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Comprehension problems in children with specific language impairment: does mental imagery training help?

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Abstract

Background. Children with specific language impairment (SLI) experience story comprehension deficits (Bishop and Adams, 1992; Botting and Adams, 2005; Norbury and Bishop, 2002). Research with typically developing children, poor comprehenders and poor readers have shown that the use of mental imagery aids comprehension of stories (Pressley, 1976; Gambrell and Bales, 1986; Oakhill and Patel, 1991).

Aim. To evaluate the effectiveness of an intervention programme in the use of mental imagery to improve the literal and inferential comprehension of children with SLI.

Methods and procedure. Nine children with SLI were trained to produce mental images for sentences and stories in five 30-minute sessions. Their ability to answer literal and inferential questions about short narratives was assessed pre- and post-intervention and compared to the performance of 16 same-age typically developing controls.

Outcome and results. The intervention improved the question-answering performance of the children with SLI for both literal and inferential questions: the improvement was only significant for the literal questions.

Conclusions and implications. The findings demonstrate that a relatively short intervention in the use of mental imagery is an effective way to boost the story comprehension of children with SLI.

Introduction

Specific language impairment (SLI) is the term used for children who experience difficulties in learning language in the absence of any other primary co-existing physical, emotional, neurological or intellectual impairment (Leonard, 1998). Children with SLI have well-established deficits in expressive and/or receptive language (Bishop, 1992). There has been extensive research into their problems with structural aspects of language, such as morphology and syntax (Leonard, 1998). In recent years, there has been increased interest in their wider language comprehension skills (Bishop, 1997). This work demonstrates that children with SLI experience pervasive problems with story comprehension: they are poor at answering questions that tap information that has been explicitly presented in stories and also those that tap information that can be inferred from the text (Bishop and Adams, 1992; Botting and Adams, 2005; Norbury and Bishop, 2002). The present study evaluated an intervention designed to improve their literal and inferential comprehension: instruction in mental imagery.

Inference and literal comprehension in different populations

To construct a coherent representation of the meaning of a story, the reader or listener has to comprehend, remember and link literal details in the text and generate inferences, either by integrating ideas within different parts of the story or by incorporating general knowledge with story details. This process enables the reader to build an integrated representation, or mental model, of the text (e.g. Kintsch and Rawson, 2005). Story comprehension is typically assessed by the quality of responses to questions tapping literal and inferential content.

Children with SLI experience poor understanding of narratives. They experience difficulties integrating information within the story and inferring information that is not explicitly stated, although their memory for literal information is also impaired (Bishop and

Adams; Botting and Adams, 2005; Norbury and Bishop, 2002). Their difficulties are not restricted to the verbal domain: their ability to answer questions about the content of stories is poorer than that of age-match controls for stories presented visually as a sequence of pictures, as well as for spoken text (Bishop and Adams, 1992). Bishop and colleagues have suggested that their failure to construct a coherent and integrated representation of a story's meaning impairs their memory for story details as well as their story comprehension (Bishop and Adams, 1992; Norbury and Bishop, 2002).

Another population with integration and inference making difficulties is children with specific reading comprehension difficulties. These children do not have the history of language-learning difficulties experienced by children with SLI. Children with specific reading comprehension difficulties develop age-appropriate word reading ability but their reading and listening comprehension is impaired (see Cain and Oakhill, 2004, for a review). They fail to generate all of the necessary inferences to ensure adequate comprehension of text (Cain, Oakhill, Barnes, and Bryant, 2001; Oakhill, 1984) and there is increasing evidence that their inference making difficulties might be an underlying cause, rather than a product, of their poor comprehension (Cain and Oakhill, 1999; Yuill and Oakhill, 1988). Poor comprehenders' inference making difficulties are not simply due to poor memory for facts in the text: their ability to answer inference-tapping questions is impaired even when the text is present (Oakhill, 1984).

Imagery training and language comprehension

Good comprehension skills are crucial to academic success. Different types of intervention have been explored to improve the story comprehension of younger and poorer readers. The one that we evaluate in this article is training children to represent story details as mental images.

Work with typically developing children demonstrates that imagery aids their comprehension and memory of stories. For example, Pressley (1976) taught 8-year-olds a representational imagery technique, one in which the image is a reasonably true and accurate depiction of the situation described. Children were told that 'a good way to remember things is to make up pictures in your head'. They were trained first with sentences containing two major elements, e.g. *'The children rode the whale'*, and progressed to sentences with three major elements and finally to longer prose passages. Children who received the training were better able to answer questions about story content than those who were not trained in the imagery technique. Pressley's training session lasted just 20 minutes. One reason for the ease with which children learn this useful technique is that some children already use imagery spontaneously when they are reading, and it has been shown that it improves with age (Guttman, Levin and Pressley, 1977). Those who report a greater number of images recall a greater number of details about a story's characters, events, and theme (Sadoski, 1985).

