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Research Report

Which are the best predictors of theory of mind delay in children with specific language impairment?

Clara Andrés-Roqueta†, Juan E. Adrian†, Rosa A. Clemente† and Napoleon Katsos‡

†Department of Educational and Developmental Psychology, Universitat Jaume I de Castelló, Castelló de la Plana, Spain
‡Department of Theoretical and Applied Linguistics, University of Cambridge, Cambridge, UK

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Abstract

Background: The relationship between language and theory of mind (ToM) development in participants with specific language impairment (SLI) it is far from clear due to there were differences in study design and methodologies of previous studies.
Aims: This research consisted of an in-depth investigation of ToM delay in children with SLI during the typical period of acquisition, and it studied whether linguistic or information-processing variables were the best predictors of this process. It also took into account whether there were differences in ToM competence due to the degree of pragmatic impairment within the SLI group.
Methods & Procedures: Thirty-one children with SLI (3;5–7;5 years old) and two control groups (age matched and language matched) were assessed with False Belief (FB) tasks, a wide battery of language measures and additional information-processing measures.
Outcomes & Results: The members of the SLI group were less competent than their age-matched peers at solving FB tasks, but they performed similarly to the language-matched group. Regression analysis showed that overall linguistic skills of children with SLI were the best predictor of ToM performance, and especially grammar abilities. No differences between SLI subgroups were found according to their pragmatic level.
Conclusions & Implications: A delay in ToM development in children with SLI around the critical period of acquisition is confirmed more comprehensively, and it is shown to be more strongly related to their general linguistic level than to their age and other information-processing faculties. This finding stresses the importance of early educational and clinical programmes aimed at reducing deleterious effects in later development.

Keywords: theory of mind (ToM), specific language impairment (SLI), pragmatic language impairment (PLI), information processing, language disorder.

What this paper adds?
The study shows that there is a ToM developmental delay in children with SLI around the typical period of acquisition (4–5 years old). Moreover, robust relationships between this delay and the linguistic abilities of children have also been observed. These results have been established by using an adequate clinical sample of children with SLI matched with two control groups by age and by language. In addition, a large battery of language and cognitive tasks has been used to examine such relationships. These findings highlight the need for early intervention programmes.

Introduction

In its simplest definition, Theory of Mind (ToM) is the socio-cognitive competence that enables people to understand and report their own and others' beliefs. This ability is therefore essential to explain and predict people's behaviour and it is also a key factor in children's social competence (Astington 1993). It is commonly agreed that children start to distinguish between these mental representations and reality between the fourth and fifth years of life and this competence has usually been tested with the classic false belief (FB) tasks:

Address correspondence to: Clara Andrés-Roqueta, Department of Educational and Developmental Psychology, Universitat Jaume I de Castelló, Av. Sos Baynat, s/n, 12071, Castelló de la Plana, Spain; e-mail: candres@uji.es

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Unexpected Content (Perner *et al.* 1987) and Change of Location (Wimmer and Perner 1983). These FB tasks were designed to assess whether children were able to predict and explain the behaviour of a character based on the comprehension of their beliefs. Later, at the age of about 7 years, children start to become aware not only of the fact that people have FBs about the world, but also that they have beliefs about the content of others' beliefs. Such beliefs about beliefs are called second-order beliefs (Perner and Wimmer 1985). To date, although the field of ToM research has increased notably in terms of topics of interest (e.g. emotional understanding), FB understanding has been assumed to be a key milestone in social cognition development. There is a large fertile body of research that has documented an important correlation between the development of linguistic competence, successful performance in ToM tasks and chronological age (e.g. Astington and Jenkins 1999, Wellman *et al.* 2001). Specifically, several studies have attempted to establish the directionality of the relationship between ToM and certain aspects of natural language development—generally grammar, semantics and pragmatics (for a review, see Milligan *et al.* 2007). In fact, intervention studies with preschoolers have shown that training methods based on sentential complements improve later theory of mind skills (e.g. Hale and Tager Flusberg 2003). In this sense, revealing the extent and direction of the relation between language and ToM is a central issue in developmental psychology and cognitive science because it can reveal important aspects of the architecture of the mind. It could also have direct implications for educational and clinical programmes that aim to enhance children's respective competencies.

Of course, it is difficult to disentangle the development of language and social–cognitive skills in typically developing children because, on the one hand, they undergo important rapidly occurring changes during the first 5 years of a child's life and, on the other hand, they rely on each other throughout the child's development. For this reason, studies with children with atypical language development are very promising with regard to the study of how language acquisition is related to ToM development. To complicate the picture further, successful performance on such an important cognitive task depends not only on the conceptual understanding required to solve the problem, but also on other non-focal information-processing or executive function capacities (e.g. remembering the key information, focusing attention or choosing the correct answer to give) (Wellman *et al.* 2001). Thus, some studies have suggested that ToM development is also related with capacities other than language (e.g. working memory or control inhibition), yet the nature of the relationship is still unclear during the typical period of acquisition (Hala *et al.* 2003).

