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Children's Problems With Inference Making: Causes and Consequences*

Jane Oakhill
Department of Psychology
University of Sussex, UK

Kate Cain
Department of Psychology
Lancaster University, UK

Understanding a text requires not only understanding the individual words and sentences, but also requires the construction of an integrated model of the text as a whole: a Mental Model (Johnson-Laird, 1983) or Situation Model (Kintsch, 1998). In the first part of this paper, we differentiate between the types of inference that occur as a reader understands a text: necessary inferences (at both the local and global level) and 'merely elaborative' inferences, which might embellish the reader's understanding, but which are not essential to it. We then go on to discuss the problems of children who have a Specific Comprehension Difficulty (i.e. they are able to read words at an age-appropriate level but, nevertheless, have a poor understanding of the text overall). We describe the particular difficulties that such children have in answering inferential questions about a text, and outline the evidence that such difficulties are causally related to comprehension skill. We then discuss the reciprocal relation between vocabulary skills and inference making. Inference skills have a clear role in helping readers to derive the meanings of unknown words from text through the use of contextual cues and, conversely, deep vocabulary knowledge (what is known about words), and rapid access to that knowledge, can support inference making.

KEY WORDS: Comprehension difficulties, Inference abilities, Vocabulary depth

* 本篇論文通訊方式：J.Oakhill@sussex.ac.uk。

Introduction

To properly comprehend a text, the reader needs to do much more than simply understand the individual words and sentences. Adequate understanding requires that the skilled reader derive a mental representation of the situation that the text describes: an integrated mental model of the whole text (Johnson-Laird, 1983). To derive such a model, the reader will need to engage in a number of processes, and this paper will consider one of the major processes in reading comprehension: inference making. Authors necessarily leave implicit some of the links and expansions in a text. In fact, only a fraction of our interpretation of language is licensed by what is explicitly stated. Indeed, a fully explicit text may not only be very tedious, but it would not allow the possibility that the reader could impose their own meaning on that text-making it "their own".

Two processes are critical to inference making. First, in order to integrate the meanings of individual words, sentences and paragraphs, the reader may have to make inferential links between them (commonly called "bridging inferences"). Second, the reader will need to go beyond what is explicitly stated in the text, both by linking the ideas in the text to form a coherent model of the overall meaning, and by bringing general knowledge to bear on their understanding of it. A very short text will serve to illustrate how both these local linking inferences and global coherence inferences are needed to understand even a short and apparently simple text. Consider the following text:

> Mary heard the ice cream van coming.
> She remembered her pocket money.
> She rushed into the house.

As skilled adult reader, you probably made a lot of inferences as you read this short text. First, there are the local cohesion inferences: you readily made anaphoric links to join up the sentences, and appreciated that the pronoun she in the second and third sentences serves the function of linking the sentences because these pronouns refer back to Mary in the first sentence. Second, a good representation of this simple text should enable you as reader to make a number of other inferences to answer questions such as "what does Mary want to do?", "Why did she rush into the house?", "Is Mary a girl, or a woman and why do you think that?", "Why did Mary need to get her pocket money?".

These processes reflect the idea that successful comprehension is both an integrative and constructive process see (e. g. Bransford & Johnson, 1972). Information from different sentences must be combined (integration), but the explicit information in the text will also need to be supplemented by knowledge about the world from long-term memory (construction). These ideas are reflected in more recent theories of text comprehension, which argued that the outcome of skilled comprehension is the construction of a coherent and integrated representation of the meaning of the text: which, depending on the particular theoretical stance of the reader, is variously called a Mental Model (Johnson-Laird, 1983) or a Situation Model (Kintsch, 1988). In this paper, the precise details of the differences between these two theoretical stances are not relevant, but we will refer to a Mental Model, or text representation, throughout. The mental model of the text will be the end product of comprehension, but what we are primarily interested in as researchers are the processes that contribute to this product. There is certainly substantial experimental evidence that readers do not remember the exact wording of a text that they have read, but rather that they remember the gist (Branford & Franks, 1971; McDermott & Chan, 2006; Sachs, 1967). So, for example, if you were asked to state which of the following statements actually occurred in the story about Mary and the ice cream van, above, you might have some difficulty (because they all fit with a gist representation of that text)[1]:

> Mary remembered her pocket money
> She rushed into the house
> Mary saw the ice cream van coming

[1] Only the second sentence was actually presented.

