presence of at least one sibling r (18) = .17, p > .05 when controlling for language. However EF scores were correlated with number of siblings when controlling for language, r = .41, although this failed to reach significance (p = .08). The partial correlation coefficient was larger than McAlister and Petersons (2006) findings. When additionally controlling for age, the correlation was not as large (r = .35). Supplementary analysis investigated the relationship between TOM and quality of sibling relationships. No relationship was found between TOM and sibling play frequency, r (17) = .29, p > .05, nor between TOM and sibling argue frequency, r (17) = -.09, p > .05. This remained the same when controlling for language and age.

Overall these results supported McAlisters and Petersons (2006) findings who found a significant correlation between TOM and EF controlling for language, but failed to reach significance when controlling for age. Although because the partial correlation coefficient is still very nearly as large, had this been a bigger sample it may have been significant. Furthermore, results show that neither number of siblings or the presence of at least one sibling benefit TOM scores. The quality of sibling relationships also was not significantly related to TOM. Finally EF scores were correlated with number of siblings, yet the relationship was not significant.

Hierarchical multiple regression

A series of hierarchical multiple regression analyses were carried out in order to examine independent predictors of TOM and EF, though results of these analyses should be interpreted with caution given the very small sample. Replicating McAlister and Petersons (2006) study, the first set of analyses used TOM as a dependent variable (DV), age and language were entered at step 1 in each analysis as a

control. For the first analysis, presence of at least one sibling was entered second, and EF was entered at the final step. When all variables were entered into the equation, the regression was significant, $F(4, 16) = 5.72$, $p < .01$. Age and language, entered at the first step, accounted for 43% of the variance in TOM (*Adj* $R^2 = .43$, $F(2, 18) = 8.6$, $p < .01$). The inclusion of presence of at least one sibling at step 2 did not exclusively account for any additional variance, R^2 (change) = .00, F (change) = .12, $p > .05$. EF, entered at the final step, accounted for a marginally significant 10 % of variance in TOM scores, R^2 (change) = .10, F (change) = 3.70, $p = .07$). This model shows that having child siblings does not predict TOM, over an above age and language. However, EF abilities did account for unique variance in TOM scores, even when entered last in the equation, and after age and language, though this effect failed to reach significance.

For the second analysis, number of siblings was entered at step 2, and EF was entered at the final step. Results were virtually identical to the previous regression analysis. Number of siblings did not exclusively account for any additional variance difference in TOM R^2 (change) = .00, F (change) = .00, $p > .05$. EF, entered at the final step, accounted for a further 10 % of the variance beyond age and language, though this effect was only marginally significant, R^2(change) = .10, F (change) = 4.07, $p = .06$. Overall, these regression findings are in line with ANCOVA results that having child siblings in this sample does not predict TOM. However EF abilities did account for unique variance in TOM scores over an above age and language. These results therefore do not replicate McAlister and Petersons (2006) findings that the presence of at least one child sibling uniquely predicted TOM.

A third set of analyses used EF as the dependent variable. Age and language were entered at step 1, number of siblings was entered second, and TOM was entered at the final step. When all variables were entered into the equation the regression was significant, $F(4, 16) = 5.61$, $p < .005$. Age and language, entered at the first step, accounted for 36 % of the variance in EF, *Adj* $R^2 = .37$, $F(2, 18) = 6.76$, $p < .05$. The inclusion of number of siblings at step 2 accounted for 6% of the variance, R^2 (change) = .07, F (change) = 2.34, $p > .05$. Though this failed to reach significance. TOM, entered at the final step accounted for 8% of the variance in EF, R^2 (change) = .09, F (change) = 3.30, $p > .05$. This also failed to reach significance. This model shows that number of child siblings did account for unique variance in EF scores, even when entered after age and language, though this effect failed to reach significant. However number of child siblings did not predict EF, over an above TOM. A similar results was found with McAlister and Peterson (2006) study.