Imagery training improves the story comprehension of children with specific comprehension difficulties. Oakhill and Patel (1991) compared the effects of imagery training on 9-10-year-old children with good and poor listening comprehension. The trained children were taught to form mental pictures of story events and were told that this would help them to answer questions about stories. Poor comprehenders who received the training improved in the ability to answer questions about stories relative to their controls; good comprehenders did not show the same level of improvement.

Training in imagery influences a wider range of comprehension-related skills, than simply question answering ability. Center, Freeman, Robertson, and Outhred (1999) found that imagery training boosted 7-year-old poor comprehenders' listening and reading comprehension, and also their narrative production skills, relative to controls. The groups did

not differ on a measure of word reading accuracy. Imagery training has also improved poor readers comprehension monitoring skills, measured by their ability to detect inconsistencies in text (Gambrell and Bales, 1986). Thus, imagery training improves a range of comprehension-related skills in children with comprehension difficulties and the benefits appear specific to skills related to text comprehension.

Why does mental imagery work?

A number of theories attempt to explain the relationship between mental imagery, memory, and comprehension. The dual-coding theory proposes that meaning can be represented by two separate coding systems: one system (verbal) specialising in language and the other (nonverbal or imagery system) dealing with non-linguistic events (Paivio, 1971; 1983; 1991; Sadoski and Paivio, 2001; 2004). These two systems can operate independently, for example activity in one but not the other: reading without mental images. They can also operate in parallel, for example separate activity in both at the same time: reading with unrelated images, and they can operate in a connected integrated way: reading with related images (Sadoski and Paivio, 2001; 2004). Sadoski and Paivio (2001; 2001) hypothesise that the verbal system is organised in a way that favours abstract, sequential and logical thought whereas the non-verbal system holds concrete sets of information (such as images), which are free from logical restraints and better at parallel processing of spatial information. Central to the dual-coding theory is that although the two systems perform independent functions, they can also perform in an integrated way, as outlined above. The key component to this interaction is the hypothesis that language can evoke imagery, and imagery can evoke language (Sadoski, Paivio and Goetz, 1991).

The role of visual imagery as a comprehension strategy can be explained by the "conceptual peg hypothesis" whereby mental images serve a key role in organisation and

retrieval from memory by acting as "mental pegs" to which associated information can be "hooked" (Sadoski et al, 1991; Sadoski and Paivio, 2001). Deficits in either the verbal or nonverbal systems could cause difficulties with processing and representing meaning. Representing ideas in a text with visual images might aid the integration of story events and ideas and facilitate the construction of a meaning-based representation of a text (Linden and Wittrock, 1981). For that reason, the effects might be specific to tasks that are dependent on integration, for example answering questions about story content (Oakhill and Patel, 1991), structuring of story events (Center et al., 1999) and comprehension monitoring (Gambrell and Bales, 1986).

It has been shown that children with SLI experience difficulties with representing and integrating information from stories (Bishop and Adams, 1992). Children with SLI may experience difficulties representing information in a verbal form as a result of their language problems. Indeed poor verbal memory has been proposed as one of the underlying reasons for the poor comprehension skills of children with SLI (Norbury and Bishop, 2002). Training in visual imagery might help children with SLI to develop their visual coding system and assist them in representing story information using an alternative (or additional) coding system, which would ease the verbal memory load associated with constructive processing.

Current therapeutic practices in reading and listening comprehension

Traditional speech and language therapy (SLT) for reading impairments has focused on developing phonological awareness and vocabulary, semantic and syntactic skills at the phoneme and word level (for example of such interventions, see, Gillon, 2002; Howell and Dean, 1994). Once words, however, have been identified and grouped into sentences, a number of other skills are necessary to fully understand text or discourse, such as inference and integration, structuring the causal sequence of events in a story, and monitoring

understanding (Cain and Oakhill, 2004). Reading comprehension training is usually only a focus in later post primary years after word recognition skills have been mastered; and research into reading comprehension instruction is relatively new (Whitaker, Gambrell and Morrow, 2004). Historically, there has been little teaching of comprehension strategies, both in the education and SLT contexts for either listening or reading comprehension (Pressley and Hilden, 2004). More recently however, there has been increased research and clinical activity in the training of text comprehension, although this trend is more evident in the education than SLT context (Pressley and Hilden, 2004). In fact, a recent review of SLT interventions showed less evidence for effective interventions for comprehension difficulties than for expressive ones (Law, Garrett and Nye, 2003).

