I hear what you say but I see what you mean: The role of gestures in children's pragmatic comprehension

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ABSTRACT

This study investigated whether gesture helps children with SLI to disambiguate speech and infer the intended meaning of an utterance. Language impaired children (N = 21) and age matched typically developing children (N = 26) were presented verbal scenarios in two conditions: speech only and speech + gesture. Children, especially those with a language impairment, were better at making correct inferences when speech was accompanied by gestures. As well as supporting comprehension, gesture was also found to be important in helping children verbalise their responses. Children gestured more when they were verbalising correct inferences than incorrect ones. Furthermore, children, especially those with SLI, produced the same gestures that they observed and were more likely to do so in correct rather than incorrect answers. Gestures make a crucial contribution to an utterance's meaning, helping children, especially those with a language impairment to understand speech that requires meaning to be inferred.

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Introduction

'Nice store you got there. Would be a shame if something happened to it.
If a speaker and a listener were ever to work through the tacit propositions that underlie their conversations, the depth of the recursively embedded states would be dizzying.'
(Pinker, 2007, p.22-23)

Effective communication involves more than simply decoding the surface meaning of an utterance. It requires the complex ability to understand language at multiple levels, particularly to read the subtle meanings and intentions behind speech. A child may ask her mother for example, 'Can I play in the garden?' From the mother's reply, 'You have your new dress on' the child has to infer that she is not suitably dressed for outside play and that the intended meaning of the reply is, 'You cannot play in the garden'. In many everyday interaction contexts, as well as an utterance being understood linguistically it has to be being comprehended pragmatically. Some children, while they can manage the former, have difficulty with the latter.

Pragmatics refers to the study of language in context. During pragmatic comprehension the listener must draw on their world knowledge and experience to interpret the context of speech. Some children with a specific language impairment (SLI) experience deficits in pragmatic comprehension. Children with SLI *'show a significant limitation in language ability, yet the factors usually accompanying language learning problems – such as hearing impairment, low non-verbal intelligence test scores and neurological damage – are not evident'* (Leonard 2000). The language profiles of children with SLI are varied, since they demonstrate a diverse range of language difficulties. However, some of these children have distinct and pronounced pragmatic comprehension difficulties, although there is still some debate over whether these children should be given a separate classification.

Children with SLI show deficits in various tasks that require pragmatic comprehension, including understanding idioms (Kerbel & Grunwell, 1998) metaphoric sentences and figurative speech (Nippold & Fey, 1983), nonliteral language (Vance & Wells, 1994), indirect requests (Shatz, Bernstein, & Shulman, 1980) and demonstrate difficulty making inferences (Botting & Adams, 2005).

The focus of this paper is the difficulties that children with SLI have when it is necessary for them to make inferences from speech. Inferencing deficits have been suggested to arise from broader comprehension problems in some children but other children may have a selective deficit (Norbury & Bishop, 2002). Successful inference making requires appreciation of the context of speech beyond the literal meaning of the words. Children with SLI have been demonstrated to experience difficulties utilising the context presented in speech. In a study

conducted by Leinonen, Ryder, Ellis and Hammond (2003), children were asked questions based on events in a story that required differential use of inference. Children with SLI were found to have more difficulty utilising the context to decode the inference compared to typically developing children. For example, children were read a story about a birthday party. One of the questions that they were asked was 'What are special clothes?' In the context of the story, the child would need to draw on his or her own knowledge of birthday parties and how children tend to wear their best clothes to the parties, so special clothes within this context refers to party clothes. In another context, not relevant to the story, special clothes could refer perhaps to a uniform or protective clothing.

Since it is known that children with SLI have trouble making inferences from spoken language, it is reasonable to question whether these difficulties extend to processing speech when some information is also presented nonverbally e.g. in hand gestures. Since '*Nonverbal behaviours add important information to a communicator's speech*' (Kelly, 2001, p. 326) gestures may provide these children with additional visual cues to what a speaker means, and so aid comprehension.

Gesture may aid comprehension by creating a richer mental representation. Indeed, imagery training has been found to improve the comprehension abilities of language impaired children (Oakhill & Patel, 1991; Joffe, Cain & Maric, 2007). The use of mental imagery in story comprehension has been proposed to aid understanding by facilitating the integration of the non-verbal and verbal coding systems (Joffe, Cain & Maric, 2007). According to the dual-coding theory (Sadoski & Paivio, 2001; 2004) meaning can be represented in both verbal and visual codes, which are processed separately. The dual coding theory distinguishes verbal and non-verbal information in such a way that is reminiscent of the view of McNeill (2002) who argues that spoken language is linear and segmented whereas gestures are global and imagistic. As such, children who have difficulty processing information in the verbal channel, may find gestural information easier to access. Gesture may tap into the same mechanisms that mental imagery training activates to serve the same facilitative function, yet because we attend to gesture implicitly, no extra burden is placed on the child.