A final multiple regression was conducted in order to compare the degree to which EF and language account for variance in TOM. TOM scores were the dependent variable (DV), age was entered at step 1 as a control variable. EF was entered second, and language was entered at the final step. When all the variables were entered into the equation the regression was significant, $F(3, 17) = 8.10$, $p < .001$. Age, entered at the first step accounted for 21% variance in TOM, *Adj* $R^2 = .23$, $F(1, 19) = 6.60$, p < .05. The inclusion of EF accounted for significant 23% of unique variance, R^2 (change) = .23, F (change) = 8.11, $p < .05$. Language, entered at the final step accounted for marginally significant 10% of unique variance in TOM, R^2 (change) = .10, $p = .06$. The final model accounted for 51% variance in TOM (Adj $R^2 = .52$). This model shows that language and EF both account for unique variance in

TOM scores. Due to the small sample, we were unable to distinguish between their relative importance in accounting for TOM.

Discussion

The first aim of this study was to replicate the findings of McAlister and Peterson (2006), who found the presence of at least one child sibling in the home offers earlier false belief understanding and benefits EF skills. This study was unable to replicate these findings. However, the study found a positive correlation between EF and number of child siblings. The second aim of this study was to replicate McAlister and Petersons (2006) partial correlation between TOM and EF, controlling for language ability. This study examined whether the correlation remained significant when controlling for age and language ability. The study found a non-significant yet positive partial correlation between TOM and EF. The third aim of the study was to examine whether there was a relationship between quality of sibling relationships and TOM, and no such association was found. The final aim of this study was to examine the independent contributions of EF and language to TOM. Hierarchical regression analysis showed that language and EF are both independently important to TOM.

The study did not replicate findings from McAlister and Peterson (2006) who found the presence of at least one child sibling uniquely predicted TOM. The results are more in line with those of Cole and Mitchell (2000), and Hughes and Ensor (2005), who did not find an association between child siblings and TOM. However these studies used a restricted sample, in the fact they had lower-class sample. This investigation was able to replicate their findings with a middle-class sample and therefore give support to the results reported by Cole and Mitchell (1999), and Hughes and Ensor (2005). Overall the study found no evidence that number of siblings, ages, and sibling position benefitted TOM scores in the children in this sample. However the study was able to replicate the findings from McAlister and Peterson (2006) who found an association between EF and number of siblings when controlling for age and language, though this failed to reach significance. Still, number of siblings did not predict variability in EF scores over an above the contribution of TOM. As postulated by McAlister and Peterson (2006), number of child siblings could be of benefit to EF skills. They suggested children who interact with several siblings at once, require complex cognitive proficiencies and the ability to interrelate and shift attention to more than one sibling at any given time. Additionally, when children play together it requires inhibitory control to take turns effectively. Similarly, Hughes and Ensor (2005) have also suggested play with siblings can further develop cognitive skills required for EF ability. Future research would be of value to establish whether number of siblings has added benefit to EF skills with a larger sample size. It would also be interesting to determine the exact number of siblings that is required to benefit EF skills.

The second aim of the study was to replicate McAlister and Peterson's (2006) finding of a relationship between TOM and EF. When controlling for language in isolation, the coefficient reported here was in fact larger in magnitude than in McAlister and Peterson's (2006) findings. However, when additionally controlling for age, we found that the relationship between TOM and EF was non-significant, although it is likely due to the small sample size. It would be reasonable to argue that this study has

then therefore successfully replicated McAlister and Petersons (2006) findings. This association has been presented throughout the literature (Carlson & Moses, 2001; Hughes & Ensor, 2005).