The current study

The review of the literature has demonstrated that training children to build visually based representations of the content of text enhances comprehension. It is a technique that is used spontaneously by good comprehenders (Sadoski, 1985) and can be taught to young children in a relatively short space of time (Pressley, 1976; Johnson-Glenberg, 2000; Sadoski and Willson, 2006). However, at present there appear to be no published accounts of the effects of visual imagery on comprehension performance of children with SLI. The primary aim of the current study was to evaluate the effectiveness of this technique for improving the story comprehension of children with SLI. Mental imagery might be a suitable strategy for children with SLI as it provides additional visual support (Hick, Botting and Conti-Ramsden, 2005) and can operate through a separate non-verbal coding system (Paivio, 2001), reducing overall processing demands on verbal short term memory, which is often impaired in this group (Dollaghan and Campbell, 1998; Gathercole and Baddeley, 1990). A secondary aim was to determine the specificity of any effect on the content of the text: does imagery

specifically facilitate inference making, or does it benefit all aspects of narrative recall and comprehension?

Method

Participants

Two groups of children participated in the study: nine children with specific language impairment (SLI) and 16 age-matched typically developing children. All children were recruited from the same mainstream primary school in a multi-cultural and multi-lingual London borough with a high proportion speaking English as a second language. All participants, however, were exposed to English at home and in the school setting. All children (both TD and SLI) followed the UK National Curriculum which includes the National Literacy Strategy in their regular literacy lessons and incorporates comprehension work for this age group.

Children with SLI

Nine children (2 girls, 7 boys) with SLI participated in the study, with a mean age of 9.6 years (SD=1.1; range: 3.5). They were matched on chronological age to the typically developing (TD) control group, (TD = 9.10 years (SD=.88), $t(23) = -.827$, ns). They were recruited from a specialist language unit based in a mainstream primary school in London. The children were identified as having SLI by an independent specialist speech and language therapist and their language difficulties were severe enough to merit full-time special educational provision. All SLI subjects scored at least one standard deviation below the mean on two of the three language measures taken (see table 1). Assessments of receptive vocabulary (British Picture Vocabulary Scale, second edition, BPVS: Dunn, Dunn, Whetton and Burley, 1997) and receptive and expressive language (Clinical Evaluation of Language Fundamentals-third edition, CELF3: Semel, Wiig and Secord, 1995) were given. The Picture

completion subtest of the Wechsler Intelligence Scale for Children 111 (WISC 111, Wechsler, 1992) was used as a measure of non-verbal IQ. Two of the SLI children scored at or below two standard deviations below the mean on the picture completion subtest of the WISC 111. (See Table 1 for language performance of SLI subjects). These children were not excluded from the study as they had been identified by a speech and language therapist as having SLI and were being educated in a specialist provision for SLI children. All SLI subjects were receiving regular speech and language therapy in the language unit. The visual imagery intervention they received was given in addition to their regular therapy.

Insert table 1 about here

Typically developing children

Sixteen typically developing (TD) children (12 girls, 4 boys) served as an age-matched control group. The TD group (mean age: 9.10 years; SD=.88; range: 2.7) were recruited from the same mainstream primary school in London as the SLI group and had similar cultural and linguistic backgrounds. Reports from their teachers confirmed that they did not present with any significant language, communication or learning difficulties. Standard assessment tests for reading confirmed this report with the children receiving average or above average scores.

Materials and procedure

All testing and intervention took place in a quiet room in the resourced provision of the mainstream school. The SLI group attended 8 sessions in total: 3 for assessment and 5 for intervention. Two assessment sessions were given before the intervention. In the first session, assessments of receptive vocabulary, receptive and expressive language, and a measure of non-verbal ability were conducted. In the second and third sessions, the story comprehension

questions were given pre- and post-intervention respectively. The TD controls were given the same story comprehension questions as the SLI children across two sessions. These sessions took place before and after the intervention given to the SLI group with the same time between the two sessions as that of the SLI group. The TD controls were not given any intervention. Oakhill and Yuill (1991) reported no additional advantage for good comprehenders when using mental imagery. Story comprehension was assessed by an independent speech and language therapist who did not participate in the intervention. A second speech and language therapist re-scored all responses to check reliability. In total, 1400 questions were asked with disagreements on 30 of the scores. Inter-rater reliability was 98%. All disagreements were resolved through discussion.

Story comprehension– pre-intervention.

Both groups completed the four stories from Bishop and Adams (1992), which have been used successfully with SLI children aged 8-12 years. The stories were between 80 and 107 words long. Story topics, designed to be familiar to school-age children, were: children making a go-cart, a space ship adventure, a trip to a sweet shop and an ice-skating story. There were 14 questions for each story: 7 required literal answers, i.e. could be answered by remembering a factual detail from the story, and 7 required an inferential response, general knowledge and contextual information from the story was used to infer information not explicitly stated in the story.