Hand gestures are a ubiquitous feature of both adult and child speech. Gestures perform varying functions and have been demonstrated to serve both the speaker and the listener at different stages of speaking and thinking. The act of gesturing has been shown to facilitate lexical access for the speaker, both in adults (Beattie & Coughlan, 1999) and children (Pine, Bird & Kirk, 2007). Gestures can also reveal children's emerging knowledge (Church, 1999) and can support learning (Cook & Goldin-Meadow, 2006). This paper focuses on the communicative purpose of gesture, specifically how gestures can help a listener understand what is being said. Adults are quicker at naming a described item when speech is accompanied by gesture (Riseborough, 1981). McNeil, Alibali and Evans (2000) found that reinforcing gestures, gestures that convey the same semantic content as speech, supported young children's comprehension of a complex spoken message. According to McNeill, et al (2000) '*gestures are an effective scaffold for speech comprehension because they guide comprehension toward the semantic content of the spoken message*' (p.133). Indeed, adults have been found to use more gestures that

depict semantic content when their communicative partner is visible than when they are not (Alibali, Heath & Myers, 2001). The purpose of the present study is to assess whether accompanying speech with gestures that convey complementary semantic information to speech can enhance the comprehension of language impaired children.

A facilitative effect of manual gestures on pragmatic comprehension has been demonstrated in non language-impaired children and adults, however this research is restricted to the role of gesture in the interpretation of indirect requests. Kelly, Barr, Breckinridge Church and Lynch (1999) showed that accompanying a spoken message with gesture affects how adults understand an indirect request. Indirect requests are pragmatically ambiguous and are common features of our language. There is nothing explicit in the verbal information that reveals the intended meaning; the context must be taken into consideration to disambiguate the speech. Adults understood the intention of an indirect request, such as *'It's getting cold'* on just 42% of occasions when communicated in speech alone. However, when the speech was accompanied by a gesture, e.g. *'It's getting cold'* + a gesture towards the window, adults understood the indirect request (to close the window) on 71% of occasions. Kelly et al (1999) also showed that participants incorporate information conveyed through gestures into their memories. When tested for recall of verbal narratives, participants integrated gestured information into what they considered to be the intended meaning of the utterance. For example, the words *'The cook went outside'* were spoken and accompanied by a cigarette smoking gesture. When one participant was asked '*She talked about a cook, what did she say?*' the participant replied *'She went outside for a smoke'*.

Gesture also boosts children's ability to understand complex indirect requests. When children aged 3-5 saw videotapes of a mother making indirect requests to a child, they were more likely to understand the meaning of the request if it was accompanied by gesture (e.g. *'Don't forget it's raining' + point to jacket)* 87% of four- and five- year olds correctly understood the intended meaning of indirect requests accompanied by gesture, however, only 29% of three- to four-year olds did. One explanation for this may, however, be due to an inability of younger children to take the perspective of others. In a second experiment Kelly (2001) removed the need for children to take the perspective of others. Rather than the children observing others receiving indirect requests, the experimenter made indirect requests to the children. Three year olds were better at comprehending the intended meaning of indirect requests when the speech was accompanied by nonverbal pointing behaviours. Kelly suggests that children who are just learning about indirect requests may initially need the complementary combination of modalities (verbal and nonverbal) to understand pragmatic meaning. Older children and adults, however, are able to glean meaning from only a single modality, but can also gather additional information from gestures to supplement meaning.

The present study aimed to investigate whether the complementary combination of modalities (verbal and nonverbal) would help children with SLI to draw inferences from speech that typically developing children are able to do

easily. The work of Kelly and colleagues demonstrates that non-language impaired adults and children are better able to comprehend speech accompanied by supplementary gestures (gestures that convey additional information to speech). While we expect the same to be true of language impaired children, we think that complementary gestures (gestures that convey the same information as speech) would aid comprehension and enable children to make inferences from speech.

To date, little is know about whether gesture offers children with SLI an easier way to access information, however research clearly demonstrates that gesture offers children with SLI a more accessible means to express themselves. Many children with SLI can convey ideas in gesture that they cannot express verbally (Evans, Alibali & McNeil, 2001) and children with SLI are known to gesture more than typically developing children (Mansson & Lundstrom, 1996). Clearly the role of gesture in helping children with SLI to interpret speech needs further exploration, particularly in the light of the importance of gesture for their speech production. Evans et al. (2001) suggest that children with SLI represent their knowledge in a format that is more readily accessible to gesture and less readily accessible to verbal expression. This is supported by evidence from neuropsychological studies showing similarities between the gesture production of adults with acquired aphasia and children with SLI (Fex & Masson, 1998). These authors conclude that gesture acts as a compensatory mechanism when the speech system is impaired. Furthermore, in clinical practice, gesture is recommended as a retrieval strategy for children and adults with word finding difficulties. German (1992) suggests that gesture be encouraged when individuals are experiencing word finding difficulty to cue a target word via the motor schema of the target word action.

According to Goldin-Meadow (2005), '*Gesture is a medium within which children can display their linguistic knowledge'* (pg 230) and this study investigates whether this extends to language comprehension as well as communication. Our aim is to see whether accompanying speech with gestures helps children with SLI to interpret and infer the intended meaning in verbal expression.

Short verbal scenarios were developed (derived from Leinonen et al, 2003) that required the child to process contextually relevant information in order to infer the intended meaning of the utterance. To assess this, children were asked questions that required them to make inferences beyond what was explicitly stated verbally in the scenarios. For example, *'Freddie helped his dad paint the bedroom. Freddie had to put on his old clothes. Why did Freddie have to put on his old clothes?*' Language impaired and typically developing (TD) children were presented these verbal scenarios in two conditions: speech only and speech and gesture.