Research in this area has focused mainly on children with Autism spectrum disorder (ASD), whose deficits in pretended play, social interaction and communication have been related to severe difficulties in ToM, as an important neural system impairment in the processing of information about mental states (Baron-Cohen 2001). Nevertheless, it has been proved that they can successfully solve FB tasks when they achieve better language competence (Tager-Flusberg and Joseph 2005). However, the atypical language development in autistic children may carry other cognitive impairments (Frith 1992), and they can overlap in the development of ToM before the fifth year of life. Other studies have examined the relationship between ToM and language development in populations of deaf children, with emphasis on the importance of early exposure to language in children's development of understanding of minds (for a review, see Corina and Singleton 2009). In this regard, whereas deaf children born in hearing families (late signers) have a delay in ToM development, deaf children born in deaf families (native signers) do not (e.g. Schick *et al.* 2007).

Hence, and in a similar rationale, populations with specific language impairment (SLI) have been considered a potentially critical group in which to study the role of language in the development of ToM, as their problems are mainly related with structural language development (ruling out sensorial or neural deficits) and consequent poor language opportunities in social interactions. Children with SLI face substantial delays in their linguistic development, but they have an age-appropriate non-verbal IQ (Leonard 1998) and are expected to develop better social interactive skills than the autistic population (Bishop 2000). This normal pattern of non-verbal intelligence and the specificity of their language delay have led several researchers to study ToM skills in SLI in order to demonstrate which aspects of language can be vital for configuring and establishing cognitive processes (e.g. Farrant *et al.* 2006, 2012, Farrar *et al.* 2009). Nevertheless, evidence for the relationships between language and ToM development in children with SLI is still not clear enough (Bishop 2006, Johnston *et al.* 2001).

First, early research into ToM development in children with SLI suggested there was no delay in solving FB tasks (Leslie and Frith 1988, Farmer 2000, Perner *et al.* 1989, Ziatas *et al.* 1998). However, in those studies the children with SLI were too old not to pass ToM tasks, because they were recruited essentially to be used as a 'control' group for children with ASD. In fact, subsequent studies have shown that although around the age of 8 most children with SLI passed first-order FB tasks, they still found it difficult to solve second-order FB tasks that were appropriate to their chronological age (Norbury 2005). In the same way, Botting and

Conti-Ramsden (2008) showed that the performance of a group of 16-year-old adolescents with a history of SLI was still poorer than that of age-matched peers solving complex ToM tasks (e.g. Strange Stories task designed by Happé 1994). Therefore, findings from these two studies suggest that poor language may play an important role in the ToM development of children with SLI.

Eventually, although some works show that at a certain age children with SLI can successfully complete first-order FB tasks without difficulty, they do not reveal whether the children's delayed language development could have led to some degree of delay earlier on during the critical period for passing these tasks (4–5 years old). In this respect, few studies have been conducted on young children with SLI and those that have been carried out offer diverse results. On the one hand, Miller (2001) administered four first-order FB task conditions with varying degrees of linguistic complexity to 10 young children with SLI (4–7 years old). The author found that they were able to solve FB tasks, but only when linguistic complexity was low. On the other hand, it has been shown that children with SLI could have a delay in ToM development due to both their general linguistic deficit (Cassidy and Balluramen 1997) and their consequent limited access to conversations (Farrant *et al.* 2006, 2012).

A second issue is that most of the studies cited above did not use a linguistic level-matched control group to give their results more strength. Miller (2001) did use such a control group, but with a small number of participants. The absence of a control group allows for the possibility of the delay that was registered being due to other deficits present in these children, such as processing capacity limitations, rather than their linguistic level. Recent research has shown that children with SLI also show difficulties in different areas of functioning not restricted to working memory. These may include non-verbal abilities (Conti-Ramsden *et al.* 2012), verbal and spatial information processing (Hoffman and Gillam 2004) or executive function skills and processing capacity (Im-Bolter *et al.* 2006). However, the severity of these problems in relation to their language impairment is still under research. As pointed out by Wellman *et al.* (2001), even though the demand of the task is mainly linguistic and socio-cognitive, children may also need to use other non-verbal and executive function resources they have available to them (e.g. sustain attention, process an amount of verbal and visual material, inhibit what they know about reality, etc.). In this sense, if children with SLI have fewer cognitive resources, their performance in FB tasks is likely to be affected. As claimed by Bishop (2006), it would be important to understand whether other aspects of cognitive processing help to account for part of the explained variance in performing FB tasks, as they have been shown to be important in attributing FB to a third person in typical developing children (e.g. Hala *et al.* 2003). Therefore, analysing the role of language in children's development of ToM is not as simple as it might seem in populations with SLI (Hughes 2011).

Moreover, research does not give a clear answer as regards to which aspects of linguistic competence of children with SLI predict success in solving FB tasks. Hence, whereas Cassidy and Balluramen (1997) found that syntactic (but not semantic) competence predicted success in the task, Farrar *et al.* (2009) found that both grammatical and semantic capacities were significant in a more representative sample of children with SLI. However, in both cases, only expressive competence was tested and semantic skill was assessed exclusively on vocabulary. In contrast, de Villiers *et al.* (2003) found that the understanding of complement clauses and turn-taking abilities in communication were better predictors than the subjects' other morphosyntactic skills. However, as pointed out by Farrar *et al.* (2009), these conclusions were drawn on the basis of a single item involving complement clauses and no semantic items were included. There is thus a need for a more comprehensive study of all the levels of language potentially involved in success/failure in ToM tasks, from the syntactic domain to lexical, semantic and pragmatic aspects, and without restricting the study to just expressive or receptive competence.