The stories were presented to the children both verbally and visually (in print) and they were encouraged to listen to the stories while following the text in front of them. The stories were read out loud to reduce the impact of any decoding difficulties in the SLI group. Two stories were read to the children at pre-and post intervention. The order of the stories

was counterbalanced within each condition for both groups: stories A and C were counterbalanced and given at pre-intervention and stories B and D counterbalanced and given at post-intervention. At the pre-intervention session, the children were told that they would hear a story and would have to answer some questions about it.

After reading each story the text was removed and questions were asked in the order the information appeared in the story. One repetition of each question was allowed if the child did not respond to the question or asked for a repetition. For ambiguous answers the therapist would prompt the child with, "*Can you tell me more?"* Responses were transcribed live as well as tape recorded using an external microphone and Bell and Howell 3185X tape recorder for checking and reliability.

Bishop and Adam's (1992) 3-point scoring system was used with fully correct responses assigned 2 points, partially correct responses, which were not incorrect, but had some information missing assigned 1 point and incorrect or no responses scoring zero. A maximum score of 28 was possible for each story.

Imagery Intervention.

The imagery training consisted of 5 thirty minute sessions and took place over a three week period. Only the SLI group received the training, which was delivered to the children in two groups, one group with four children and the other with five. Children were told that they would be learning "*to think in pictures*" as this would help them to understand and remember what they read.

Materials of between 1-5 sentences in length were used. Stimuli included five high imagery sentences, three related sentence pairs, two four-sentence stories and two five-sentence stories. Individual and paired sentences were used in the first three sessions, with the longer stories employed in the final two sessions. The sentences and stories were based

on the materials used by Gambrel and Bales (1986). The children were encouraged through picture cues to visualise the sentences, first by breaking each sentence into individual parts (for example, visualise first 'pig' and then 'large pink pig' from the sentence stimulus: 'the large pink pig was eating hot brown potatoes'). Thereafter they practised visualising individual sentences and later, an entire 5-sentence story.

Initially visual prompts in the form of drawings were used to encourage visualisation of images for each sentence and/or part of the sentence. In the first session, children were shown a picture of a common item (umbrella) and asked to visualise it in their mind. This was used to introduce the idea of visualisation. The use of picture cues was reduced over time with no pictures provided in sessions 4 and 5 and the children required to evoke their own images independently. They were then encouraged to share, describe and discuss these images.

For each sentence/story a set of probing questions were prepared in order to assess overall understanding. Therapy materials including sentences, stories and questions are provided in Appendix 1 with procedural details of the intervention for sessions one and five in Appendix 2.

Story Comprehension – post-intervention.

The SLI participants were reminded to "*make pictures in your head*". They were given the following instructions: *"Remember you learned to make pictures in your head to help you remember the stories. Now I'm going to read you a story. Then I will ask you questions about the story. I want you to make pictures in your head to help you answer those questions"*. Two stories were again read to the children and were counterbalanced. Instructions for the TD controls were the same as those given at the first session.

Results

The total scores obtained by the two groups for each question type in the two sessions are reported in Table 2. A maximum score of 28 was possible per condition. These scores were treated as the dependent variable in a mixed Analysis of Variance. Group (SLI, TD) was a between-subjects factor and Session (pre-therapy, post-therapy) and Question Type (literal, inferential) were within-subjects factors. Partial Eta squared (ηp^2) is reported for effect size, being the proportion of the effect + error variance that is attributable to the effect.

Insert Table 2 around here

There was a main effect of group, $F(1,23) = 41.39$, $p < .001$, $\eta p^2 = .643$, with the TD group obtained higher scores in general. There was also a main effect of session, $F(1,23) = 35.69$, $p < .001$, $\eta p^2 = .608$, with higher score obtained in the second session, which was post-therapy for the SLI group. The effect of question type did not reach significance, $F(1,23) = 3.25$, $p = .085$.