We hypothesised that children with SLI would answer significantly more questions correctly when the verbal scenarios were presented with accompanying gesture than when presented in speech only. On the other hand, TD children were anticipated to answer the questions equally well when presented with or without gesture as these children were expected to be able to glean sufficient information from speech to enable them to make relevant inferences, whereas children with SLI would benefit from the combination of modalities. Accompanying the verbal scenarios with gesture was speculated to help the children with SLI to make

relevant inferences because the gestures convey the same information as speech but in a format more accessible for children with SLI. These gestures reinforce the verbal message and are predicted to aid comprehension and the ability to make inferences.

Since the information conveyed in gesture is complimentary to the spoken message, the intended meaning of the verbal scenarios could be inferred from the spoken message alone. Therefore, to determine whether children have attended to and utilised the information conveyed in gesture, we will analyse the gestures in the children's responses to determine whether a) they incorporate the gestured features of the verbal scenarios into their representation of the scenario and b) doing so has a positive effect on their understanding. For the TD children, the information conveyed by gesture may be redundant, since their pragmatic comprehension ability is at such a level that they are able to infer the meaning from the speech alone. Therefore they are not expected to incorporate the gestures that they observe into their own representations. If the language-impaired children use the gestural input as an additional source of information to aid their comprehension, we expect them to reproduce more of the observed gestures in their answers than TD children. If observing gesture supports the pragmatic comprehension of the language impaired children we predict observed gestures will be more likely to accompany correct rather than incorrect responses.

Method

Participants

Two groups of children participated, children with SLI and a typically developing (TD) sample. Overall, 47 children were tested (21 SLI, 26 TD). The mean age of the children with SLI was 7;7 (SD = 1.82, range = 5;2 – 11;1). The mean age of the TD sample was 7;7 (SD = 0.67, range = 6;8 – 8;8). All children with SLI attended a language unit as part of mainstream schools in Hertfordshire. The children with SLI were tested for receptive grammatical skills by using the Test for Reception of Grammar (TROG) if a recent (within six months prior to testing) TROG score was not available from their school. The mean language age of the children with SLI was 6;11 (SD = 1.58, range 4;3 – 10;8).

Chronological age matched sample

For a subset of analyses, SLI and TD children were matched on chronological age (CA). This smaller subset included 9 children with SLI (6 males and 3 females) who had a mean CA of 7;7 (range 6;8 – 8;4). The mean age equivalent TROG score of the children with SLI was 5;10 (range 4;3 – 7;11). Each SLI child was matched to a typically developing child within 3 months of CA. The typically developing group consisted of 9 children (4 males, 5 females) with a mean CA of 7;8 (range 6;10 – 8;7) .

Materials

Children watched ten short vignettes presented on a laptop computer. Each vignette presented a two sentence verbal scenario followed by a question. The

questions required contextual inferences to be made beyond the material explicitly stated in the question (see Appendix A).

The verbal scenarios were presented as video clips to ensure that each child experienced the same presentation, thus controlling for the timing, size and shape of gestures as well as other nonverbal cues including eye gaze and voice intonation. Each vignette consisted of the researcher reading aloud a verbal scenario and then asking a question relating to the scenario. All of the verbal scenarios were recorded with speech only and speech + gesture. In the 'speech only' verbal scenarios, the researcher read the verbal scenario and question with no accompanying gesture. In the 'speech + gesture' condition, the researcher accompanied the speech with iconic gestures. Iconic gestures are gestures that '*in form and manner of execution exhibit a meaning relevant to the simultaneously expressed linguistic meaning*' (McNeill, 1985, p.354). For example in the scenario '*Freddie helped his dad paint the bedroom. Freddie had to put on his old clothes. Why did Freddie have to put on his old clothes?*' A painting gesture (right hand moving vertically as if painting) accompanied the speech '*paint the bedroom*' and a gesture representing covering up arms accompanied the speech '*put on his old clothes'*. The presentations in both conditions were identical (for example speech intonation and stress patterns) with the exception of the addition of gesture.

A within-subjects design was employed so that all children completed the task under both conditions: 'speech only' and 'speech + gesture'. Each child was presented with 5 verbal scenarios in 'speech only' and 5 in 'speech + gesture'. The presentation was counterbalanced so that not all children saw the same verbal scenarios with or without gesture.

Pilot

To ensure that the gestures that accompanied the verbal scenarios were realistic and valid, 10 adults were instructed to read the verbal scenarios aloud as if speaking to a child and were asked to use their hands as they spoke. All ten were videotaped as they did this and their gestures were coded. The most consistent gestures produced for each scenario were modeled in the verbal scenarios related in the speech + gesture condition. All gestures were iconic in nature, that is, they conveyed semantic information relevant to the accompanying speech. All gestures, with the exception of one (out of 16) complemented the information conveyed verbally. That is, the gestures reinforced the spoken message, rather than adding information that was not present in speech. (See Appendix for a description of the gestures that accompanied the verbal scenarios.)

Procedure

Children were tested individually in a quiet room at their school. Children were told they were going to be shown some videos of a person telling some very short stories and that after each story there would be a question. Children were told they needed to listen and watch carefully and to try and answer the question. The vignettes were presented one at a time on a laptop computer. Each was presented to the child twice, unless the child supplied the correct answer after the first viewing. If the child could not give an answer after two showings the experimenter

moved on to the next verbal scenario. Children were video recorded as they completed the task. The sessions lasted no longer then 15 minutes.

