Author(s): Edmonds, Caroline J; Pring, Linda.
Article title: Generating inferences from written and spoken language: a comparison of children with visual impairment and children with sight
Year of publication: 2006
Citation: Edmonds, C.J. & Pring, L. (2006) 'Generating inferences from written and spoken language: a comparison of children with visual impairment and children with sight.' British Journal of Developmental Psychology 24 (2) 337-351
Link to published version: http://dx.doi.org/10.1348/026151005X35994
DOI: 10.1348/026151005X35994

Generating inferences from written and spoken language: A comparison of children with visual impairment and children with sight

Caroline J. Edmonds 1 and Linda Pring 2

1 Institute of Child Health, UCL, London, UK
2 Goldsmiths College, London, UK

Abstract

The two experiments reported here investigated the ability of sighted children and children with visual impairment to comprehend text and, in particular, to draw inferences both while reading and while listening. Children were assigned into 'comprehension skill' groups, depending on the degree to which their reading comprehension skill was in line with that predicted by their decoding skill. They then read (either print or Braille) and listened to a series of novel short stories. These were followed by a series of questions, which required either the generation of inferences, or an answer that could be taken literally from the text. The results suggest that children with and without sight are comparable in their ability to draw inferences, and that children with visual impairment show an advantage for literal questions under auditory presentation.

Introduction

Comprehension processes have not been studied in any great detail in children with visual impairment (VI), partly because it is assumed that they will simply mirror those observed in sighted children. However, it is especially important to understand the comprehension processes of Braille readers, because greater resources are required for teaching Braille in terms of equipment, time, and teacher support. This is reflected in the delay of approximately 2 years in the development of reading in children with VI (Nolan & Kederis, 1969). The aim of the present study was to explore comprehension in children with VI in more detail: firstly to investigate whether, as is the case for children with sight, comprehension skill in children with VI is associated with better inference generation; and secondly, to examine whether an advantage for auditorially presented information shown by children with VI for digit recall is also shown for more meaningful information.

Reading Braille is both like and unlike reading print. Braille has a letter-letter mapping from print and is comprised of patterns of raised dots presented in a 2 × 3 matrix. However, Braille (or Braille Grade II to be precise) employs many contractions, where commonly occurring groups of letters or words are represented by individual symbols; for example, there are symbols that represent letter strings such as 'and', 'ea', and 'ing'. Even with the use of contractions, experienced Braille readers are slower than sighted people reading print, averaging 70-100 words per minute, compared with just under 300 words per minute for sighted print readers (Foulke, 1982; Nolan & Kederis, 1969). Reading Braille is similar to reading print in that reading times in both media are affected by word length, word frequency, repetition, and semantic priming (Carreiras & Álvarez, 1993; Pring, 1984).

While the literal interpretation of text involves searching for explicitly stated information, successful comprehension of text often requires the inference of information that is not explicitly stated, but implicitly implied. Full comprehension of text often requires the reader to fill in missing information by applying general knowledge, and to make links between different sections of text. While this ability to generate inferences has been extensively studied in children with sight (Cain & Oakhill, 1999; Oakhill, 1984; for a summary see Yuill & Oakhill, 1991), to date, no research has been conducted that explores the ability of children with VI to generate inferences from text.

In the case of children with sight, comprehension performance has been examined under different presentation modalities, with reading and listening comprehension ability correlating positively (Nation & Snowling, 1997; Smiley, Oakley, Worthen, Campione, & Brown, 1977). The modality in which information is presented may differently influence the comprehension ability of good and less good comprehenders. Some studies have observed similarities in the performance of able and less able comprehenders whilst reading and listening (Nation & Snowling, 1997; Stothard & Hulme, 1992). However, others have reported discrepancies; for example, Miller and Smith (1990) found that poor readers showed no difference between reading aloud and listening, average readers performed better on a listening comprehension test compared with a read aloud version, and good readers showed an advantage for reading aloud over listening.

In sighted children, comprehension success is associated with a greater ability to generate inferences. Many studies have shown that children who are skilled at comprehension differ from their less skilled counterparts in their inference-making skill (Cain & Oakhill, 1999; Oakhill, 1984; for a summary see Yuill & Oakhill, 1991). Most of the research exploring inference generation by skilled and less skilled comprehenders has concentrated on reading comprehension; in the present study, we aimed to investigate the role of inference making in comprehension success in both reading and listening, in children with sight, and children with visual impairment. While modest correlations have been found between reading and listening comprehension in Braille reading adults with VI (Daneman, 1988), no research has considered the ability of either adults or children with VI to generate inferences whilst reading or listening. Children with VI have shown an advantage for auditorially presented information that might extend to text comprehension. Children with VI show superior performance on the Digit span subtest of the Wechsler Intelligence Scales for Children (WISC; Wechsler, 1974), a test that requires the serial recall of verbally presented digits (Smits & Mommers, 1976; Tillman & Osbourne, 1969; Warren, 1984). This advantage is not shown when items are presented tactually using Braille (Millar, 1974). This auditory advantage may extend to other types of information, and may be affected by the complexity of the information, or by how much processing is required. In terms of comprehension, an auditory advantage may be restricted to simple information, such as literal information in text, and may not be observed when information requires additional processing, as is the case with information generated by inferences.