A third issue in the existing literature is that many of the studies have taken SLI as a coherent and homogenous disorder, with all children in the group presenting a similar profile of SLI impairment, maybe because they had problems in obtaining the resources to recruit larger samples. However, SLI is not a homogeneous disorder and the existence of a pragmatic subtype (pragmatic language impairment (PLI) without autistic features) has been proposed (Adams 2001, Bishop 2000). These children tend to be talkative and verbose, to run up against problems when it comes to producing and comprehending connected conversation (most of the time by being over-literal) and/or to give socially inappropriate responses. There is an ongoing debate as to whether these children with reduced pragmatic skills might be better described as having ASD. However, studies assessing this population have stated that it is possible to make a differential diagnosis within children with SLI by using only pragmatic measures, as they share a structural language-delayed profile (e.g. Adams and Bishop 1989, Botting and Conti-Ramsden 2003).

In this respect, Shields *et al.* (1996) broke new ground by studying the mental state abilities of children with a specific subtype of language delay, semantic–pragmatic disorder (SPD), and comparing them to a group of children with ASD, a group with phonological–syntactic SLI and a control group. The authors concluded that the SPD group behaved in a similar way to the autistic participants, failing on the FB tasks, whereas the phonetic–syntactic SLI group behaved in a similar manner to their age-matched peers and performed successfully. Such findings have led other authors to hypothesize that SPD lies on the 'borderlands' of ASD, with a behaviour in mental state tasks that is very similar to that of a group of participants with Asperger's syndrome (Ziatas *et al.* 1998). However, the study by Shields *et al.* (1996) lacked both clear criteria for defining SPD (where some autistic participants could have been recruited) and also suitable diagnostic instruments for objectively documenting the overall language deficits; hence, the phonological–syntactic group could also contain participants with other types of language impairment (Bishop 2000). A further limitation of the studies conducted by Shields *et al.* (1996) is that, as in the studies cited earlier, the age range was too old for the children with phonetic–syntactic SLI not to be able to successfully complete the FB task (between 7 and 11 years old). To complicate the picture further, our understanding of semantic–pragmatic disorder seems to be evolving. Currently, it is being reconceptualized as PLI, with an emphasis on communicative rather than lexical–semantic deficits (Bishop 2000). It is worth noting that, to date, no research has addressed the study of FB understanding in young children with SLI with this specific pragmatic impairment.

Based on the previous assumptions, the aim of this research was to provide a more detailed study of the relationships between ToM and language in children with SLI, especially geared towards addressing the three issues outlined above. Accordingly, the following hypotheses were formulated:

- If successful performance in the FB tasks depends on language skills, all participants with SLI could generally be expected to score lower than their age-matched peers with typical linguistic development, thereby showing a certain delay in the acquisition of these faculties in the critical period in which they are usually completed with success. Likewise, if this ToM delay is due to the language level of children with SLI and not to other cognitive aspects related to information processing, a group of typically developing younger children, but who are linguistically matched with SLI children, could be expected to perform the tasks at a similar level.
- Due to the strong relationship between language and ToM (Milligan *et al.* 2007), linguistic variables are expected to be good predictors of performance in FB tasks in the SLI group. However, other non-focal capacities where children with SLI may face problems (e.g. executive function, non-verbal reasoning and information processing) might also explain part of the variance within the group (Wellman *et al.* 2001). An open question concerns which specific linguistic variables would predict FB competence best.
- If the problems in FB tasks are not due to language delays in general, but specifically to difficulties with the use of language in communicative settings (semantic–pragmatic skills), then two clinical groups with different levels of pragmatic skill will display differences in FB tasks.

Method

Participants

Ninety-three Spanish-speaking children participated in this study. They all attended six state-run primary schools located across a range of working to upper-to-middle-class areas in three Spanish cities. All 93 children spoke Spanish as their first language and were native speakers.

The sample was organized into three groups: children with SLI (19 boys and 12 girls; mean age = 5;4, SD = 14.09 months), and two typically developing control groups: one group of 31 chronological age- and gender-matched participants (mean age = 5;4, SD = 13.40 months) and another group of 31 younger participants who were matched by gender and language level (mean age = 4;4, SD = 10.75 months).

SLI group

All the participants with SLI in this study were recruited from Language and Communication Units attached to those six ordinary primary schools. The process used in this study to classify children as having SLI consisted in several different steps:

First, the research group contacted the educational psychologist and speech and language therapist of each school to recruit them and confirm the following criteria: the children (1) were being attended by the speech and language therapist at the time of the study; (2) had a history of language delay in their clinical record; (3) showed significant language disability (in the presence of normal non-verbal intelligence) as their primary reason for having speech and language therapy; (4) had no hearing loss or other neurological impairment, behavioural disorder, or emotional disorders; and (5) and, finally, no medical condition that could affect language was reported in their clinical record (such as a diagnosis of ASD).

Second, in addition to these criteria, inclusion in the SLI group was conditional upon scoring 1 SD below the mean (age level) on either of two standardized grammar measures administered by the researchers: (1)

a Spanish receptive grammar language measure, Comprension de Estructuras Gramaticales (CEG) (Mendoza *et al.* 2005), which is similar in structure to the Test for Reception of Grammar for English (Bishop 1989), and measures the understanding of grammatical structures with sentences of varying length and complexity; and (2) a Spanish expressive grammar measure, Memoria de Frases, which is a subtest of an oral language assessment battery called Evaluacion del Lenguaje Infantil (ELI) (Saborit and Julian 2005), where children are asked to repeat a series of different sentences that get increasingly longer. This measure assesses the child's expressive language ability and short-term auditory memory, a criterion that is considered particularly valid for the diagnosis of SLI (Conti-Ramsden *et al.* 2001). Thus, from a total of 41 potential participants with SLI, only 31 were recruited to become part of the sample after the language assessment carried out by the researchers.