Coding Children's Responses.

Children's responses that incorporated the contextual information given in the verbal scenario were coded as correct. Responses not incorporating this information were coded as incorrect, e.g. if children simply repeated the verbal scenario back to the experimenter. To answer the questions correctly it is necessary to go beyond the verbal information and make an inference. For example, in the scenario '*Gordon's cat had run away. Gordon left a saucer of milk outside every night. Why did Gordon leave a saucer of milk outside every night?*' it is not explicitly stated that the milk is left out in case the cat returns, or to encourage the cat to return, this must be inferred. An example of a correct answer would be something along the lines of '*In case he came back and started like drinking the milk and if he did Gordon could get him*'. Incorrect answers would be irrelevant to the context, e.g. '*Because he maybe had a friend that was a hedgehog that liked milk*'. Examples of correct and incorrect answers are given in the appendix.

Coding Children's Gestures.

The gestures that children produced alongside their spoken responses were also coded. Gestures were coded because previous research has demonstrated that children with SLI not only gesture more, but that their gestures convey information not necessarily present in speech (Mansson & Ludstrom, 1996; Evans et al., 2001). For the purpose of this study only iconic gestures were coded. These are gestures that convey semantic meaning. For example, one child said '*Because it was really hot*' whilst performing a fanning action with her hand against her mouth. The gestures that children produced in the Speech + Gesture condition were coded as being either a 'reproduction' or 'other'. A gesture was coded as a reproduction if it resembled in form the gesture modelled in the verbal scenario. There were no instances of a child producing a gesture that had the same meaning as the modelled gesture but with a different form. Therefore coding reproduced gestures was unambiguous. All gestures that were not reproductions were coded as 'other'. For example, after viewing a verbal scenario accompanied by the gesture hot (hand waving in front of mouth), one child produced a gesture to convey "hot" by wiping her hand across her forehead. A gesture was classed as beginning when the hands left an equilibrium position and was broadly defined as any hand, finger or arm movement. Self-adaptor gestures (e.g. head scratching, jumper pulling) beat gestures (e.g. finger tapping) and deictic gestures (points) were not coded.

Results

The following results focus on children's verbal and nonverbal responses to the verbal scenarios separately. Section one compares the impact that adding gesture to the verbal scenario presentation had on SLI and TD children's ability to correctly answer the verbal scenario questions. Section two presents an analysis of the gestures that the children produced in their responses, in terms of both gesture frequency and gesture content.

Section One: Children's Verbal Responses

A 2 x 2 repeated measures ANOVA was conducted to assess the impact of presentation condition (speech only/ speech + gesture) and group (SLI/TD) on children's ability to answer correctly the verbal scenarios questions. This analysis was conducted with the CA matched sample. In the speech only condition, children with SLI (n = 9) answered a mean number of 2.33 (1.41) questions correctly whereas age matched TD children (n = 9) answered a mean number of 4.11 (1.36) correctly. When the verbal scenarios were accompanied by gesture, children with SLI answered a mean number of 3.67 (1.66) questions correctly. Adding gesture did not improve the number of correct responses given by TD children, who answered a mean number of 4.22 (.97) questions correctly (Fig. 1).

Children with SLI answered fewer questions correctly overall than TD children, however this difference did not reach significance, $F(1,16) = 3.92$, $p = .07$. There was a significant main effect of condition, $F(1,16) = 7.19$, $p = .02$, indicating that children answered significantly more questions correctly in the speech + gesture condition than in the speech only condition. There was a significant interaction between presentation condition and group [$F(1, 16) = 5.15$, $p = .04$]. Post-hoc comparisons indicated that children with SLI answered significantly more questions correctly when the verbal scenarios were accompanied by gesture than when they were presented in speech only [$t(8) = 4.62$, $p = .002$]. For TD children, there was no significant difference between the number of questions answered correctly when presented in speech only or in speech + gesture [$t(8) = .24$, $p = .81$].