The third aim of the study was to examine the relationship between quality of sibling relationships and TOM. Correlation results did not support findings from Hughes and Ensor (2005), this study found no association between quality of sibling relationships and TOM. This result could have been because the data that was collected was not sufficient enough to accurately reflect the quality of sibling relationships. Simply having a 0-10 scale does not shed much light on sibling interaction, types of play, and their level of affection for one-another. In addition a 0-10 scale is a subjective measure. Parents will have different interpretations of the scale, but also they may not be as aware of the children's relationship as the siblings themselves. A more reliable method could measure the quality of sibling relationships using covert observations, with the experimenter's interpretation as the limiting factor. Unfortunately due to time and resource constraints this was unachievable in this study.

The final aim of the study was to examine the extent of the independent contributions of EF and language on TOM. Results from this study showed a very strong positive correlation of .68 between EF and TOM, and a correlation of .70 between language and TOM. A hierarchical multiple regression analysis showed that overall, age, EF, and language accounted for 51% of variance in TOM scores. It appears that both EF and language ability are both independently important predictors of TOM. Due to the sample size we were unable to distinguish their independent relative importance. Future research should examine the individual contributions of EF and language ability on TOM with a larger sample.

The children in this sample who were younger than three years of age (N = 7) were too young to fully engage with the tasks and answered none of the false belief questions correctly. Because they were at floor with the tasks they were excluded from further analysis. Nevertheless, this is an important finding because it replicates the majority of studies who have shown children begin to develop theory of mind between the ages of 3-5 years old (Wellmann, Cross & Watson, 2001).

Despite the study successfully satisfying its aims there are a number of limiting factors that could improve the robustness of the results, and further add value to the investigation. One such factor that impacts TOM development is the input from parents. Parenting is an exogenous variable, with the mother usually acting as the primary caregiver. Through listening to their mother's language and conversations with the child about different mental states and feelings, children show a greater awareness of TOM (Dunn, 1996; Ruffman, Slade & Crowe, 2002). The present study did not measure the influence of parenting. Hughes and Ensor (2005) who did explore this aspect measured positive parenting through variables such as responsiveness. However, they found positive parenting was not as strong predictor as was sibling relations for children's TOM development. Still, had parenting factors been tested in this study it could have added an insightful layer replicating previous studies.

A further limitation to this study is the very small sample size. Initially the study aimed to collect 50-70 participants, however the parental response to the study was extremely low. Therefore this limits the investigations ability to generalise findings and has also reduced the likelihood of a statistically significant result. When interpreting descriptive statistics, it was important to look beyond significance levels and focus on the strength of the correlations. Statistical power may therefore have served to enhance the reliability of the investigation.

The sample may also be called into question for it's over representation of girls in the sample. However the literature suggests that gender differences are not apparent in TOM development (Jenkins & Astington, 1996). This may limit the research in its scope for generalisation throughout the population. Unfortunately due to the low response rate the investigation could be too particular about the sample.

Another possible limitation regarding the sample was apparent when categorising the participants into sibling groups. Although age was entered as a covariate in the ANCOVAs to control for the varied ages in the different sibling constellation groups, group 3 (participant had both older and younger siblings) only consisted of one participant. This made comparisons using one-way ANCOVAs less reliable. Group 3 was also less representative of the population as a result. An improvement would therefore be to collect a sample with an equal number of participants in each category.

The validity of the methodology is an additional factor for improvement. The tasks administered with the children took part over a two-day period; this may have altered the continuity of the children's behaviour. This has possibly reduced the investigations internal consistency. However an ethical decision had to be made between the child's fatigue effects and day-to-day behavioural differences. In addition, due to the volume of tasks being administered splitting the experiment over two days was deemed most appropriate.

This study was based upon replicating McAlister and Petersons (2006) study. Their sample specifically included child siblings aged from 1-12 years old. The literature has argued siblings younger than one years old and siblings older than 12 years old will not be of any benefit to TOM development (Peterson, 2000). This study however included two child siblings younger than 1 year of age, and three child siblings over 12 years of age. Any insignificant findings may therefore be due to the inclusion of siblings beyond the age range suggested by McAlister and Peterson (2006). Due to a limited sample this study could not be too particular about participants. Had the study been able to exclude siblings not within their age range, the findings may have been different and more robust as a result.