Types of inferences

A great deal has been written about the different types of inferences needed to understand text (see Graesser, Singer, & Trabasso, 1994). Although there is still some disagreement about the nature and types of inference required for effective text comprehension, there is substantial evidence that at least the two mentioned above are important. These are local cohesion inferences (aka bridging inferences or text-connecting inferences), which are needed to establish coherence between different parts of the text, and global coherence inferences, which need to be made to make the text as a whole cohere. Local cohesion inferences are typically triggered by "linguistic signals" such as a definite reference, or other anaphoric links such as pronouns (Mary… she… the girl). Global coherence inferences in contrast, might depend on links between meanings of words or phrases in the text, but the need for them is not usually explicitly "signaled". This type of inference might be made, for example, to derive the setting or theme of the text overall.

As far as educational settings are concerned, McNamara and Magliano (2009) suggest that the construction integration (Kintsch, 1998) and constructionist (Graesser, et al., 1994) models are most applicable to understanding children's comprehension development and difficulties. Both of these models stress the importance of knowledge-based inferences, and also differentiate between the construction of local cohesion and global coherence. Both types of inferences are needed in order to construct an integrated representation of the text overall. Local cohesion inferences are needed to establish links in the text (typically anaphoric or other co-referential links between sentences). Global coherence inferences are needed to fill in missing details and understand the text as a whole and typically require the incorporation of information from outside the text (general knowledge) with information within the text.

Other inferences are "merely" elaborative. For example if you read "he slipped on a wet spot and dropped the delicate glass vase on the floor" you might infer that the delicate glass vase broke when it was dropped. However, there is no evidence that such merely elaborative inferences are made during reading. Indeed, it can plausibly be argued that only inferences that are necessary for the coherence of the text will be made on-line during reading since infinitely many inferences could be made from a text, and the reader's inferential machinery has to be restrained in some way. Empirical support for this idea is provided by, for example, Thorndyke (1976) and Corbett and Dosher (1978).

In the remainder of this paper, some of the studies that show that children with comprehension difficulties have particular problems with inference making will be outlined, and possible reasons why this might be the case will be discussed. The direction of the link between inference skill and comprehension skill will then be considered, and evidence that supports a link <u>from</u> inference <u>to</u> comprehension will be presented. Finally, the relations between different aspects of vocabulary knowledge and inference skills will be considered, with reference in particular to the Lexical Quality Hypothesis (e.g. Perfetti, 2007; Perfetti & Hart, 2001; Perfetti, Wlotko, & Hart, 2005).

The particular difficulties of poor comprehenders

Problems with reading comprehension may arise for a number of reasons: some have to do with decoding and others with language comprehension. When poor reading comprehension occurs in the presence of normal or good word reading, the difficulties are specific to comprehension (rather than being more general reading problems) and are referred to as specific comprehension difficulties.

In our studies of children with poor reading comprehension, we typically select children using at least two assessments: one is a group administered assessment of word recognition, where the child's task is to choose a word from four options to go with a picture, or (in more difficult versions of the task) to select a synonymous word from a choice of four. The other is an individually-administered assessment of word reading and comprehension (typically the Neale Analysis of Reading Ability, 1997). In this assessment, the child is required to read out loud a series of passages that increase in difficulty and to answer a number of comprehension questions about each passage. Any words that the child reads wrongly, or is unable to read, are corrected or supplied by the assessor. In this way one can be sure that

any problems with comprehension cannot be simply attributed to the fact that the child is unable to read the words in the text. Following these tests, children can be selected who are matched on both tests of word reading, but who differ in comprehension skill. Typical groups of participants can be seen in Table 1.

Table 1

typical groups of good and poor text comprehenders

	chron. age	word reading	reading comp.	sight vocab (max=45)
Good comps	7,8	7,8	8,3	38
Poor comps	7,9	7,10	6,7	37

There is evidence that poor comprehenders have problems making both sorts of inference discussed above. In Cain and Oakhill's (1999) study, the children read a number of short stories each followed by several questions. Some questions tapped their literal comprehension, and there were two types of inference question, which tapped the sorts of inferences described above: local cohesion and global coherence inferences. The poor comprehenders performed poorly on both types of inference question, but did not have any problems answering the literal questions. The pattern of performance in the two groups can be seen in Figure 1.