Finally, the Coloured Progressive Matrices test (Raven *et al.* 1998) was administered by the research group to ensure that the non-verbal intelligence of all the children in the SLI group was within the normal range. The 31 participants were seen to present scores within 1 SD of the mean on this test (mean percentile = 71, range = 20–95).

SLI subgroups: cSLI and PLI

The initial SLI group was further divided into two subgroups: a conventional SLI group (cSLI) and an SLI group with predominantly pragmatic-type difficulties (PLI). Children grouped in the PLI sample were those participants within the SLI population who had lower communicative competence in pragmatic-demanding tasks, where it is necessary to use context to understand some language utterances (e.g. understanding figurative language). The criterion for isolating PLI was the presentation of 1 SD below the expected mean for their age in the pragmatics subtest in the ELI battery.

Following these criteria, the initial SLI group was divided into: cSLI subgroup (19 children: 12 boys and seven girls; mean age = 5;4, SD = 15.17 months) and PLI subgroup (12 children: seven boys and five girls; mean age = 5;4, SD = 12.85 months).

Control groups: CA and LA

Finally, two control groups for the SLI group were selected: one matched by gender and age (CA), and another by gender and linguistic level (LA):

- CA: 31 participants with typical linguistic development, being of the same age ± 3 months and being of the same gender.
- LA: each participant with SLI was also matched on the raw score on the receptive language test with a typically developing participant of the same sex.

Moreover, inclusion in the CA and the LA group was also conditional upon having non-verbal IQ abilities within 1 SD of the mean on the Raven Coloured Matrices test (CA: mean percentile = 77, range = 30–95; LA: mean percentile = 79, range = 30–95).

Procedure

All the children were evaluated individually by the researchers during school time in two 40-min sessions. During the first session, the research group administered the selection and matching measures (linguistic and non-verbal intelligence measures). It should be noted that, for some participants in the sample, this session was split into two, depending on how quickly they completed the tasks and how tired they appeared to be. During the second session, the two FB tasks related to the aims of this study were administered, together with the information-processing and executive function measures.

Instruments

Cognitive measures

It has been claimed that children with SLI present difficulties in non-verbal abilities (Conti-Ramsden *et al.* 2012), short-term memory and visual information processing (Hoffman and Gillam 2004) and/or executive function skills (Im-Bolter *et al.* 2006). Indeed, such difficulties could be involved in children's performance on FB tasks (Wellman *et al.* 2001).Therefore, in this study the following scales were included:

Non-verbal reasoning. The general intelligence test from the Raven's Coloured Progressive Matrices scale was administered to have a non-verbal reasoning score for each participant. This test consists of 36 coloured patterns with a piece missing, and children had to select the correct picture (from six options) that best completed a visual analogy. Performance in this test has been related with analogy thinking but also with visual information processing.

Short-term auditory memory and visual–spatial processing. Two subtests from the Kaufman Assessment Battery for Children (Kaufman and Kaufman 1983) were administered to measure sequential and simultaneous processing capacities: Number Recall and Gestalt Closure:

- *Number Recall* subtest, which belongs to the Sequential Processing scale, is considered a measure of short-term auditory memory (Jonsdottir *et al.* 2005). This subtest requires the children to repeat different series of digits (19 items growing in length) in the same order as the one in which they are presented by the examiner. Therefore, it measures the child's short-term memory skills, auditory–vocal fluency ability and the ability to follow a given model.
- *Gestalt Closure*, from the Simultaneous Processing scale, is considered a measure of visual–spatial information processing (visual closure). In this subtest, the children were shown 25 incomplete inkblot pictures and they were asked to name the objects they could recognize in those pictures. Therefore, it requires them to integrate different visual stimuli and synthesize them simultaneously in order to reach the right solution. According to Kaufman and Kaufman (1983), this ability to mentally complete an incomplete picture and name the figures they think they see is also related with organization and perceptual closure (attention to visual and spatial details) and flexibility.

*Executive function: sustained attention and inhibitory skills.*To measure sustained attention and inhibitory skills the Matching Familiar Figures Test (MFFT; Cairns and Cammock 1978) was administered. The MFFT consists of 12 items where the children were shown a picture (it could be a person or an object) and six similar stimuli, but only one is identical to the person/object shown. After two example items, the children were required to pick the picture that was identical to (e.g. matches) the person/object given. There are two main variables of interest: the total number of errors committed until the correct one is found, and the mean latency prior to the first response:

- *Sustained attention measure.* The MFFT requires the child to find the correct picture that matches one selected from six others. Consequently, the examiner counts the number of errors (trials) before the correct option is chosen as a measure of sustained attention. For each of the 12 items, children are allowed to commit eight errors (maximum). Therefore, scores on this measure could range from 0 to 96 (maximum).
- *Response Latency measure*. In each item it is also possible to register the number of seconds the children take to make the first choice (that is, their response latency). This is related with the children's impulsivity and inhibitory skills.