Despite these limitations the study did achieve its aims. Results from this study were unable to replicate the findings of McAlister and Peterson (2006), who found the presence of at least one child sibling benefits TOM and EF skills. However these results make an important finding of how number of child siblings benefit EF performance. Language and EF were both highly important predictors of TOM. Sibling relationship quality was not a significant predictor of TOM. This study has demonstrated the impact number of siblings have on children's cognitive development.

In addition to these key findings, the investigation has also highlighted areas that will benefit from further research. Future exploration may consider using a longitudinal approach with observational assessments, in order to measure sibling relationship quality directly. This study has shown number of siblings are of benefit to EF, but it does not explain to what extent, and how they are of benefit. Further research should aim to examine this in more detail. The study has also shown the strong association between TOM and EF, yet the causality of the link remains unknown. Longitudinal research could examine the expression and emergence accounts of EF on TOM. Expression accounts suggest children already have EF skills required to pass TOM tasks, yet they are unable to express their knowledge in practical terms. This brings into question the child's language abilities. Manipulating the demands of EF required for TOM tasks could test this. Conversely, emergence accounts indicate that children need to acquire EF skills before they can pass TOM tasks. Once causality has been established, children may be able to benefit if this can be applied to learning resources.

References

Baron-Cohen, S. (1994). How to build a baby that can read minds: Cognitive mechanisms in mindreading. *Current Psychology of Cognition*, *13*(5), 513-55.

Carlson, S. M., & Moses, L. J. (2001). Individual Differences in Inhibitory Control and Children's Theory of Mind. *Child Development, 72*(4), 1032-1053.

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How Specific is the Relation between Executive Function and Theory of Mind? Contributions of Inhibitory Control and Working Memory. *Infant and Child Development, 11*(2), 73-92.

Carlson, S. M., Moses, L. J., & Claxton, L. J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87*(4), 299–331.

Carlson, S. M., Moses, L. J., & Hix, H. R. (1998). The Role of Inhibitory Processes in Young Children's Difficulties with Deception and False Belief. *Child Development, 69*(3), 672-691.

Cole, K., & Mitchell, P. (2000). Siblings in the development of executive control and a theory of mind. *British Journal of Developmental Psychology, 18*(2), 279-295.

Cutting, A. L., & Dunn, J. (2006). Conversations with siblings and with friends: Links between relationship quality and social understanding. *British Journal of Developmental Psychology, 24*(1), 73-87.

Dunn, J. (1996). The Emanuel Miller Memorial Lecture: 1995 Children's Relationships: Bridging the Divide Between Cognitive and Social Development. *Journal of Child Psychology and Psychiatry, 37*(5), 507 –518.

Dunn, J., Brown, J., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young Children's Understanding of Other People's Feelings and Beliefs: Individual Differences and Their Antecedents. *Child Development, 62*(6), 1352-1366.

Dunn, L., Dunn, L., Whetton, C., & Burley, J. (1997). British Picture Vocabulary Scale (2nd Ed). Windsor: NFER-Nelson.

Flavell, J. H., Miller, P. H., & Miller, S. A. (2002). *Cognitive development, 4th edition*. Upper Saddle River, NJ: Prentice Hall.

Flynn, E., O'Malley, C., & Wood, D. (2004). A longitudinal, microgenetic study of the emergence of false belief understanding and inhibition skills. *Developmental Science, 7*(1), 103-115.

Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule-based reasoning. *Cognitive development, 10*(4), 483-527.

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*(1), 31–60.

Gestadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3.5-7 years old on a Stroop-like day-night test. *Cognition, 53*, 129-153.

Hughes, C. (1998). Executive function in preschoolers: Links with theory of mind and verbal ability. *British Journal of Developmental Psychology, 16*(2), 233-253.

Hughes, C., & Ensor, R. (2005). Executive function and theory of mind in 2 year olds: a family affair? *Developmental Neuropsychology, 28*(2), 645-668.