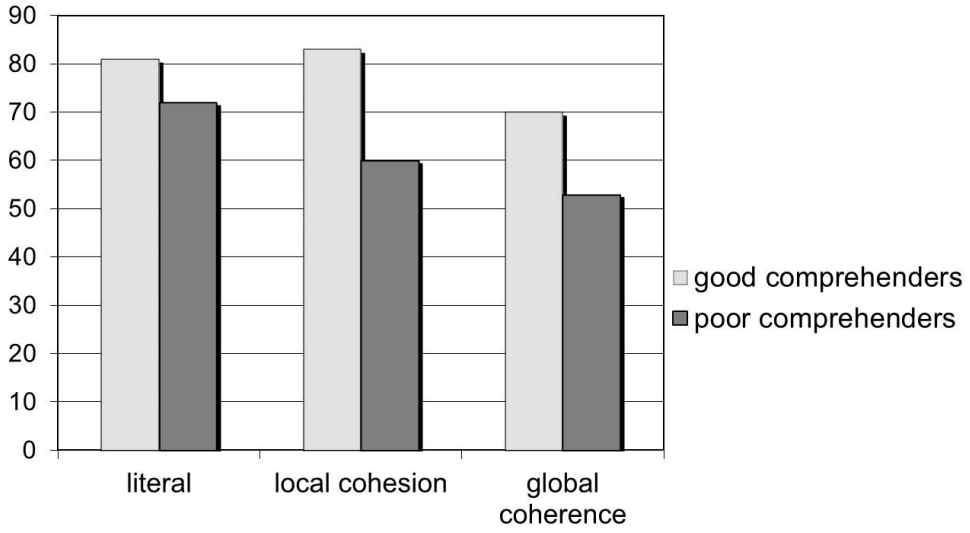

Figure 1. percentage of correct responses as a function of comprehension skill and question type

Of course, in order to be able to answer even literal questions about the text, one needs to have remembered the content of the text, so an obvious question is whether poor comprehenders simply have memory problems. However, it has been shown that poor comprehenders have difficulties in answering questions even when they are free to search through and reread the text to help them find the answers (Oakhill, 1984, see also Cain & Oakhill, 1999). Thus, their problems cannot be attributed simply to their inability to remember the wording of the text.

Another factor that might influence the ability to make inferences is background knowledge: an inference that relies on background knowledge cannot be made if the child does not possess the relevant knowledge. The influence of this variable was investigated by Cain, Oakhill, Barnes and Bryant (2001). To ensure that all children in their study had comparable background knowledge, they taught them a knowledge base about an imaginary planet until all children had learnt the knowledge base to criterion (perfect). Even under such circumstances, the poor comprehenders still exhibited specific difficulties with inference questions. Their problem seemed to be not that they did not have the knowledge, but that they failed to activate and use relevant knowledge when it was required to make an inference. Work by Barnes and colleagues (Barnes, Dennis, & Haefele-Kalvaitis, 1996) suggests that availability of knowledge is the critical factor.

Issues of causality

Thus far we have demonstrated that there is a clear link between inference skill and reading comprehension. However, from the research described so far, it is not clear what the direction of this link is. It may be that being good at reading comprehension and reading a lot provides practice in inference skills, and thus improves them. Alternatively, it may be that inference skills are causally implicated in reading comprehension and its development: thus, being good at inference skills supports comprehension. It is important to have more information about the direction of causality if we are going to be able to suggest ways of improving comprehension and remediating comprehension difficulties. Obviously, there is no point in training a skill that is correlated with comprehension if practice in reading comprehension will improve that skill anyway.

There are several ways in which causality can be explored. Each of these will be discussed in more detail now with some examples of the designs and findings. Briefly, three main designs can be used to address causality: comprehension-age match studies, longitudinal studies, and training studies. In the comprehension-age match design a group of average, typically younger, readers who have the same absolute level of comprehension skill as the older poor comprehenders, is included. This group is called the comprehension-age match group. If the comprehension-age match group performs better at (for example) inference making than older poor comprehenders then they cannot be better because they have better comprehension (because they do not). Thus, a causal link in the opposite direction-from inference making to comprehension-is more likely (but not proven from such data alone). An example of typical groups of children from such a design is shown in Table 2 (see, e. g. Cain & Oakhill, 1999; a detailed discussion the interpretation of this design can be found in Cain, Oakhill, & Bryant, 2000).

Table 2

Characteristics of typical groups of subjects in a comprehension-age match design

	Less-skilled	Skilled control	Younger control
Age yrs.	7,8	7,8	6,8
Neale accuracy	7,11	7,10	6,8
Neale Compr.	6,7	8,2	6,8
Gates vocab.	37.14	37.88	33.59

As can be seen from the characteristics of these children, the less skilled comprehenders and the younger control group have roughly the same Neale comprehension scores. In the case of the less skilled group, these scores are about a year behind on average for their age whereas, for the younger control group, their reading comprehension is average for their age. In a study using such groups, the children's performance was compared on stories with the three types of questions illustrated above. There were two types of inference questions: local cohesion inferences and global coherence inferences, and literal questions, which tap information that was actually presented in the text. The children's performance on these three question types can be seen in Figure 2.