Insert figures 1, 2 and 3 about here

The three two-way interactions were all significant and were followed up with Tukey post-hoc comparisons to determine the source of the interaction. The interaction between question type and group, $F(1,23) = 5.92$, $p < .025$, $\eta p^2 = .205$, is illustrated in Figure 1. It arose because the TD group performed similarly on literal and inferential questions (*M*s = 20.46 and 20.91), whereas the SLI group obtained significantly higher scores on the literal questions relative to those tapping inferences (*M*s = 13.56 and 10.61, $p < .05$). The interaction between question type and session, $F(1,23) = 25.54$, $p < .001$, $\eta p^2 = .526$, is illustrated in Figure 2. The source of the interaction was greater improvement in performance on the literal

questions compared to the inferential questions (*M*s = 14.52 and 21.44 for literal; *M*s = 16.68 and 17.72 for inferential). Only the literal question improvement was significant, $p < .001$. The interaction between group and session, $F(1,23) = 8.37$, $p < .01$, $\eta p^2 = .267$, arose because the TD group showed less improvement between the two sessions than did the SLI group, (*M*s = 19.50 and 21.88, for TD group, $p < .05$; *M*s = 8.67 and 15.50 for the SLI group, $p < .001$) See Figure 3. The three-way interaction was not significant, $F < 1.0$.

Discussion

The study evaluated the effectiveness of instruction in mental imagery to improve the story comprehension of children with SLI. Imagery training enhanced the story comprehension of children with SLI, with the greatest gains found for memory for literal detail. The theoretical implications of these findings are discussed first, followed by the implications for practice and future research.

The results strongly suggest that the mental imagery training helped the children with SLI to answer questions about short narratives. It is unlikely that the effect can be attributed to practice with the stories, because the typically developing control group did not show a similar level of improvement. Neither can the effects be attributed to the level of difficulty of the stories used in each session, because the materials were counterbalanced in the pre- and post-test sessions. However, there remains the possibility that the effects arose from the additional intervention received, rather than the specific imagery training. This point is discussed further below in relation to future research.

The improvement was greatest for the literal questions. Thus, the mental imaging technique improved SLI children's memory for explicit details in the text; it did not impact as much upon their inferential processing. It might be speculated that imagery should have the greatest effect on inferential processing, because the construction of images involves

integration of different concepts. Alternately, a difficulty with the construction of clear and complete representations of meaning may impair memory for facts in a story as well as inferential processing (Bishop and Adams, 1992; Norbury and Bishop, 2002). It is important to note that improvement, albeit not significant, was evident for inferential questions in the SLI group. Research has produced mixed results in improving inferential understanding through imagery training. Oakhill and Patel (1991) found that imagery training improved performance on all types of questions about a text (inferential as well as questions about story content). Other studies have reported more success with visual imagery training specifically improving inferential comprehension (Gambrell, 1982; Gambrell and Bales, 1986; Johnson-Glenberg, 2000), and in the case of the Johnson-Glenberg study, imagery training was in fact more effective at improving inferencing skills than reciprocal training. In the current study, the training was short and it may be that additional practice and use of the technique might have further enhanced inferential performance. The lack of a significant impact on inferential processing does not detract from the finding that a relatively short period of training boosted the recall of literal content so dramatically for the SLI group. This statistically significant improvement was obtained despite the pervasiveness and severity of their primary language disorder. The SLI group's language impairment was such that it necessitated them being educated full time in a specialist language provision and, as a group, they performed two standard deviations below the mean on measures of receptive and expressive language. Despite this, a short and focused intervention enhanced story comprehension.

It has been proposed that the use of mental imagery in story comprehension allows for the integration of the non-verbal and verbal coding systems (Sadoski and Paivio, 2001), and acts as a compensatory strategy resulting in an enhanced organisation of both systems through what Gambrell and Jaywitz (1993) refer to as the formation of holistic nested sets of

information. In this way, imagery facilitates story comprehension by encouraging the integration of information in different story propositions. Imagery may have provided the SLI cohort with an additional (different) representational system that eased the memory load associated with the constructive processing required to represent meaning of connected prose. However, it should be noted that the time spent in intervention may have improved the comprehension ability of the SLI group without the need for imagery training. To test this possibility, future work could compare the effects of imagery training and some other comprehension intervention with different groups of children with SLI.

This was a small-scale exploratory study with a limited sample size. For that reason, the findings should be interpreted with caution. However, the findings are noteworthy, given that significant improvements were found with an experimental design of limited power. We have shown that children with SLI are able to generate mental images independently with only a small amount of training. The enhanced performance as a result of a visualisation technique is pleasing considering the ecological validity of such an approach. The intervention in this study progressed from the use of single words to text comprehension, a development which realistically mirrors the increasing demands of the National Curriculum in later years in school, as well as, it can be argued, beyond that into the child's social context. The therapy also encouraged the independent creation and use of mental images through the gradual withdrawal of visual cues, thus ensuring more independent learning and less reliance on support staff. Children will not always be able to rely on text illustrations, so the formation of self generated images should be encouraged. The automatic use of mental images to support text comprehension, which this intervention encourages, is also immediate and unobtrusive and therefore may be more readily accessible to and accepted by the SLI individual in the classroom context. The nature of the intervention is such that it can be easily

formulated and described by the specialist speech and language therapist and carried out by teaching support staff in the classroom. In this way, it reinforces collaborative practice between teaching and therapy staff, a recommendation of SLT service delivery (Hartas, 2004; McCartney, 1999).