In the present paper, an adaptation of Oakhill's (1983, 1984) study design of skilled and less skilled comprehenders was used. The conventional method of assigning children to comprehension skill groups is to match them on decoding age using the Neale Analysis of Reading Ability (NARA; Neale, 1966), and categorize them as skilled comprehenders if their NARA comprehension age matches, or is better than, their decoding age; and as less skilled comprehenders if their comprehension age is 6 months below their decoding age (e.g. Oakhill, 1983; Oakhill, Yuill, & Parkin, 1986). With special populations, like children with VI, whose numbers are small, an approach that requires selecting subsets of participants after initial screening is impractical. A common approach with many assessment tests is to examine discrepancies between observed skill, and that predicted from general ability (e.g.

Wechsler Objectives Numerical Dimensions, 1996; Wechsler Objectives Reading Dimensions, 1993); we adopted a similar method here. Linear regression was used to predict comprehension age from decoding age, and children were assigned to comprehension skill groups on the basis of the discrepancy between their measured comprehension age, and their predicted comprehension age. This method is advantageous with small samples because it allows every child initially assessed to be assigned to a group. In this paper, children whose comprehension skill was less than that predicted from their decoding ability are referred to as *less advantaged comprehenders*, while those whose comprehension ability exceeded that predicted from their decoding age are referred to as *advantaged comprehenders*.

Data from two experiments are reported here. Both compared the comprehension performance of children with sight and children with VI when answering literal questions and inferential questions in response to stories. Additionally, both experiments compared children who were advantaged comprehenders with those who were less advantaged comprehenders. Experiment 1 examined these factors in a reading comprehension task (printed text and Braille), and Experiment 2 used auditorially presented stories to examine listening comprehension. If the comprehension success of children with VI is akin to that of children with sight, it would be expected that children who were advantaged comprehenders would make fewer errors when answering questions for which an inference must be generated, compared with children who were less advantaged comprehenders, both when reading and listening, and regardless of vision group. If the advantage that children with VI have for auditorially presented digit strings is extended to other relatively simple types of auditory information, it might be expected that they would show an advantage for literal information, compared with information for which an inference must be generated in Experiment 2 (listening), an advantage that would not be shared by children with sight.

Method

Participants

All children participated in both Experiments 1 and 2.

<u>Children with visual impairment</u>

A group of 17 children with VI participated in this study. The mean age was 9 years 11 months (range: 7;9-11;7); there were 9 male and 8 female children. All attended a school for the visually impaired. Of the participants with VI, eight were congenitally blind with no pattern but some light perception, three additional children were totally blind, but had lost their sight within a 2 year period after birth. The remaining six children were partially sighted, but used Braille as their literacy medium. All children were experienced Braille readers; they had been learning Braille from the time they entered school. Children with known brain damage and/or physical and/or mental impairments were excluded.

Sighted children

A second group of 17 sighted children were matched with the children with VI on the NARA reading decoding age. The sighted children were chronologically younger than the children with VI in order that they could be matched on decoding age: their mean age was 8 years 2 months (range: 7;5-9;2); there were 5 males and 12 females.

Materials

NARA

Form C of the NARA was used to obtain decoding and comprehension reading ages. The Braille version of the NARA (Lorimer, 1977) was used for children with VI, while sighted children were tested with the storybook format (Neale, 1966). Both Braille and print versions of the NARA provide age-related measures of children's ability, both to read text aloud (decoding skills) and to comprehend the short passages presented. When calculating reading ages, the sighted norms were used for both groups.

Comprehension stories

A total of 16 stories were used: eight of these were used in Experiment 1 (reading); four of these were taken from Oakhill (1984) and four additional stories were constructed. A random selection of four of these stories was administered to each child. 1 A further eight stories formed the pool from which a random four were selected for use in Experiment 2.

All of the stories were approximately 100 words in length. Eight questions followed each story; four literal, with answers stated in the text, and four for which inferences had to be made. Accuracy was ascertained by comparing children's answers to previously prepared lists of acceptable answers and, in both Experiment 1 and 2, the dependent variable was the percentage of questions to which incorrect answers were made.

Experiment 1:Reading comprehension

The stories used in Experiment 1 were printed onto separate A4 sheets in Braille and text. No contractions were used in the Braille versions to ensure that all children with

VI could decode the Braille. For the print version, a large (Helvetica 24 pt.) type font was used.

Experiment 2:Listening comprehension

The eight stories used in the listening comprehension were recorded by a female experimenter onto audio tapes. All were a similar temporal length (mean length = 40.49 seconds; *SD*=3.13 seconds). Stories were presented using a Sony Walkman personal tape player with Alba headphones.

Procedure

Each child was tested individually. The NARA and Experiment 1 (reading) were administered in one session (NARA always first), and Experiment 2 (listening) followed after a delay of at least 1 month.

NARA

The NARA comprises a series of short stories followed by questions that were read aloud; any word reading mistakes were corrected before children were asked the questions.

Experiments 1 and 2

In both experiments, children were informed that questions would follow story administration. In Experiment 1 (reading), children read the stories aloud, and mistakes were corrected. They were told that they would not be able to refer back to the text when answering these questions, and the text was removed when they finished reading aloud. In Experiment 2 (listening), the stories were played to the child. As a result of noise leakage, the experimenter could hear when each story was finished.