Linguistic measures

A comprehensive battery of receptive and expressive tasks was administered to assess the linguistic profile of the participants:

Grammatical measures. Asexplained in the Participants section, the CEG test was used to evaluate the participants' capacity to understand different types of grammatical sequences (grammatical comprehension), and the Memoria de frases (Sentence Recall) subtest from the ELI battery was used to evaluate grammatical and morphosyntactic expressive skills.

Vocabulary measures. Two vocabulary subscales from ELI were used to assess children's level of expressive (naming objects/people/places) and comprehensive (identifying objects/people/places) vocabulary.

Semantic–pragmatic measures.

- *Semantic measure:* Riddles subtest, from the Kaufman K-ABC battery (Kaufman and Kaufman 1983). This subtest is an advanced semantics task that measures children's skill to integrate auditory stimuli presented sequentially (clues) in order to reach the correct concept. Consequently, it is related with conceptual inference skills and world knowledge.
- *Pragmatic measure:* Pragmatics subscale from the ELI battery, consisting in two types of comprehensive and expressive items related with functional communication. On the one hand, in the case of receptive items the examiner tells the child a sentence and the child must decide if there is a discrepancy between statements and gestures. For example, Examiner: 'Tell me if what I'm saying is true or false in comparison to what I'm doing: I'm washing my face' (and he/she acts as if he/she was brushing his/her hair). On the other hand, expressive items are related to figurative language understanding and polite use of language, where the examiner asks questions like 'What do you say when somebody gives you a present?' or 'What does "you're a pig" mean?'.

ToM measures: false beliefs tests

In order to evaluate ToM skills, two of the classic tasks for evaluating first-order FB were employed:

- *Change of Location (CL)* task (Wimmer and Perner 1983). In this task, children were told a story about two friends (Sally and Ann), in which Sally plays with a ball and leaves it in a basket. Then she goes outside the room and, while Sally is away, Ann removes the ball from its hiding place (the basket) and puts it in a different location (a box). Later, Sally comes back to play with the ball. In this moment, the children were asked about Sally's FB, that is to say, where Sally will look for the ball. Control questions were asked to check that the participant remembered where Sally had put the ball initially and its later location. In order to score successfully on the FB question, participants had to answer the control question correctly.

- *Unexpected contents (UC)* task (Perner *et al.* 1987). In this task, children were shown a tube of Smarties and asked, 'What do you think there is in the tube?'. After the child answered that the tube contained sweets or Smarties, the tube was emptied to reveal it contained a pencil. So, in that moment the child identified the true content of the tube. After putting the pencil back into the tube, the participants were asked about their own FB: 'When you first saw the tube, all closed up like this, what did you think there was inside it?'. Then, the examiner asked them about what another person (who was outside the room) would think is in the tube (third person FB).

To get an 'overall understanding of the FB' variable, the scores obtained in both FB tasks were added together, in accordance with the following weighted criteria: 1 point (FB of Sally in CL), 1 point (own FB in UC) and 1 point (FB about a third person in UC), as seen in Farrar *et al.* (2009). Therefore, the maximum value of the variable was 3 and the minimum 0.

Results

Inter-group differences between the SLI, CA and LA groups on the key measures

Table 1 reports the descriptive statistics of the raw scores of the SLI group, age-matched controls and language-matched controls. No significant differences were found between the groups on non-verbal IQ percentiles ($F(2,90) = 1.88$, n.s.). Nevertheless, a main effect of age was found ($F(2,90) = 8.69$, $p < 0.01$), with the LA group being different to the others due to its being the youngest group in the sample.

The SLI group's means were similar to those of the LA group on all the linguistic measures when raw scores were compared, and no significant differences were observed. In contrast, the SLI group was significantly different from the CA group on all the linguistic measures: grammar–comprehension ($t(60) = 4.94$, $p < 0.01$), grammar–expression ($t(60) = 5.61$, $p < 0.01$), vocabulary–receptive ($t(60) = 2.35$, $p = 0.09$) vocabulary–expressive ($t(60) = 2.48$, $p = 0.02$), advanced semantics ($t\ (60) = 3.90$, $p < 0.01$) and pragmatics ($t(60) = 4.11$, $p < 0.01$).

As regards to the information-processing measures, the SLI group differed from the LA group on the raw scores of non-verbal reasoning ($t(60) = 2.57$, $p = 0.01$), where the SLI group was more competent. However, they behaved similarly in the rest of the cognitive tasks. On the other hand, the SLI group displayed a lower level than the CA group on the number recall subscale ($t(60) = 4.16$, $p < 0.01$) and latency response in the executive function task ($t(60) = 3.10$, $p < 0.01$).

With relation to Hypothesis 1, a comparison of the groups on the overall understanding of the FB variable revealed a main effect of Group ($F(2,90) = 6.85$, $p < 0.01$), where pair-wise comparisons showed that the SLI group did not differ from the LA group, with a small size effect ($t(60) = 0.89$, n.s.; Cohen's $d = 0.22$), but there was a significant difference with the CA group with a large size effect ($t(60) = 3.77$, $p < 0.01$; Cohen's $d = 0.96$) (see the means in Table 1). Moreover, the CA group also performed better than the LA group, as was expected ($t(60) = 2.59$, $p = 0.01$).