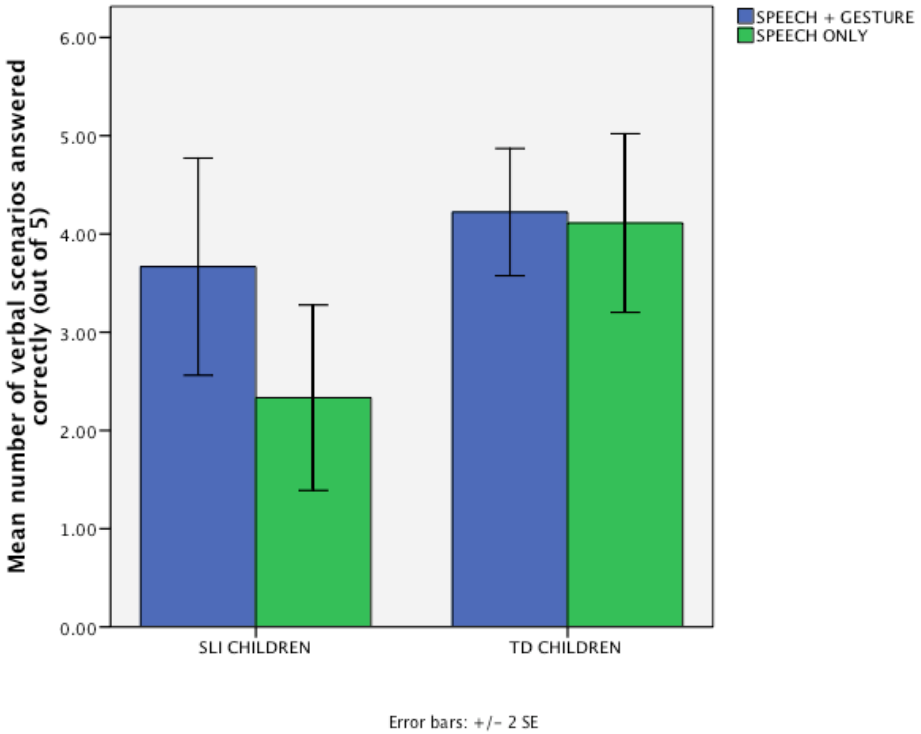

Figure 1. Impact of presentation condition on the number of correct answers given by SLI and TD children

When the verbal scenarios were delivered in speech only, TD children answered significantly more questions correctly than children with SLI [$t(16) = -2.71$, $p = .02$]. However, when gesture was added, there was no significant difference between these children in the number of correct answers that they gave [$t(16) = -.87$, $p = .40$]. Thus, when children with SLI were presented with information in a combination of modalities, their performance was indistinguishable from their age-matched peers.

Is it only children with a language impairment who benefit from the addition of gesture, or did gesture generally help those children who were poor at the task? The TD children in this comparison were scoring close to ceiling in the speech only condition. This raises the question of whether TD children who did not answer all of the questions correctly in the speech only condition were benefited by gesture in the same way as the children with SLI. Looking at the sample as a whole, half of the TD children (13 out of 26) answered 5 out of 5 questions correctly in the speech only condition. The remaining 13 TD children scored between 1 and 4, indicating that these children had some degree of difficulty making inferences from speech. We examined whether these children benefited from the addition of gesture in the same way as the children with SLI.

The mean number of questions answered correctly by TD children who scored ≤ 4 in the speech only condition ($n = 13$) was 2.92 ($SD = 1.26$). The mean score of the children with SLI ($n = 21$) was 2.48 ($SD = 1.66$) thus these TD children are similar to the children with SLI in terms of their task performance. Did these TD children demonstrate an improvement in their ability to answer verbal scenario questions when presented in speech + gesture? The mean number of questions these TD children answered correctly in the speech + gesture condition was 3.54 ($SD = 1.61$). This difference was not significant, $t(12) = 1.30$, $p = .22$. Whereas children with SLI benefit from the addition of gesture, lower ability TD children did not answer significantly more questions correctly when the verbal scenarios were accompanied with gesture. This finding indicates that gesture does not simply benefit children who performed below ceiling in the speech only condition, but that children with SLI derive particular benefit when speech is accompanied by gesture.

Section Two: Children's Gestures

Children produced up to 18 gestures as they gave their responses to the verbal scenarios questions. We explored whether observing gesture increased children's gesture production and whether there were any differences in the quantity and content of the gestures performed by SLI and TD children. These analyses are based on the sample as a whole ($n = 47$).

Gesture Quantity

We compared the gesture production of TD and children with SLI to determine whether children with SLI gestured more. When giving their responses to the verbal scenarios (both conditions combined total) children with SLI produced more gestures than the TD children. Children with SLI ($n= 21$) produced a mean number of 3.57 ($SD = 4.19$) gestures while TD children ($n=26$) produced a mean number of

1.77 (SD = 3.97) gestures, however this difference did not reach significance [t(45) = 1.51, p = .14].

We predicted that observing gesture would increase gesture production and that all children would gesture more alongside their responses to verbal scenarios presented in the speech + gesture condition than in the speech only condition. Children (n = 46) produced a mean number of 1.13 (SD = 2.20) gestures in the speech only condition and 1.43 (SD = 2.28) in the speech + gesture condition, a non significant difference, t(46) = -1.13, p = .26. Next we examined differences between the TD and children with SLI. Children with SLI produced a mean of 1.48 (SD = 1.91) gestures in the speech only condition. This increased to a mean of 2.05 (SD = 2.65) gestures in the speech + gesture condition, however this difference was not significant, t(20) = 1.28, p = .21. TD children produced a similar amount of gestures in both conditions, a mean of .85 (SD = 2.41) in the speech only condition and .92 (SD = 1.83) in the speech + gesture condition [t(25) = .25, p = .81].

Gesture Content

While seeing gestures may not have increased children's gesture production, we noted that it did change the type of gestures they were producing. Children often reproduced the gestures that they had observed the experimenter modelling in the presentation of the verbal scenarios. All children reproduced some of the gestures, however the children with SLI did so more often than the TD children. Children with SLI (n = 21) reproduced a mean of 1.48 (SD = 2.09) observed gestures. Out of the total number of gestures that they produced, the proportion that were reproductions was .29 (SD = .38). TD children (n = 26) only produced a mean of .27 (SD = .67) reproductions. The proportion of TD children's total gestures that were reproductions was .07 (.21). Children with SLI produced a significantly higher proportion of gestures that were reproductions than did TD children [t(30.11) = 2.41, p = .02].