The literal and inferential questions followed story presentation; if children did not answer within 10 seconds, the question was repeated and a further 20 seconds provided for a response. If there was no response after this time, the experimenter continued to the next question. The stories were presented to each child in a random order. Every child participated enthusiastically and willingly.

Assignment to comprehension skill groups

NARA decoding and comprehension ages were used to assign children into advantaged or less advantaged comprehender groups. Mean NARA decoding and comprehension reading ages for sighted children and children with VI are presented in Table 1. Both sighted children and children with VI were well matched on both decoding and comprehension reading ages.

Linear regression was used to predict comprehension age from decoding age, and group assignment was made according to the way in which observed comprehension age differed from that predicted (Pring, Dewart, & Brockbank, 1998); separate analyses were conducted for children with VI and for sighted children. For clarification, our group assignment method was different from that commonly used in the sighted inference literature, in which the comprehension age of less skilled comprehenders is lower than their decoding and chronological age. Limited sample size means that it is not possible to adopt such a method in a special population. In our study, following our regression method, children were assigned to the advantaged comprehenders (AC) group if their observed comprehension age was better than that predicted from their decoding age. They were assigned to the less advantaged comprehenders (LAC) group if their observed comprehension age was lower than that predicted from their decoding age.

Of the children with VI, eight were assigned to the LAC group (6 male, 2 female). The remaining nine were assigned to the AC group (3 male, 6 female). Of the sighted children, 10 were assigned to the LAC group (4 male, 6 female), and 7 to the AC group (1 male, 6 female).

Results

Characteristics of comprehension skill groups

Table 2 presents the characteristics of the AC and LAC in both the sighted and VI groups. For both children with VI and children with sight, there were no significant differences between AC and LAC on either chronological age (VI, $t(15)=-0.65$, $p=.528$; sighted, $t(15)=0.40$, $p=.698$), decoding age (VI, $t(15)=0.35$, $p=.729$; sighted, $t(15)=-0.74$, $p=.474$), or on overall NARA comprehension age (VI, $t(15)=-1.01$, $p=.327$; sighted, $t(15)=-1.73$, $p=.105$). These non-significant findings occurred because children were not assigned to groups on the basis of their *observed* comprehension age, but on the basis of the size of the *discrepancy* between their observed comprehension age, and that predicted from their decoding age. It can been seen from data presented in Table 2 that, in the case of both children with VI and children with sight, the mean predicted comprehension age is lower than the observed comprehension age for the AC group; thus demonstrating comprehension skill better than that expected given decoding age. The reverse pattern was observed for the LAC group. In order to test that the AC and LAC groups varied on the difference between observed and predicted comprehension age, discrepancy scores between observed comprehension reading age and predicted comprehension reading age were calculated (regression residuals). A positive value indicates better performance than predicted, and vice versa; for example, if observed comprehension age was 9.83 years and predicted was 9.5 years, the discrepancy would be .33. Data presented in Table 2 show that these discrepancy scores are negative for LAC and positive for AC. For both sighted children and children with VI, there was a significant difference between comprehension skill groups on this discrepancy measure (VI, $t(15)=-7.10$, $p<.001$; sighted, $t(15)=-6.19$, $p<.001$).

Experiment 1:Reading comprehension

Table 3 presents the mean percentage errors made when answering literal and inferential questions by the vision group and comprehension skill group in Experiment 1. These data suggest that, for both children with VI and sighted children, LAC gave more incorrect answers to inferential question compared with literal questions, while there was far less difference in errors between question type for AC. A mixed model three-way ANOVA was conducted on the percentage errors; vision (VI, sighted), comprehension group (AC, LAC), and question type (literal, inferential) were entered as factors. Age was entered as a covariate because children with VI were significantly older than children with sight, $t(32)=5.27$, $p<.001$, and inferences might be assumed to be dependent on developmentally acquired general knowledge.

There was a significant interaction between question type and comprehension skill group, $F(1, 29)=9.21$, $p=.005$; this is shown in Fig. 1. When answering literal questions, there was no significant difference in the number of errors made by advantaged and less advantaged comprehenders, $t(32)=0.85$, $p=.404$. However, less advantaged comprehenders made significantly more errors when answering inferential questions than advantaged comprehenders, $t(32)=2.61$, $p=.014$. In addition, while there was no difference in the amount of errors made by AC to literal and inferential questions, $t(15)=-1.37$, $p=.191$, LAC made significantly more errors to literal questions than they did when answering inferential questions, $t(17)=-4.86$, $p<.001$.

None of the main effects were significant: question type, $F(1, 29)=0.58$, $p=.451$; comprehension skill group, $F(1, 29)=3.56$, $p=.069$; vision group, $F(1, 29)=0.01$, $p=.917$; neither was the covariate of age, $F(1, 29)=0.001$, $p=.981$. There were no other significant interactions, and age did not interact with any variable.

Experiment 2:Listening comprehension

Mean percentage errors by question type, comprehension skill group, and vision group are presented in Table 4. These data suggest that, for both children with VI and sighted children, LAC gave more incorrect answers to inferential questions compared

with literal questions, while AC showed less influence of question type.
The analysis design employed in Experiment 1 was also used in Experiment 2, with age again entered as a covariate. There was a main effect of question type, $F(1, 29)=6.85$, $p=.014$, with more errors made in answer to inferential questions than literal questions. The covariate, age, was significant, $F(1, 29)=6.80$, $p=.014$, but none of the other main effects reached significance: vision group, $F(1, 29)=1.96$, $p=.172$; comprehension skill group, $F(1, 29)=3.53$, $p=.070$. The covariate interacted significantly with question type, $F(1, 29)=4.67$, $p=.039$.