Correlations and predictions of the age, linguistic and cognitive variables concerning the understanding of FB within the clinical group (n = 31)

Table 2 shows the correlations found between the overall score on FB tasks, the age of participants, and the direct score obtained on all the linguistic and cognitive variables within the clinical group. FB performance was significantly correlated with age ($r(31) = 0.39$, $p < 0.05$) and also with all the linguistic variables: grammatical comprehension ($r(31) = 0.59$, $p < 0.01$), grammatical expression ($r(31) = 0.45$, $p < 0.05$), comprehensive vocabulary ($r(31) = 0.54$, $p < 0.01$), expressive vocabulary ($r(31) = 0.58$, $p < 0.01$), advanced semantics ($r(31) = 0.44$, $p < 0.05$) and pragmatic skills ($r(31) = 0.54$, $p < 0.01$). Nevertheless, only two out of five of the cognitive variables were significantly correlated with FB performance: non-verbal reasoning ($r(31) = 0.47$, $p < 0.01$) and the sustained attention test ($r(31) = 0.44$, $p < 0.05$).

However, many of the variables were correlated with age, which made it more difficult to determine the independent contribution of each experimental variable to FB understanding. To achieve this goal, new composite variables were created taking into account the following criteria: firstly, significant correlations observed between independent variables and FB competence (dependent variable); secondly, significant correlations observed among the containing independent variables; and

Table 1. Descriptive statistics of key measures of the SLI group, CA group and LA group

	SLI ($n = 31$) X (SD)	CA ($n = 31$) X (SD)	LA ($n = 31$) X (SD)
Age (months)	64.32 (14.09)	64.06 (13.40)	52.41 (10.75)
Theory of Mind: False Belief	1.45 (1.05)	2.45 (1.02)	1.70 (1.21)
Cognitive measures			
Non-verbal reasoning	21.80 (5.57)	23.64 (5.07)	18.29 (5.19)
Number recall	5.90 (2.93)	9.06 (3.04)	7.06 (2.97)
Gestalt closure	10.16 (4.24)	10.32 (5.06)	8.32 (3.64)
Sustained attention	34.45 (12.80)	39.22 (8.47)	32.74 (7.95)
Response latency	7.47 (5.49)	15.62 (13.58)	11.97 (13.40)
Linguistic measures			
Grammar rec.	49.96 (11.40)	63.29 (9.75)	52.77 (10.18)
Grammar exp.	5.32 (1.98)	7.83 (1.50)	6.38 (1.80)
Vocabulary rec.	20.16 (6.28)	23.51 (4.81)	18.67 (4.80)
Vocabulary exp.	17.67 (6.91)	21.93 (6.56)	15.83 (6.16)
Advanced semantics	7.83 (3.91)	11.90 (4.27)	9.67 (3.21)
Pragmatics	7.70 (2.90)	10.48 (2.37)	8.22 (1.87)

Note*:* Values from Cognitive and Linguistic measures are raw scores.

Table 2. Zero-order correlations between overall performance in key measures within the SLI group (*n* = 31)

	Age	FB	Nv-R	NR	GC	SA	RL	Gr. R.	Gr. E.	Voc. R.	Voc. E.	Adv. S
False Belief	0.39*											
N-V reasoning	0.67**	0.47**										
Number recall	0.28	–0.05	0.03									
Gestalt closure	0.60**	0.19	0.47**	0.40*								
Sust. attention	0.66**	0.44*	0.65**	–0.02	0.26							
Res. latency	0.44*	0.27	0.58**	–0.00	–0.06	0.66**						
Grammar rec.	0.64**	0.59**	0.76**	0.27	0.48**	0.49**	0.48**					
Grammar exp.	0.62**	0.45*	0.56**	0.40*	0.32	0.40*	0.38*	0.51**				
Vocabulary rec.	0.64**	0.54**	0.68**	0.38*	0.39*	0.56**	0.45*	0.81**	0.69**			
Vocabulary exp.	0.70**	0.58**	0.71**	0.35	0.36*	0.57**	0.51**	0.82**	0.65**	0.87**		
Adv. semantics	0.58**	0.44*	0.53**	0.43*	0.53**	0.29	0.21	0.76**	0.39*	0.58**	0.69**	
Pragmatics	0.60**	0.54**	0.61**	0.12	0.35	0.44*	0.55**	0.62**	0.41*	0.54**	0.63**	0.58**

Note*:* *$p < 0.05$; **$p < 0.01$.

thirdly, the independent variables were grouped according to whether they were linguistic or cognitive. Finally, two composite variables were created:

- Language-composite variable (all linguistic variables). According to the open question posed in the second hypothesis of this study, linguistic variables were also grouped into three different composite variables, depending on the linguistic skill measured: (1.a) Grammar (receptive and expressive); (1.b) Vocabulary (receptive and expressive); and (1.c) Semantic–Pragmatic (semantics and pragmatics).
- Cognitive-composite variable. Sustained attention and non-verbal reasoning were combined into one variable. In addition, both tasks involve visual pattern recognition and analogy thinking (one to complete a figure, and the other to match the identical figure) and attention to a given model.

Related to Hypothesis 2, a linear regression analysis was carried out to identify the predictors of FB performance within the SLI group. Firstly, the variables that were significantly correlated with FB competence were introduced, divided into three steps: age (Step 1), cognitive measures (Step 2) and linguistic measures (Step 3).