Hughes, C., & Ensor, R. (2007). Executive function and theory of mind: Predictive relations from ages 2 to 4. *Developmental Psychology, 43*(6), 1447–1459.

Jenkins, J. M., & Astington, J. W. (1996). Cognitive factors and family structure associated with theory of mind development in young children. *Developmental Psychology, 32*(1), 70-78.

Joseph, R. M., & Tager-Flusberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Development and Psychopathology, 16*(1), 137-155.

Lang, B., & Perner, J. (2002). Understanding of intention and false belief and the development of self-control. *British Journal of Developmental Psychology, 20*(1), 67-76.

Lewis, C., Freeman, N. H., Kyriakidou, C., Maridaki-Kassotaki, K., & Berridge, D. M. (1996). Social Influences on False Belief Access: Specific Sibling Influences or General Apprenticeship? *Child Development, 67*(6), 2930-2947.

McAlister, A., & Peterson, C. C. (2006). Mental playmates: Siblings, executive functioning and theory of mind. *British Journal of Developmental Psychology, 24*(4), 733-751.

McAlister, A., & Peterson, C. C. (2007). A longitudinal study of child siblings and theory of mind development. *Cognitive Development, 22*(2), 258-270.

Milligan, K., Astington, J. W., & Dack, L. A. (2007). Language and Theory of Mind: Meta Analysis of the Relation Between Language Ability and False-belief Understanding. *Child Development, 78*(2), 622-646.

Perner, J. (1998). The meta-intentional nature of executive functions and theory of mind. In P. Carruthers & J. Boucher (Eds.), *Language and thought: Interdisciplinary themes* (pp. 270-283). Cambridge, England: Cambridge University Press.

Perner, J., Leekam, S., & Wimmer, H. (1987). Three-year-olds' difficulty with false belief: The case for conceptual deficit. *British Journal of Developmental Psychology, 5*(2), 225-137.

Perner, J., Ruffman, T., & Leekam, S. R. (1994). Theory of mind is contagious: You catch it from your sibs. *Child Development, 65*(4), 1228-1238.

Peterson, C. C. (2000). Kindred spirits: Influence of siblings' perspectives on theory of mind. *Cognitive Development, 15*(4), 435-455.

Ruffman, T., Perner, J., Naito, M., Parkin, L., & Clements, W. A. (1998). Older (but not younger) siblings facilitate false belief understanding. *Developmental Psychology, 34*(1), 161-174.

Ruffman, T., Slade, L., & Crowe, E. (2002). The Relation between Child and Mothers' Mental State Language and Theory-of-Mind Understanding. *Child Development, 73*(3), 734 -751.

Sabbagh, M. A., Xu, F., Carlson, S. M., Moses, L. J., & Lee, K. (2006). The Development of Executive Functioning and Theory of Mind: A Comparison of Chinese and U.S. Pre-schoolers. *Psychological Science, 17*(1), 74-81.

Schneider, W., Lockl, K., & Fernandez, O. (2005). Interrelationships among theory of mind, executive control, language development, and working memory in young children: A longitudinal analysis. In W. Schneider, R. Schumann-Hengsteler, & B. Sodian (Eds.), *Young children's cognitive development: Interrelationships among executive functioning, working memory, verbal ability, and theory of mind* (pp. 259-284). Mahwah, NJ: Lawrence Erlbaum Associates.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-Analysis of Theory-of-Mind Development: The Truth about False Belief. *Child Development, 72*(3), 655-684.

Wellman, H. M., & Liu, D. (2004). Scaling of Theory-of-Mind Tasks. *Child Development, 75*(2), 523-541.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*(1),103-128.

Wright-Cassidy, K., Fineberg, D. S., Brown, K., & Perkins, A. (2005). Theory of Mind May Be Contagious, but You Don't Catch it From Your Twin. *Child Development, 76*(1), 97-106.