Figure 2 shows the significant interaction between question type and comprehension skill group, $F(1, 29)=7.02$, $p=.013$; there was no significant difference in response to literal questions between comprehension skill groups, $t(32)=0.37$, *ns*, while advantaged comprehenders made significantly fewer errors to inferential questions than less advantaged comprehenders, $t(32)=2.43$, $p=.021$. As in Experiment 1, LAC made more errors when answering inferential questions than literal questions, $t(17)=-4.18$, $p=.001$, while there was no difference in errors to the two question types in the case of AC, $t(15)=-1.61$, $p=.128$.

The results for the listening comprehension showed a significant interaction between question type and vision group, $F(1, 29)=6.82$, $p=.014$; this is shown in Fig. 3. There was no significant difference in errors to literal and inferential questions for sighted children, $t(16)=-2.06$, $p=.056$, while children with VI had an advantage for literal questions in the listening comprehension condition, $t(16)=-3.82$, $p=.002$. When the errors made by children with VI were compared with those made by children with sight, there was no difference in the case of inferential questions, $t(32)=-0.05$, $p=.963$, but the difference approached significance in the case of literal questions, $t(32)=-1.44$, $p=.159$, with children with VI making fewer errors.

Discussion

The experiments reported here are the first to investigate the role of inference making for successful comprehension in children with VI. The results of Experiment 1 showed that, when reading, the ability to successfully generate inferences distinguished advantaged and less advantaged comprehenders, thus replicating well-established research findings with sighted children (Cain & Oakhill, 1999; Oakhill, 1984; Yuill & Oakhill, 1991). There were no differences between children with sight or children with VI when reading. Experiment 2 showed that comprehension skill was also associated with inference generation when listening, with less advantaged comprehenders generating fewer successful inferences than advantaged comprehenders. In addition, in Experiment 2, the size of the question type effect was moderated by vision, with the difference in errors made to literal and inferential questions being larger in the case of children with VI than children with sight. Thus, children with VI had an advantage for taking literal information from text compared with inference generation when the information was presented auditorially.

The advantage children with VI have previously shown for auditorially presented number strings (Smits & Mommers, 1976; Tillman & Osbourne, 1969) extended to the auditorially presented stories used in the present study, but only in the case of auditorially presented literal information. Children with profound VI cannot acquire information through the visual domain, and thus have greater familiarity than children with sight of experiencing verbally transmitted information. Verbally transmitted information may, therefore, be more salient for children with VI than children with sight. The difference in the number of errors made to literal and inferential questions when listening reached significance in the case of children with VI, while for sighted children, although non-significant, it approached significance. It is possible that, given a larger sample size, this difference may have reached significance in the case of children with sight, however, the important finding was that the interaction between vision group and question type reached statistical significance.

The auditory advantage for literal information over that for which an inference must be generated may occur because literal information has a lower memory load, and requires relatively less additional processing. There may be an optimum or maximum length of presentation of auditory information that gives an advantage to children with VI, and this could be explored further. Alternatively, this auditory advantage may be restricted to information that has a lower semantic content; literal information may have a lower semantic content because it can be stored verbatim and does not require additional semantic processing. If this were the case, it may be a feature shared with digit span tasks on which children with VI have an advantage when oral presentation is used (Smits & Mommers, 1976; Tillman & Osbourne, 1969). This may be consistent with recent suggestions that working memory discriminates between information with a high and low semantic content (Baddeley, 2000). Children with VI may show a cognitive style favouring literal memory, reminiscent of children with autism (Frith, 2003) as suggested by Pring and Tadic (2004). Individual differences in language learning have been reported in children with sight; some children prefer a rote learning style, while others use an analytic style (Lieven, 1997). Further research is necessary to consider these alternative explanations and to maximize the potential educational benefits of such an advantage. It is possible that rote learning of literal information such as facts would benefit from being presented in an auditory manner. In the present study, a cross-experiment comparison of reading and listening was not appropriate because different materials were used in the two experiments: these experiments were designed at different time points. However, visual inspection of the data suggests broadly similar patterns of error rates were observed across Experiments 1 and 2, suggesting that the auditory advantage shown by children with VI for literal questions was specific to literal information, and did not represent a general advantage for listening. Future work could extend the results reported here by making a direct comparison of comprehension, while reading and while listening, using the same materials in both presentation modalities and counterbalancing across conditions.

When selecting our sample, in order that children could be equated on reading age, the children with VI were chronologically older than the children with sight; this age difference was controlled for by including age as a covariate in the analyses. In Experiment 1, where children read the stories, age was not a statistically significant covariate and did not interact with any other variable. In Experiment 2, where children listened to the stories, age was significant and interacted significantly with question type. Age may be significantly associated with listening and not with reading for a number of reasons that need further exploration. It may be that children are generally more familiar with, and therefore more skilled at, obtaining information from books than from audio material. Additionally, comprehension skills may be more commonly assessed in the context of reading. Alternatively, listening may be computationally more complex; for example, reading allows children to progress at their own pace. Furthermore, when reading it is normally possible to refer back to the text, although this was not the case in Experiment 1.