Next we examined whether the gestures of the children with SLI were more likely to be reproduced gestures as opposed to any other kind of gesture. A lower proportion of TD children's gestures were reproductions (M = .08, SD = .22) compared to other types of gestures [M = .27, SD = .43, t(25) = -2.08, p = .05]. Children with SLI, on the other hand, produced a higher proportion (though not significantly higher proportion) of reproduced gestures (M = .35, SD = .44) than other gestures [M = .17, SD = .33, t(20) = 1.41, p = .17].

Was it copying these gestures that improved the children with SLI's ability to give correct answers? We examined whether children who reproduced the gestures were more likely to do so with their correct or incorrect responses. The proportion of correct and incorrect responses accompanied by reproduced gestures was compared for SLI and TD children. TD children were just as likely to reproduce gestures with their correct responses (M = .15, SD = .10) as they were with incorrect responses [M = .10, SD = .12; t(3) = .52, p = .64]. However, for children with SLI, a significantly higher proportion of their correct responses (M = .40, SD = .25) were accompanied by reproduced gestures than incorrect responses [M = .04, SD = .12; t(10) = 3.63, p = .01].

However, it was possible that children gestured more alongside their correct responses than their incorrect responses, meaning that reproduced gestures were not special compared to any other type of gesturing. To evaluate this possibility, we compared the proportion of children's correct and incorrect responses that were accompanied by gesture in response to the verbal scenarios presented in speech only. Our rationale was that if all correct responses are more likely to be accompanied by gesture, then a higher proportion of children's correct responses would be accompanied by gesture, even in the absence of observing gesture. On the other hand, if reproduced gestures are special, then we would not expect more correct responses to be accompanied by gesture.

This analysis revealed an interesting divergence between the children with SLI and the TD children. The mean proportion of the SLI children's correct responses accompanied by gesture ($M = .20$, $SD = .31$) was not significantly different from the mean proportion of incorrect responses accompanied by gesture ($M = .29$, $SD = .40$. $t(20) = -.92$, $p = .37$). However, a significantly higher proportion of the TD children's correct responses were accompanied by gesture ($M = .12$, $SD = .26$) than incorrect responses ($M = .03$, $SD = .15$, $t(25) = 2.38$, $p = .03$). This suggests that the reproduced gestures are not special for the TD children, but they are for the children with SLI.

Next we examined whether reproducing the gestures improved the likelihood that children with SLI would answer the verbal scenarios questions correctly. Children with SLI who reproduced gestures answered a mean of 3.09 ($SD = 1.63$) questions correctly in the speech + gesture condition. Children with SLI who did not reproduce gestures answered a mean of 3.00 ($SD = 1.83$) questions correctly. Therefore, children did not answer more questions correctly if they reproduced the gestures, yet they were more likely to produce these gestures alongside correct responses than incorrect responses.

Therefore to summarise the findings:

Children's Verbal Responses

- In a sample of SLI and TD children matched for chronological age, the children with SLI found the verbal scenarios task more difficult than TD children, answering significantly fewer questions correctly.
- All children answered more questions correctly when verbal scenarios were accompanied by gesture, however this difference was only significant for children with SLI.

Children's Gestures

- Children with SLI gestured more than TD children, however this did not reach significance.
- All children reproduced some of the same gestures that they had observed in the gestured verbal scenarios.
- Children with SLI were more likely than TD children to reproduce these gestures. Furthermore, for children with SLI their reproduced gestures accompanied a higher proportion of correct responses than incorrect responses.

Discussion

The aim of this study was to determine whether gesture could enhance the pragmatic comprehension abilities of children with SLI. Children were presented with short verbal scenarios, some of which were accompanied by gesture. Children were asked a question about each verbal scenario that required some inference to be made. For example, in the scenario '*Gordon's cat had run away. Gordon left a saucer of milk outside every night. Why did Gordon leave a saucer of milk outside every night?*' it is not explicitly stated that the milk is left out in case the cat returns, or to encourage the cat to return. Yet typically developing children with sufficient pragmatic comprehension abilities could infer this and answer accordingly. Children with pragmatic comprehension difficulties give answers which are irrelevant to the context, e.g. '*Because he maybe had a friend that was a hedgehog that liked milk*'.

Overall, children with SLI demonstrated greater difficulty in answering the verbal scenario questions than TD children. The children's incorrect answers indicated that they had failed to integrate the meaning of the question with the context of the scenario. This finding is consistent with those reported by Leinonen et al (2003); Bishop and Adams (1992) and Crais and Chapman (1987).

Presenting the verbal scenarios with gesture increased the number of questions that children answered correctly. Closer inspection revealed that this modality advantage was only significant for children with SLI. Children with SLI produced more correct answers (using context of the verbal scenario to make an inference) when information was conveyed both verbally and nonverbally. These children struggled to make such inferences when contextual information was embedded in speech alone, therefore gesture appeared to present contextual information in a way that these children could more readily access and utilise.

Gesture provides semantic enrichment. Accompanying speech with complementary gestures reinforced the spoken message allowing language impaired children to better understand the verbal scenarios. The enhanced comprehension afforded by gesture enabled these children to draw inferences beyond the literal meaning of the verbal scenarios. Thus, gestures facilitate sophisticated language abilities, i.e. inferential processing, via improved comprehension.