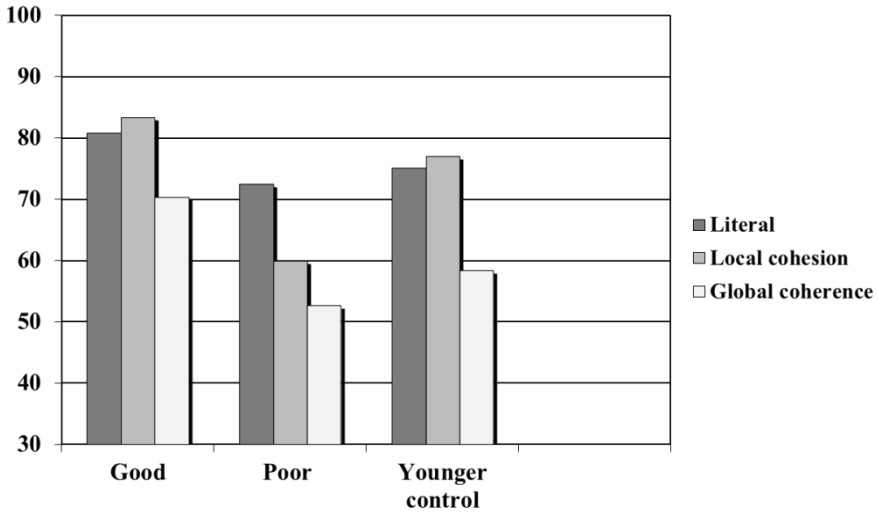

Figure 2. percentage of correct responses as a function of comprehension skill (including CAM group) and question type

As can be seen from Figure 2, the performance of the three groups of children was rather similar and not significantly different for the literal questions. As is usual, the poor comprehenders performed worse

than the same age good comprehenders on both the local cohesion and global coherence inferences. But what is particularly interesting about these data is that the poor comprehenders also performed more poorly than the younger control group on both inference types. In the case of the global coherence inferences this difference was not significant but it was significant for the local cohesion inferences. Thus this pattern of data demonstrates that the older poor comprehenders cannot be performing more poorly on the inference questions simply as a consequence of their poor reading comprehension because their comprehension is at the same level as that of the younger control group who do better on these questions. This means that a causal link from comprehension ability to inference skills can be ruled out. It does not however mean that a link in the opposite direction from inference making to comprehension skill is proven. In order to support such a causal link other methodologies and designs are required.

The second method for exploring causality is longitudinal studies. In a longitudinal study one can explore the relation between early skills and later reading ability-in this case comprehension ability-in order to see which of the earlier skills and abilities best predict development in comprehension. In a recently published longitudinal study (Oakhill & Cain, 2012) we explored the abilities that predict reading comprehension skill between the ages of 7 and 11 years assessing the children at three different time points. We assessed a number of different abilities at each time point: the children's reading word reading ability and their reading comprehension, verbal and performance IQ, and general language and cognitive skills that are related to reading specifically: vocabulary, syntactic knowledge, phonological skills (phoneme deletion and odd one out tasks) and working memory tasks. In addition, we included measures of three specific processes important for the construction of the mental model that have previously been found to be correlated with reading comprehension in children: that is inference skills, comprehension monitoring (which was measured by an inconsistency detection task) and story structure understanding (which was measured by a task that required the children to reorganise a set of jumbled sentences into a coherent story and also a task that required children to explain the purpose and content of story titles).

Comprehension skill at time point three-that is when the children were aged 10 or 11 years old-was predicted by their earlier comprehension ability and also by their verbal ability and vocabulary. But, independently and over and above these measures the three measures of specific comprehension skills namely: inference making, story structure understanding and comprehension monitoring all accounted for variance in later comprehension skill. The longitudinal design is particularly interesting in assessing causality between these earlier skills and later reading comprehension because, even once the level of children's reading comprehension at the beginning of the study had been controlled for-that is the so-called "auto-regressor"-the component skills that we assessed predicted comprehension later in development. Thus this pattern of results is an indication that early comprehension skills are not simply associated with later comprehension through their relation with comprehension ability because they predict independent variance in later comprehension even when early comprehension is taken into account.