Table 3 shows the results that were obtained. The general model (Model A) was significant and accounted for a total of 41.2% of the variance in the successful completion of FB tasks: $F(3,27) = 6.3$, $r = 0.64$, $p < 0.01$. The variable age was seen to account for 15.7% of the variance, the change in F being significant ($p = 0.027$). Cognitive variables accounted for 8.6% of the additional variance. It must be noted, however, that the independent contribution of these variables was not significant ($p = 0.085$). Finally, linguistic variables accounted for 16.9% of the additional variance of the model, the change in F being significant ($p = 0.01$).

Table 3. Summary of the linear regression statistics predicting the performance of the clinical participants (n = 31) in the overall performance in FB tasks.

Predictor	β	t	R^2 and ΔR^2	Pr
Model A				
Step 1: Age	0.40	2.32*	0.15	0.39
Step 2: Cognitive composite	0.42	1.78	0.08	0.32
Step 3: Language composite	0.63	2.78**	0.17	0.47
Model B				
Step 3 (Stepwise method): Grammar (excluded variables: Vocabulary, Semantic–pragmatic)	0.55	2.60*	0.15	0.44

Notes: β = standardized regression coefficient; R^2 = proportion of variance explained by a variable; ΔR^2 = additional variance explained by a variable; and pr = partial correlation.
*$p < 0.05$; **$p \leq 0.01$.

Secondly, to determine the linguistic variables that best predicted the successful completion of FB tasks within the disorder, a stepwise linear regression method was carried out from the third step. Model B shows that grammatical competence (composed of the expression and comprehension variables) alone remained in the equation ($\beta = 0.55$, $t = 2.60$, $p = 0.015$), whereas vocabulary competence (β In = 0.15, $t = 0.45$, $p = 0.65$) and semantic–pragmatic inference variables (β In = 0.24, $t = 0.95$, $p = 0.34$) were successively removed.

In sum, it can be seen that the model which best explained the variance in the understanding of FB within the clinical group was Model A, that is to say, the one that included all the participants' linguistic skills. Moreover, grammar competence was the most important individual contributing variable (Model B).

Inter-group differences between the cSLI and PLI groups on the key measures

With regard to the comparison between the two clinical groups that were divided according to the pragmatic component (cSLI versus PLI), Table 4 shows that they were only different on the pragmatic subscale, in favour of the cSLI ($U = 28$; $Z = 3.52$; $p < 0.01$), but not on the rest of the linguistic variables. Moreover, they also showed a similar profile as far as the cognitive variables were concerned.

In relation to Hypothesis 3, no differences in the FB performance of the two SLI subgroups were observed. Although there were numerically more correct answers in the cSLI group than in the PLI group, the inter-group differences did not reach statistical significance in any of the cases, a moderate size effect being obtained (U= 85.50, $Z = 1.20$, n.s.; Cohen's $d = 0.45$).

Table 4. Descriptive statistics of key measures of the clinical subgroups: cSLI and PLI

	cSLI ($n = 19$) X (SD)	PLI ($n = 12$) X (SD)
Age (months)	64.21 (15.17)	64.50 (12.85)
Theory of mind: False Belief	1.63 (1.06)	1.16 (1.02)
Cognitive measures		
Non-verbal reasoning	22.05 (5.85)	21.41 (5.31)
Number recall	5.73 (2.25)	6.16 (3.88)
Gestalt Closure	10.52 (4.97)	9.58 (2.84)
Sustained attention	32.68 (13.98)	37.25 (10.62)
Response latency	7.72 (6.07)	7.09 (4.65)
Linguistic measures		
Grammar receptive	50.94 (13.68)	48.41 (6.61)
Grammar expressive	5.21 (2.01)	5.50 (2.02)
Vocabulary receptive	19.78 (6.95)	20.75 (5.32)
Vocabulary expressive	17.95 (7.39)	17.25 (6.36)
Advanced semantics	8.78 (4.15)	6.33 (3.08)
Pragmatics	9.15 (2.60)	5.41 (1.56)

Note: Values from Cognitive and Linguistic measures are raw scores.

Discussion

The present study aimed to investigate ToM understanding in young children with SLI in a more comprehensive way, while also seeking to clarify which variables were related to it. This was achieved by comparing a group of children with SLI with two control groups, one matched for chronological age and the other matched for language age, and by analysing the relationships between these children's language skills, cognitive variables and FB understanding. Finally, a comparison between the SLI subgroups with different pragmatic skills was conducted.

With regard to the first hypothesis formulated at the beginning of this paper, the data confirm that SLI participants performed less well in FB tasks than the age-matched control group without language problems. Moreover, as was also expected, this impoverished performance is similar to that found in the language level-matched control group (that is, younger children with similar linguistic levels). Such results confirm findings from previous studies regarding the existence of a developmental delay related to a lack of linguistic abilities to successfully complete the FB task and not to a deficit in mental state skills that is intrinsic to SLI (Cassidy and Balluramen 1997, Farrant *et al.* 2006, 2012). Moreover, data from this study, based on comparisons with younger typically developing children, allow us to be more confident about the idea that language is the critical variable to explain the gap that is observed. Likewise, this finding has enabled us to determine that this gap is approximately one chronological year for children with SLI with an average age of 5;4 years. These data are congruent with findings from other studies cited in the

Introduction section, which report that older children with SLI pass FB tasks over the age of seven years (e.g. Farmer 2000), given that most of the children recruited in our sample did not successfully complete all the FB tasks administered.