What we do not know is whether these newly acquired visualisation skills would generalise into the classroom and transfer to other comprehension activities across National Curriculum subjects, or standardised measures of comprehension. However a recent large scale study delivering a reading intervention programme in the classroom, which included a mental imagery training component, reported a very positive impact of imagery training on reading comprehension (Sadoski and Willson, 2006). Future studies are planned to investigate the generality of these findings: for example, does imagery training aid other comprehension-related skills such as comprehension monitoring? Can it be used to help productive language skills, for example, in supporting narrative production? In the context of such a shortage of evidence-based practice in comprehension impairment (Law et al., 2003), the findings of this study are encouraging and have significant educational and clinical implications.

In conclusion, we have demonstrated that a simple technique that is quick to teach improves memory and comprehension of short narratives for children with SLI. This study needs to be replicated with a larger sample and comparisons between different types of comprehension intervention are needed. Text comprehension is complex, requiring the integration of many different types of information in order to yield an accurate mental representation (Kintsch and Rawson, 2005). Other comprehension interventions that have been found to enhance text comprehension in typically developing children and poor comprehenders, such as reciprocal training (Johnson-Glenberg, 2000), explicit inference

training (Oakhill and Yuill, 1991), and summarisation (Bean and Steenwyk, 1984) should be investigated in the SLI population. It is important in future studies to assess the best strategies for facilitating inferential understanding, a result not achieved to the same degree as literal understanding, in this study.

What this paper adds

What is already known on this subject

Children with Specific Language Impairment (SLI) experience story comprehension deficits: their ability to recall facts from stories and their ability to generate inferences is weak (e.g. Bishop and Adams, 1992). Other populations of children with story comprehension deficits benefit from being taught support strategies, such as use of mental imagery to represent story details (e.g. Oakhill and Patel, 1991).

What this study adds

This study demonstrates that children with SLI can be taught to generate mental images to represent story details. This technique enhanced their story comprehension. It showed that a short period of intervention using mental imagery enhanced literal and inferential understanding in the SLI group.

Footnote

1. The range of scores is reported in Table 2. One child in the TD group was performing at ceiling (28/28) on the inferential questions at pretest, but they were not at ceiling on the literal questions. Another children in the TD group obtained 26/28 on both question types at pretest. A re-analysis of the data excluding these children resulted in exactly the same pattern of significant main effects and interactions. We are confident that our results are not simply due to ceiling performance by the TD group at pre-test restricting their room for improvement in performance.

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Table 1: Standard scores of SLI group on receptive vocabulary, total receptive language, total expressive language and picture completion of the WISC 111

Subject	CELF3 receptive (mean = 100; SD = 15)	CELF3 expressive (mean = 100; SD = 15	BPVS (mean = 100; SD = 15	Picture Completion (mean = 10; SD = 3)
SLI1	65	72	78	7
SLI2	65	65	74	4
SLI3	65	71	86	8
SLI4	71	71	84	8
SLI5	65	65	74	5
SLI6	66	66	86	9
SLI7	74	69	73	11
SLI8	66	66	79	10
SLI9	65	65	74	1
Mean (SD)	68.89 (3.30)	67.78 (2.95)	78.67 (5.41)	7.00 (3.16)

Table 2. Mean scores (standard deviations and range) obtained on the literal and inferential questions

	pre-test		post-test	
	Literal	inferential	literal	inferential
TD Mean SD range	 17.88 (4.46) (11-26)	 21.13 (3.74) (14-28)	 23.06 (3.75) (14-28)	 20.69 (2.58) (16-24)
SLI Mean SD range	 8.56 (5.79) (2-19)	 8.78 (4.84) (3-17)	 18.56 (5.13) (12-26)	 12.44 (5.25) (6-20)