In addition to our group of children with VI being chronologically older than the group of children with sight, there was a wider age range in the VI group. This was necessary in order to assess a reasonable sample of children with VI: the incidence of severe visual impairment in the population is quite low. A recent report found the incidence of severe VI was 4.0 in 10,000 children, when diagnosis was made in the first-year of life (Rahi & Cable, 2003). This is low compared with developmental disorders such as autism, for which recent incidence estimates include 16.8 in 10,000 (Chakrabarti & Fombonne, 2001), and 26 in 10,000 (Lingam *et al.*, 2003). Given the low incidence of profound visual impairment, our sample of 17 children with VI who did not have additional brain, physical, or behavioural impairments is not insubstantial.

The children with less advantaged comprehension ability studied here have quite subtle difficulties compared with those of less skilled comprehenders reported in the literature. Unfortunately, it is difficult to make comparisons across studies when the degree of comprehension impairment in individual children differs. Our results show that inference making is not only impaired in children with substantial comprehension problems, but that children with more subtle comprehension difficulties are at a disadvantage when it comes to making inferences. However, as data presented in Figs 1 and 2 indicate, less advantaged comprehenders successfully generated appropriate inferences for 65.28% of inferential questions when reading, and 68.3% when listening. Thus, they were not characterized by total failure at inference generation, but their inference generating strategy is somewhat unreliable. Poor comprehenders' failure to generate inferences consistently may be a cause or a consequence of their poor comprehension. Research suggests that inadequate comprehension of text occurs as a result of poor inference making, rather than the reverse (Cain & Oakhill, 1999). Remedial training in inference generation has been shown to be more successful at helping less advantaged comprehenders to generate inferences spontaneously than training in rapid decoding or comprehension exercises, supporting the argument that inference making failure may be a cause of unsuccessful comprehension (Yuill & Oakhill, 1988). Similar training may benefit visually impaired less advantaged comprehenders who also have difficulties generating inferences.

Acknowledgements

This work was carried out with the support of grant NUF-URB94 from the Nuffield Foundation. The authors would like to thank the children and teachers of the schools that participated in the study; Alice Spooner for helpful comments; and Mark Gardner for statistical advice and detailed comments.

References

Cain K, Oakhill J. V. Inference making ability and its relation to comprehension failure in young children. Reading and Writing: An Interdisciplinary Journal. 11, 489-503. 1999.

Carreiras M, Álvarez C. J. Comprehension processes in Braille reading. Journal of Visual Impairment and Blindness. 93, 589-595. 1993.

Chakrabarti S, Fombonne E. Pervasive developmental disorders in preschool children. Journal of the American Medical Association. 285, 3093-3099. 2001.

Daneman M. How reading Braille is both like and unlike reading print. Memory and Cognition. 16, 497-504. 1988.

Foulke E. Reading Braille. Schiff W. Foulke E. Tactual perception: A source book. 168-208New York. Cambridge University Press. 1982.

Frith U. Explaining the enigma. (2nd ed.) Oxford. Blackwells. 2003.

Lieven E. Variation in a crosslinguistic context. Slobin D. I. The cross-linguistic study of language acquisition. 5, 199-263. Mahwah, NJ. Erlbaum. 1997.

Lingam R, Simmons A, Andrews N, Miller E, Stowe J, Taylor B. Prevalence of autism and parentally reported triggers in a north east London population. Archives of Diseases in Childhood. 88, 666-670. 2003.

Lorimer J. The Neale Analysis of Reading Ability: Adapted for use with blind children. Windsor, UK. NFER Publishing. 1977.

Baddeley A. D. The episodic buffer: A new component of working memory? Trends in Cognitive Sciences. 4, 417-423. 2000.

Millar S. Tactile short-term memory by blind and sighted children. British Journal of Psychology. 65, 253-263. 1974.

Miller S. D, Smith D. E. P. Relations among oral reading, silent reading and listening comprehension of students at differing competency levels. Reading Research and Instruction. 29, 73-84. 1990.

Nation K, Snowling M. Assessing reading difficulties: The validity and utility of current measures of reading skill. British Journal of Educational Psychology. 67, 359-370. 1997.

Neale M. D. The Neale Analysis of Reading Ability. London. Macmillan Education. 1966.

Nolan C, Kederis C. Perceptual factors in Braille word recognition. New York. American Foundation for the Blind. 1969.

Oakhill J. Instantiation in skilled and less skilled comprehenders. Quarterly Journal of Experimental Psychology, 35A. 441-450. 1983.

Oakhill J. Inferential and memory skills in children's comprehension of stories. British Journal of Educational Psychology. 54, 31-39. 1984.

Oakhill J. V, Yuill N. M, Parkin A. J. Memory and inference in skilled and less skilled comprehenders. Gruneberg M. M. Morris P. E. Sykes R. N. Practical aspects of memory. 2, 315-320. Chichester. Wiley. 1986.

Pring L. A comparison of the word recognition processes of blind and sighted children. Child Development. 5, 1186-1213. 1984.

Pring L, Dewart H, Brockbank M. Social cognition in children with visual impairments. Journal of Visual Impairment and Blindness. 92, 754-768. 1998.

Pring L, Tadic V. More than meets the eye: Blindness, talent and autism. Pring L. Autism and Blindness. 50-73. London. Whurr. 2004.