Gestures greatly augment communication when infants are acquiring language and impaired language learners may still need to exploit this manual modality. The gestures that infants are exposed to are modified in much the same way that adults adapt their speech when talking to children – so called 'motherese' (Snow, 1977). Child directed gestures – 'gesturese' (Bekken, 1989; Iverson, Capirci, Longobardi & Caselli 1999) are 'conceptually simple', always accompany speech and complement the information conveyed by speech. These gestures help scaffold young children's burgeoning language skills. For example, if a toddler points to an object, the adult may respond by labelling the object and producing an iconic gesture that highlights the object's function. Thus, adults model spoken language and provide semantic enrichment via gesture – just as we did in the speech and gesture condition. Other researchers have found that the combination of the speech and gesture modalities enhances the word learning of children with SLI. Weismer &

Hesketh (1993) demonstrated that children with SLI learned location words better if an iconic gesture-speech model was provided, rather than when no gesture was used. Thus, for children with SLI, the manual modality has the capacity to greatly enhance comprehension.

Past research has told us that children with SLI find it easier to express information through gesture (e.g. Snyder, 1975, 1978). We now know that the compensatory nature of gesture for language-impaired children extends to both the expression and comprehension of language. The use of gestured input with language impaired children is considered good clinical practice within the field of speech-language pathology (German 1992). However, there is a still a lack of research to support the use of gesture by clinicians, indeed recent McGregor (2008) commented in recent review that '*Although the use of gesture-enhanced input in clinical settings is widespread, the evidence base is currently scant*' (McGregor, 2008, p115). Our findings have great practical implications and can help inform good evidence-based clinical practice.

The TD children did not significantly benefit from the extra information conveyed in the gestural modality, indicating that they were able to make inferences about the context from verbal information. This finding is in-line with those of McNeil et al (2000) and Kelly (2001) who found that older children did not need the combination of modalities to comprehend a spoken message, whereas younger children benefited from reinforcing gestures accompanying speech.

However, even the TD children who were not fully proficient at making inferences, performing below ceiling on the task in the speech only condition, were not helped by gesture. They answered just as many questions correctly when the verbal scenarios were accompanied by gestures as when they were not. Why would gesture help the children with SLI to make inferences, yet not these children? We suggest that the typically developing children may not have been as sensitive to information conveyed by gesture. Indeed, they very rarely reproduced the same gesture that they had seen modelled, suggesting that they had not assimilated the information conveyed nonverbally into their representation of the verbal scenarios. The children with SLI, on the other hand, often reproduced the modelled gestures and were more likely to do so alongside their correct responses. Therefore, we suggest that the children with SLI were helped by gesture whereas the TD children scoring below ceiling were not, because of differences in sensitivity to nonverbal cues. To help compensate for their language impairment, the children with SLI may have developed more sensitivity and dependence on nonverbal cues, including gesture, voice intonation and eye gaze. For these children, gestures help guide comprehension towards the semantic meaning of the speech.

Why do gestures help? McNeil et al (2000) suggest that while words are arbitrarily related to the meaning of the message, gestures represent meaning iconically, therefore semantic meaning is intrinsic to the gesture. In this way, gestures can offer a visuo-motor representation of an action, attributes of an object and affective cues, which not only serve to amplify the key semantic content of the message but may also tap into the observers' motor representation of a particular concept. Neurophysiological evidence examining the mirror-neuron system has demonstrated that when observing another person performing an action, neurons

that represent that action are activated in the observers' motor cortex. In this way it has been suggested that '*the mirror system transforms visual information into knowledge*' (Rizzolatti & Craighero 2004, p.4). In the present study, observing gesture may have boosted comprehension by activating the same neural correlate that is active in the motor cortex of the communicator. In essence, the gestures were a way of tapping into the child's semantic representation via a non-linguistic channel.

When responding, language impaired children were found to gesture more than typically developing children. This finding is in line with current literature concerning the importance of gesture for children with SLI, which has found that children with SLI gesture more than typically developing children (Mansson & Lundstrom, 1996) and convey more advanced information in their gestures than their speech (Evans et al. 2001). Children with a language impairment are suggested to make more use of gesture in compensation of their poor speech production. Our findings add to this to suggest they these children exploit the gestural modality in comprehension as well as production. We found the gestures that the children with SLI produced in their answers, and in turn their task success, was influenced by the gestures they observed. Replicating an observed gesture has been found to improve children's performance in other domains. Cook and Goldin-Meadow (2006) found that children who imitated a teacher's gestures were more likely to succeed after instruction than those who did not. The authors suggest that gesturing during instruction is effective because it encourages children to produce gestures of their own, which in turn, leads to learning. When asked to gesture, children who previously failed at maths tasks added new and correct problem solving strategies to their repertoires (Broaders, Cook, Mitchell & Goldin-Meadow, 2007). Similarly, we found that the children with SLI often reproduced the gestures that they had observed the experimenter performing and did so alongside their correct responses. However, merely observing the gesture was overall a more powerful predictor of task success than gesture production. Yet some of the children with SLI utilised gesture as both listeners and speakers, highlighting the great value of gesture for these children.

We have seen that speech can contain multiple meanings, including the literal and the inferred, and gestures are said to '*extend the range of meanings that the child is able to convey*' (Goldin-Meadow, 2002, p.1394). This study demonstrates that gestures also function to extend the range of meanings a child can comprehend and implies that speakers should gesture to children and also encourage children to gesture, particularly when there is a language impairment. The potential benefits of encouraging children to gesture has far reaching implications for the facilitation and promotion of effective communication in children, especially those with a language impairment.