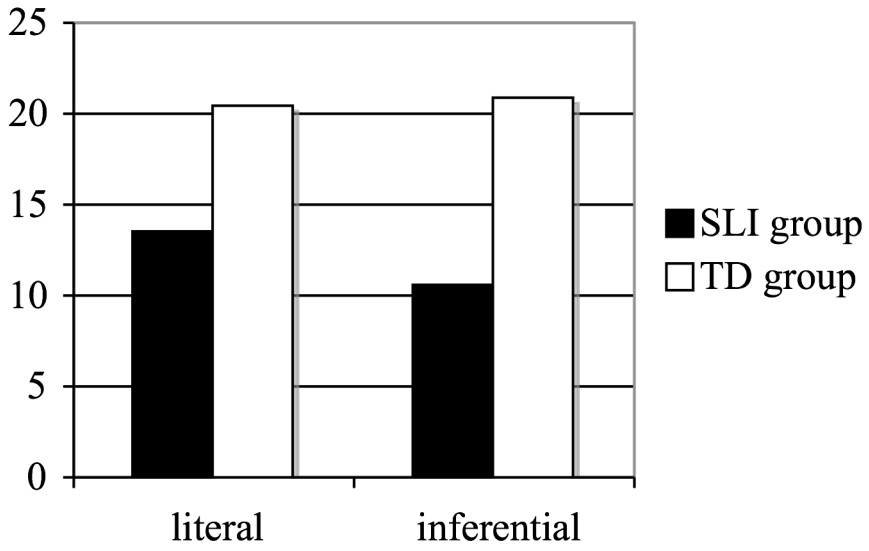

Figure 1: Graph to show two-way interaction between group and question type

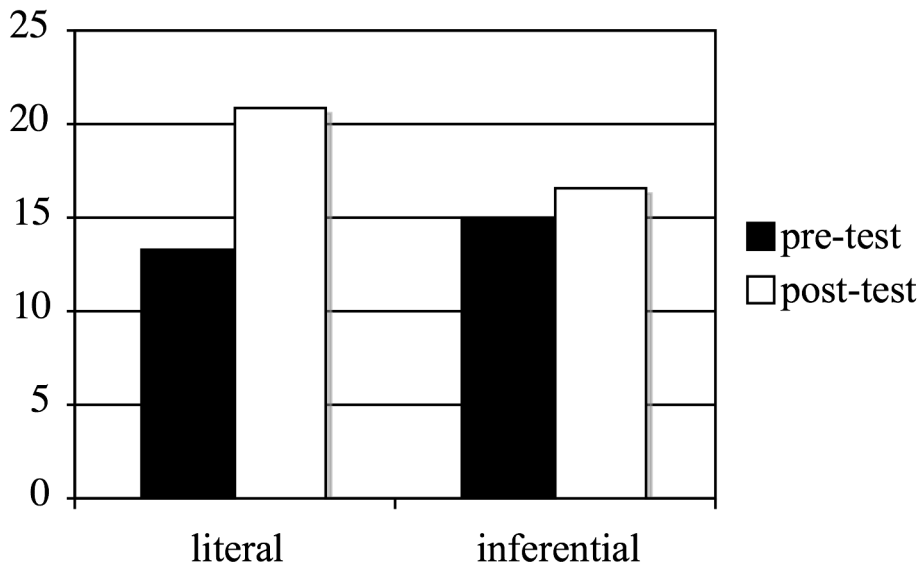

Figure 2: Graph to show two-way interaction between group and question type

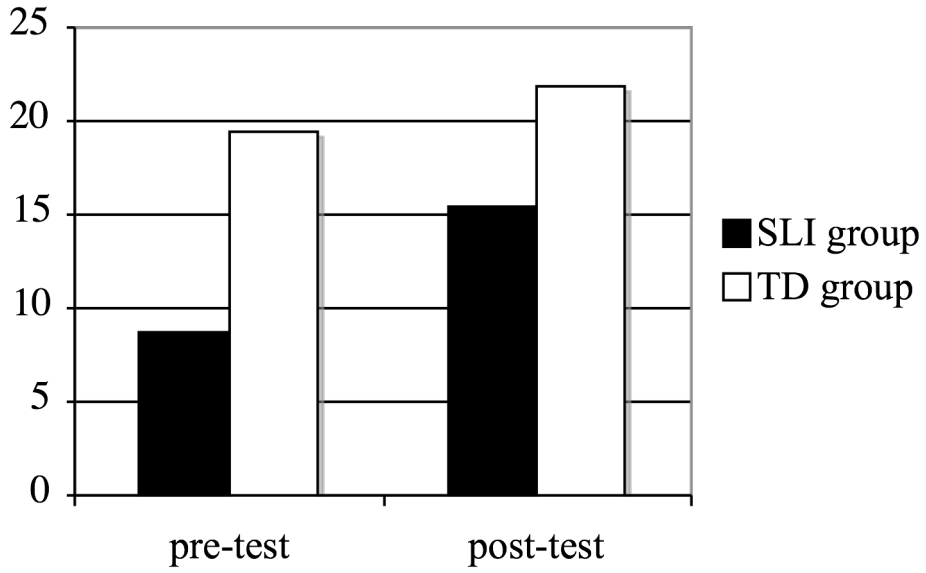

Figure 3: Graph to show two-way interaction between group and session

Appendix 1: Stimuli used for the intervention in therapy sessions 1 and 5 (based on materials used by Gambrel and Bales, 1986)

Therapy session 1- Two sentences, each one broken down into four parts with pictures as visual cues

Sentence 1:

1. The large, pink pig was eating hot, brown potatoes.

Recall questions
Step 1- general question
What do you remember about the sentence?