Rahi J. S, Cable N. Severe visual impairment and blindness in children in the UK. Lancet. 362, 1359-1365. 2003.

Smiley S, Oakley D, Worthen D, Campione J. C, Brown A. L. Recall of thematically relevant material by adolescent good and poor readers as a function of written versus production. Journal of Educational Psychology. 69, 381-387. 1977.

Smits B. W, Mommers M. J. Differences between blind and sighted children on WISC verbal subtests. New Outlook for the Blind. 70, 240-246. 1976.

Stothard S. E, Hulme C. Reading comprehension difficulties in children: The role of language comprehension and working memory skills. Reading and Writing: An Interdisciplinary Journal. 4, 245-256. 1992.

Tillman M. H, Osbourne R. T. The performance of blind and sighted children of the Wechsler Intelligence Scale for Children: Interaction effects. Education of the Visually Handicapped. 1, 1-4. 1969.

Yuill N, Oakhill J. Effects of inference awareness training on poor reading comprehension. Journal of Applied Cognitive Psychology. 2, 33-45. 1988.

Yuill N, Oakhill J. Children's problems in text comprehension: An experimental investigation. Cambridge, UK. Cambridge University Press. 1991.

Warren D. H. Blindness and early childhood development. New York. American Foundation for the Blind. 1984.

Weschler D. Manual for the Weschler Intelligence Scale for Children-Revised. New York. Psychological Corporation. 1974.

Wechsler D. Wechsler Objective Reading Dimensions Test. Sidcup, UK. Psychological Corporation. 1993.

Wechsler D. Wechsler Objective Numerical Dimensions Test. Sidcup, UK. Psychological Corporation. 1996.

Figure 1. Experiment 1 (reading) - mean percentage errors to literal and inferential questions by advantaged (AC) and less advantaged comprehenders (LAC).

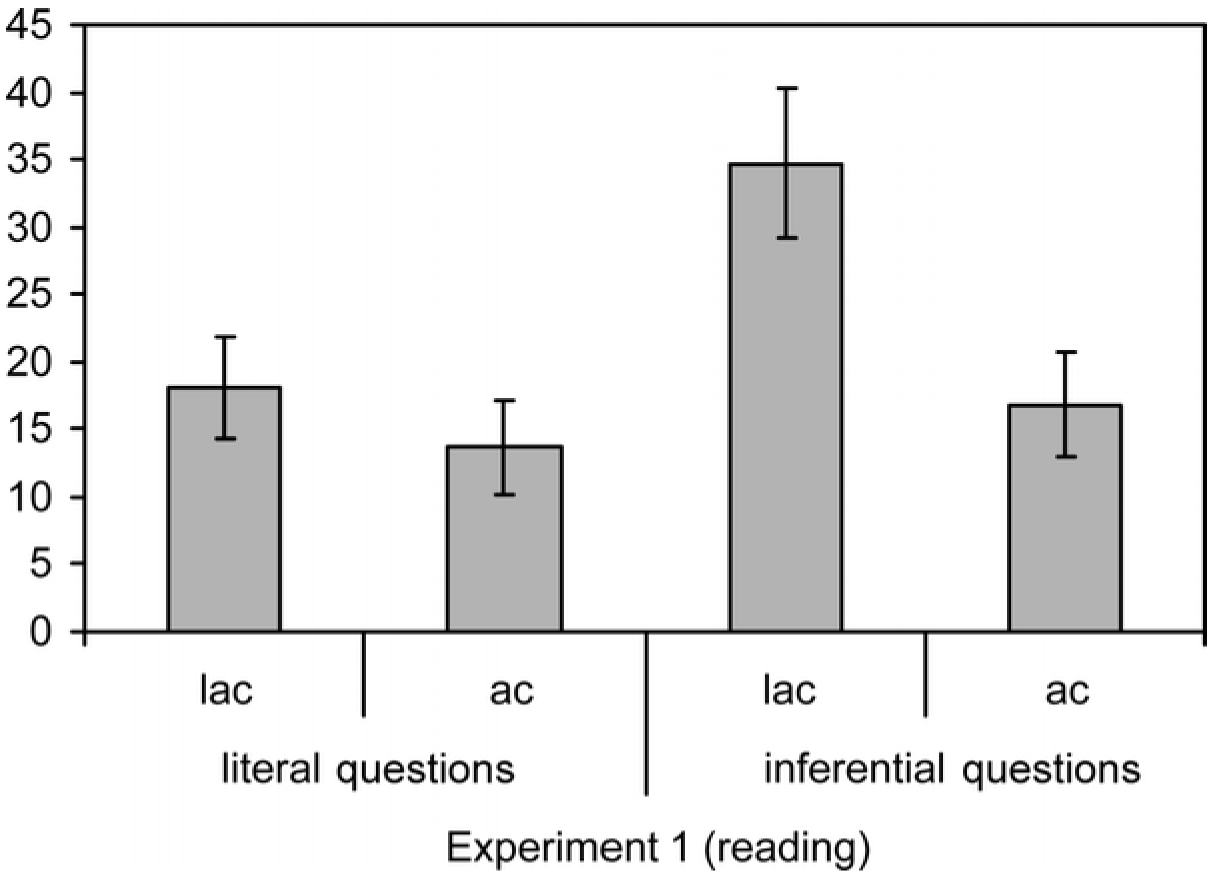

Figure 2. Experiment 2 (listening) - mean percentage errors to literal and inferential questions by advantaged (AC) and less advantaged comprehenders (LAC).