This research has been the first to explore the role of gesture in the pragmatic comprehension of language-impaired children. We agree that children with SLI '*represent their knowledge in a format that is more readily accessible to gesture, and less readily accessible to verbal expression'* (Evans et al. 2001, p. 328) and extend this further to say that children with SLI can also access information conveyed in gesture more readily than that offered in speech. Gesture can help the

listener to disambiguate speech and this has implications for teachers as well as speech and language therapists. Capone (2007) has articulated a need for empirical support for the positive effects of gestural input on gesture production in language-impaired children to validate the use of gesture in clinical practice. We present evidence to support the use of gesture to encourage and support language impaired children to communicate effectively. Hence we hope that further research can establish the most effective way to utilise gesture as an aid to communication and even as a learning strategy.

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Appendix

Verbal Scenarios

The underlined text refers to the part of the speech that was accompanied by gesture. Examples of correct and incorrect responses made by children are also given.

(1) Freddie helped his dad paint the bedroom[1]. Freddie had to put on his old clothes[2]. Why did Freddie have to put on his old clothes?

Gestures

[1]Right hand performing a painting action

[2]Both hands come towards the body and down indicating outing clothes on.

Responses

Example correct answer: 'Because his clothes that were nice would get dirty and old clothes don't matter'

Example incorrect answer: 'Because he ran out of clothes'

(2) Preea saw a spider in the garden. Preea ran into the house. Why did Preaa run into the house?

Gestures

[1]both hands brought quickly to top of chest, palms facing body, fingers outstretched to indicate scared.

[2]right hand sweeping from left to right horizontally

Responses

Example correct answer: 'Because erm she was scared and she didn't want to touch it because she thought it was like scary'

Example incorrect answer: 'Because maybe she was picking a flower and there was a spider there and she ran in the house. Maybe she was allergic.'

(3)Gordon's cat had run away[1]. Gordon left a saucer of milk[2] outside every night. Why did Gordon leave a saucer of milk outside every night?

Gestures

[1]right hand sweeping from left to right horizontally

[2]Right hand moving forward as if holding a saucer

Responses

Example correct response: 'In case he came back and started like drinking the milk and if he did Gordon could get him'

Example incorrect response: 'Because he maybe had a friend that was a hedgehog that liked milk because he was really sensitive to or allergic to some waters or juices'

(4) Stuart was back from his school trip. Stuart hugged his mum tightly[1]. Why did Stuart hug his mum tightly?

Gestures

[1]Arms wrapped round self to indicate hugging

Responses
Example correct response: 'Because he was on a school trip and he probably missed his mum'
Example Incorrect response: 'Because he loves her. On the school trip he might have seen a lion. Because she was so beautiful and he loved her'.

(5) Miranda saw a long queue[1] at the playground slide. Miranda decided to go on the swings. Why did Miranda decide to go on the swings?
Gestures
[1]right hand sweeping from left to right horizontally
Responses
Example correct response: 'Because there was a big queue and she got really fed up with it and she just decided to go on the swings'
Example incorrect response: 'Maybe she liked the swings more than the slide'

(6) Susie took her sick cats to the vets. Susie started to cry[1]. Why did Susie start to cry?
Gestures
[1] index finger of both hands brought to eyes and brought down face to indicate crying.
Responses
Example correct response: 'Because she was sad that her cat was ill'
Example incorrect response: 'Because she wanted her teddy or she wanted her mum or something or her dad because she was at school doing stuff.'

(7) The postman took a parcel to Mary's house[1]. The postman left the parcel with Mary's neighbour[2]. Why did the postman leave the parcel with Mary's neighbour?
Gestures
[1]both hands in front of body as if holding a parcel and then both hands are moved to the left.
[2]both hands in front of body as if holding a parcel and then both hands are moved to the right.
Responses
Example correct response: 'It might be because Mary wasn't in so he gave it to her neighbour and when she gets in he can give it to her'
Example incorrect response: 'Cos he went to the wrong house'

(8) Matthew left his schoolbag in the car[1]. Matthew had to borrow a P.E. kit[2]. Why did Matthew have to borrow a P.E. kit?
Gestures
[1] left hand, palm down, moving from in front of the body to over left shoulder, palm facing away from camera
[2] both hands in front of body palms down, then brought towards body, palms facing body
Responses

Example correct response: 'Cos he left his school bag in the car he put his P.E. kit in his school bag'
Example incorrect response: 'Cos erm he didn't have one and he lost it he had to go and borrow one'

(9) Lucy <u>ate something hot</u>[1]. Lucy <u>quickly drank a glass of water</u>[2]. Why did Lucy quickly drank a glass of water?
Gestures
[1] right hand up by mouth performing a fanning action to indicate hot.
[2] right hand up by mouth shaped as if holding a glass and bringing glass to mouth.
Example correct response: 'Because it was really hot and it was hurting her mouth so she had water and it cooled her down.'
Example incorrect response: 'Cos it was boiling in the room she was really sweaty and that so she took a glass of water'

(10) Becky was a fairy in the school play. Becky's friends <u>did not recognize her</u>[1]. Why didn't Becky's friends recognise her?
Gestures
[1]right hand brought up to face, palm facing face and performing a circular sweeping motion over face.
Responses
Example correct response: 'Because she looked different because she was in the school play'
Example incorrect response: 'Because might be a new girl'