Step 2 – list of possible prompt questions

1. What colour was the pig?
2. What size was the pig?
3. Was the pig big or small?
4. What was the pig doing?
5. What was the pig eating?
6. What kind of potatoes did the pig eat?
7. What colour were the potatoes?
8. Could you see the steam coming out of potatoes?
9. Were the potatoes hot or cold?

Sentence 2:

2. The angry, strong lion roared in the cage on top of the hill.

Recall questions
Step 1- general question
What do you remember about the sentence?

Step 2 – list of possible prompt questions

1. Can you tell me what did the lion look like?
2. Was he friendly or angry?
3. Was he strong or weak?
4. Could you see his muscles?
5. What was the lion doing?
6. Could you see lion's teeth when he was roaring?
7. Where was the lion?

8. What colour was the cage?
9. Was the lion standing or sitting in the cage?
10. Where was the cage?
11. Did the hill have any trees?

Therapy session 5 - sentence stories

Story 1-presented as individual sentences
The little girl went to the zoo with her mum. She liked elephants. She threw her sandwiches to the hungry elephants. The tall, fat zookeeper was cross. He said: "Do not feed the animals."

Recall questions
Step 1- general question
What do you remember about this story?
Step 2 – list of possible prompt questions

1. Who went to the zoo?
2. Which animals did the girl like/
3. What did she do?
4. Who ate the sandwiches?
5. Who was cross?
6. What did the zookeeper look like?
7. What did the zookeeper say?

Possible prompt questions for helping the child describe his/her images:
What did the girl look like? How old was she? What did she wear? What did her mum look like? How many elephants did you see? What did zookeeper's face look like?

Story 2- presented as a whole story
The forgetful teacher was late for school. The naughty class played a trick. They hid in a big store cupboard. The teacher was worried. She thought they had gone home.

Recall questions
Step 1- general question
What do you remember about this story?
Step 2 – list of possible prompt questions

1. Who was late?
2. What was she late for?
3. Why was the teacher late?
4. What did the class do?
5. Where did they hide?
6. How did the teacher feel?
7. What did the teacher think?

Possible prompt questions for helping the child describe his/her images:

What did your teacher look like? Did you make a picture of your teacher? What did her face look like? What did the school look like? Did you make a picture of this school? Where did you see the store cupboard? Was it in the classroom? What did the class look like?

Appendix 2: Detailed procedures of first and fifth intervention sessions

Intervention session 1

Subjects were first shown a photo of an umbrella and asked to picture it in their mind. Then the picture was taken away and they were asked to describe it. This was done to ensure that students understood what it means to visualise.

The subjects were trained using 2 unrelated high imagery sentences. Each sentence had 3 key elements: subject-verb –place or subject-verb-object (E.g. The large, pink pig was eating *hot, brown potatoes)*. The sentences were broken down and visualising process graded to four steps:

Reading of a single known (e.g. pig)

Reading of a single known described by high imagery adjectives (e.g. large, pink pig) for them to develop a detailed image

Reading of the "known noun" with the verb (The large pink pig eating) in order for students to visualise the subject doing an action

Reading of the "known short phrase" adding the object or the place where the action takes place , so that subject could develop a more detailed image of an action (eating potatoes) or the background where the action takes place (e.g. near the river).

Subjects were given parts of the sentences on separate cards and the therapist read them aloud. The therapist also produced two sets of drawings; one, a sequence depicting each element of the sentences (*pig/pink, large pig/the action of eating/potatoes/hot, brown potatoes*) and then a single picture (*the large, pink pig eating hot, brown potatoes*). The

subjects were told: "*Imagine that these pictures are in y our heads. This will help you answer questions about them".*

The sentence and pictures were then taken away before the subjects were asked questions about each sentence. First the therapist asked a general question "What do you remember about the sentence?" If all information was mentioned the therapist responded with "*Well done you remembered everything*." If all the information was not recalled, then the missing details were probed with specific questions. (E.g. "*What colour was the pig? What was pig doing? What was pig eating?"*)

Intervention session 5

In this session two stories of five sentences were used. The first story was read sentence-by-sentence in order to gradually prompt the children to develop linked images. The second story was presented together written on the same card. As in previous sessions after reading the sentences the children were asked questions and given feedback and suggestions on improving their images.