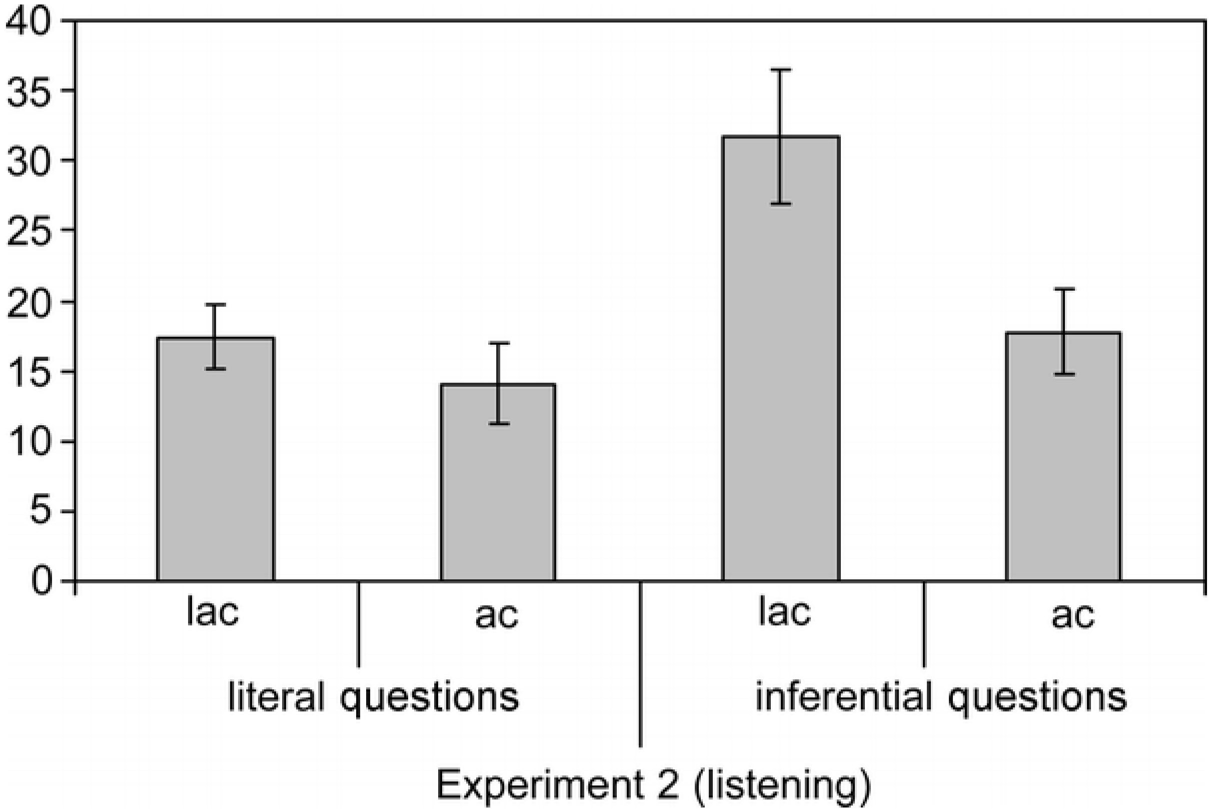

Figure 3. Experiment 2 (listening) - mean percentage errors to literal and inferential questions by children with sight and children with visual impairment.