Results from linear regression analyses related to the second hypothesis indicated that the overall linguistic variables taken together were the best predictor of FB performance, as they significantly accounted for most of the total variance explained (17% out of 41.2%), after controlling for the age and other cognitive variables (non-verbal reasoning and attention). This result is consistent with previous studies on typically developing children (e.g. Ruffman *et al.* 2003). It seems that overall linguistic capacities of participants with SLI are also developed in tandem, thereby nourishing each other, and all of them together provide part of the competence needed to interpret the actions and activities that take place around people. At the same time, the contribution of age in this predictive model was also significant (15% of the total). This fact indicates that being older or younger is also important within the impairment. Nevertheless, the percentage of variance explained by age is modest in comparison to samples of typically developing children. Again, this finding highlights the developmental delay in FB acquisition. Moreover, the two cognitive capacities entered in the model (sustained attention and non-verbal reasoning) did not significantly predict FB performance after partialling out the effect of the children's age. This finding would suggest that important non-verbal processes such as visual pattern recognition and analogy thinking (since both variables entered in the cognitive composite involved such abilities) are not specifically associated with FB performance in children with SLI. However, there are reasons to interpret this finding with care. Although this study included different cognitive measures where children with SLI were at risk of facing problems (e.g. Im-Bolter *et al.* 2006), they were still very limited. In this sense, given that cognitive deficits present in children with SLI have been said to be important in basic terms (Bishop 2006, Hughes 2011), more refined or goal-oriented tasks designed to identify those cognitive functions related with the ToM delay observed in young children with SLI would be needed. Future research should identify this in more depth.

Moreover, an open question was concerned with which specific linguistic variables would be the best predictors. Research has shown an interest in determining which of these linguistic faculties has a greater weight in successful performance within the disorder, as well as in expanding the number of linguistic aspects measured in previous works (e.g. Farrar *et al.* 2009). With regard to this, we used six different receptive and expressive language measures to better assess the linguistic profile in a comprehensive way, which were grouped into three predictive variables (grammar, vocabulary and semantic–pragmatic) in a stepwise regression method (model B of linear regression). The results showed that grammar was the best predictor, after controlling for age, non-verbal reasoning and attention (cognitive composite variable), as they accounted for 15% of the total variance explained (38%). Again, this finding about the role of grammar is in agreement with previous research and is likely to reflect a specific issue of linguistic code related to ToM (e.g. de Villiers and Pyers 2002). Indeed, conversational exchanges carrying intentional states mainly take the form of sentences, which become progressively more complex as social interactions develop, and they also contain the other elements, namely, vocabulary and pragmatics. Thus, the predictive value of the grammatical tasks in FB performance may also indicate that grammar is the most vulnerable language area in children with SLI.

Related to the expected differences in FB competence between cSLI and PLI stated in the third hypothesis, inter-group comparisons showed that PLI performed poorer than cSLI, but there were no significant differences. Consequently, our assumption was not confirmed.

In this respect, we are aware that our two subgroups of SLI were composed of a small number of participants (12 and 19), which opens up the possibility that by using larger samples the differences between groups could reach significance. The moderate size effect (Cohen's $d =$ 0.45) observed in inter-group comparisons would support this assumption. Additionally, it is possible that in the later development of children with SLI, pragmatic skills play an increasingly more relevant role in being able to take part in conversational exchanges, which become more and more dependent on situational cues as children grow up and social contexts become more complex. In this regard, this idea would be coherent with previous data in the literature established by Shields *et al.* (1996).

From the findings of the present paper, different conclusions and theoretical–practical implications can be considered. First, the developmental delay equivalent to one chronological year observed in ToM acquisition in young children with SLI in our sample could entail very serious damage to their later social development throughout middle infancy and adolescence. The difficulties in understanding and attributing one's own beliefs and those of others may limit the number of opportunities to access and/or take part in social interactions, not only with adults from school and in family contexts, but also with peers. Consequently, at the same time, poorer social interaction will limit the possibilities of progressing in their social-cognition development. In other words, these children are at risk of getting stuck in a damaging and closed loop. Indeed, some research has confirmed that primary school children and adolescents with SLI have problems in their social interaction with peers (e.g. Conti-Ramsden and Botting 2004, Redmond and Rice 1998). Thus, it is important to develop early educational interventions aimed at reducing the delay in FB acquisition in the developmental period, where not only ToM development is being initiated, but also the social interactions at school are expanding.

Furthermore, from our data it can be stated that the relation between language and ToM development in children with SLI is more robust than shown by the cognitive measures used in this study. Consequently, in the absence of new data in this regard, intervention methods should focus on the zone where language and ToM are connected. In this sense, early interventions based on linguistic features of conversational exchanges involving intentional states have been successful in typically developing children (Lohmann and Tomasello 2003). Similarly, but with atypical populations with language and communication disorders, Serrat *et al.* (2012) revealed that labelling objects with a double perspective improves FB understanding. In conclusion, this study states that overall linguistic skills (especially grammar) are crucial in FB performance. This exhaustive analysis of how language evaluated with a wide range of linguistic measures affects FB performance in children with SLI can be helpful to design intervention programmes.

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