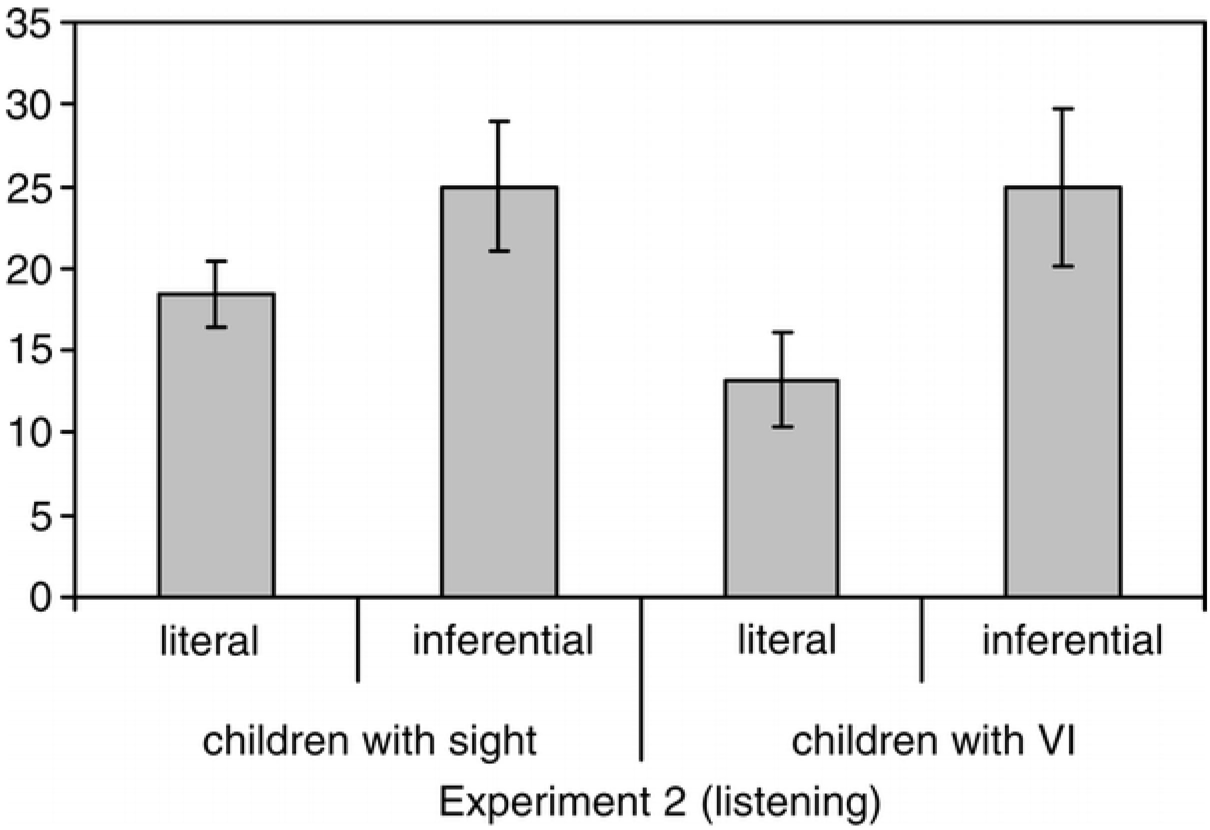

Table 1. Mean and range of NARA decoding and comprehension reading ages by vision group

	NARA decoding age		NARA comprehension age	
	Mean (years;months)	Range (years;months)	Mean (years;months)	Range (years;months)
Children with VI	8;11	7;0–11;4	9;9	7;1–12;1
Children with sight	8;10	7;4–11;6	9;6	7;3–12;5

Table 2. Mean chronological, decoding and comprehension age, and observed-predicted comprehension discrepancy measure by vision group and comprehension skill group, range is shown in brackets

Group	Comprehension skill group	Group *N*	Chronological age (years;months)	NARA decoding age (years;months)	NARA comprehension age (years;months)	Predicted comprehension age (predicted from decoding age)[a]	Residuals (Observed comp. age − predicted comp. age)
Children with VI	Less advantaged comprehenders	$N = 8$	9;9 (7;10 to 11;3)	8;11 (7;0 to 11;4)	9;5 (7;1 to 12;1)	9;11 (7;6 to 12;9)	−0.55 (−0.91 to −0.17)
	Advantaged comprehenders	$N = 9$	10;2 (7;10 to 11;7)	8;11 (7;2 to 10;4)	10;2 (7;10 to 12;1)	9;8 (7;9 to 11;7)	0.48 (0.03 to 1.06)
Children with sight	Less advantaged comprehenders	$N = 10$	8;3 (7;6 to 9;2)	8;8 (7;5 to 11;6)	8;10 (7;3 to 12;4)	9;3 (7;8 to 12;10)	−0.30 (−0.91 to −0.01)
	Advantaged comprehenders	$N = 7$	8;1 (7;5 to 9;0)	9;2 (7;4 to 10;10)	10;3 (8;2 to 12;5)	9;10 (7;7 to 12;0)	0.43 (0.24 to 0.64)

[1] [a]For children with VI, the regression equation that predicted comprehension age from decoding age was (1.2 × decoding age) − 0.94. The overall fit of the line was good, $F(1, 15) = 86.98$, $p < .001$, and accounted for 85% of the variance. For sighted children, the regression equation that best predicted comprehension age was (1.3 × decoding age) − 1.8. The overall fit of the line was good, $F(1, 15) = 193.99$, $p < .001$, and accounted for 92% of the variance.

Table 3. Mean percentage incorrect answers (and *SD*) to story questions by vision group, comprehension skill group, and question type in Experiment 1 (reading)

		Literal questions			Inferential questions		
		Mean	SD	Range	Mean	SD	Range
Children with VI	Less advantaged comprehenders ($N = 8$)	21.88	19.19	0–56.25	38.28	28.63	0–68.75
	Advantaged comprehenders ($N = 9$)	11.11	13.90	0–37.5	15.28	17.43	0–43.75
Children with sight	Less advantaged comprehenders ($N = 7$)	15.00	13.57	0–43.75	31.88	19.42	6.25–68.75
	Advantaged comprehenders ($N = 10$)	16.96	13.84	6.25–43.75	18.75	13.01	6.25–37.5

Table 4. Mean percentage incorrect answers (and *SD*) to story questions by vision group, comprehension skill group, and question type in Experiment 2 (listening)

		Literal questions			Inferential questions		
		Mean	*SD*	Range	Mean	*SD*	Range
Children with VI	Less advantaged comprehenders ($N = 8$)	17.97	12.25	0–34.38	35.16	21.63	9.38–75.00
	Advantaged comprehenders ($N = 9$)	9.03	10.88	0–31.25	15.98	13.39	3.13–37.50
Children with sight	Less advantaged comprehenders ($N = 7$)	16.88	8.10	0–25.00	28.94	19.23	3.13–64.38
	Advantaged comprehenders ($N = 10$)	20.54	8.99	9.38–37.50	20.09	10.50	9.38–40.63