The final way of assessing causality is by the use of training studies. The assumption of such studies is that if a skill is causally implicated in the development of another ability then training that skill-in this particular case inference making-will result in an improvement in the ability of interest-in this case comprehension skill. Our own training studies have focused on trying to improve the processing strategies that children use when they are reading text and in particular the ways in which they think about text: the way in which it relates to what they know and whether their understanding is adequate. The general idea of such training is to get children more aware of and more involved in their own comprehension-to encourage inferences and other skills such as the monitoring of their comprehension. In one study, Yuill and Oakhill (1988) showed the training in inference making, prediction and question generation (using a reciprocal teaching methodology) was effective in improving comprehension scores on standardised test. In a more recent study, graphic organisers were used to enhance the contribution of the reader's knowledge to inference making. This training in use of graphic organisers had positive effects on both inference making and reading comprehension (Elbro & Buch-Iversen, 2013). Further information about this and related studies can be found in the paper by Elbro (this volume).

Inference, memory and vocabulary learning

We now turn to one aspect of language that is known to be fundamental to comprehension skill: vocabulary. At a superficial level, vocabulary knowledge will be crucial for comprehension because, even if words can be decoded to sound, the text cannot be understood unless the meanings of (most of) the words are understood. However, it is not necessarily the case that poor comprehenders have poor vocabularies. Groups of good and poor comprehenders, who differ on standardized measures of reading comprehension as well as tests of specific comprehension skills such as inference making, can be matched for knowledge of both written and spoken word meanings (Cain, Oakhill, & Lemmon, 2004) and, in general, poor comprehenders difficulties in reading comprehension cannot be accounted for by their level of vocabulary alone. Thus, although children's knowledge of word meanings and their reading comprehension are typically quite highly correlated, it is quite possible to find children who have problems with reading comprehension even in the presence of a good level of vocabulary.

However, the most commonly used tests of vocabulary are measures of vocabulary at shallow levels (e. g. assessments of ability to select one from a choice of pictures to go with a word). Such measures are typically described as assessments of breadth of vocabulary, and the knowledge about the words assessed can be fairly superficial. However, recent research suggests that measures of vocabulary knowledge at greater depths (typically referred to depth) might be more important for reading comprehension (Ouellette, 2006; Tannenbaum, Torgesen, & Wagner, 2006), an issue that will be discussed further below. In this section and the one following, the more specific relation between vocabulary knowledge and inference skill will be considered.

First, the issue of how vocabulary is learnt from text will be considered. It is generally agreed that written text is an important source of new vocabulary (and the refinement of existing vocabulary) once children become relatively fluent readers (Cunningham & Stanovich, 1998; Nagy & Scott, 2000). Reading provides opportunities to acquire, refine, and consolidate vocabulary knowledge via inference from context (we continue to refine our vocabulary in this way throughout our lives, providing we read sufficiently challenging texts). Printed text affords more learning opportunities than does spoken language, mostly because writers tend to use a different register to speakers, and the written register is likely to include more obscure vocabulary items.

There is experimental evidence to show that poor comprehenders do have more difficulty inferring the meanings of unknown vocabulary items from context, particularly when the memory demands are high. Cain, Oakhill and Lemmon (2004) asked good and poor comprehenders (9-to 10-year-olds) to try to work out the meanings of unknown words (in fact, nonwords) in short texts, such as that shown in Table 3. In the example story, the unknown word is wut. There are various clues to the possible meaning of the word in the text (shown in grey in Table 3) and these clues appeared in the text either immediately following the unknown word, or after some filler text. As can be seen in Figure 3, the poor comprehenders in this study were only worse at coming up with a reasonable meaning for the unknown word when the clues were more distant from the target word. In the near condition, there was little difference between the good and poor comprehenders in their ability to infer meanings. Thus, it seems that poorer compehenders do have the potential to make such inferences about vocabulary (at least when explicitly required to infer meanings), but if they have to integrate information across several sentences in the text in order to do so they find the task more difficult than do good comprehenders.

Table 3

Example of materials used in vocabulary inference study

Intro: Lucy was taking her dog, Ben, to the park. First, she had to find Ben's **wut**.
* near: clues appear immediately after novel word
* far: clues appear after the filler text (here)
Clues: Dad suggested taking a football, but that was not quite right. The football was too big to play catch with and it had lost its bounce.
Filler: She searched all the rooms in the house, even the kitchen. During her hunt, she found all sorts of things….
Ending: Lucy decided that she had to be more tidy in the future.

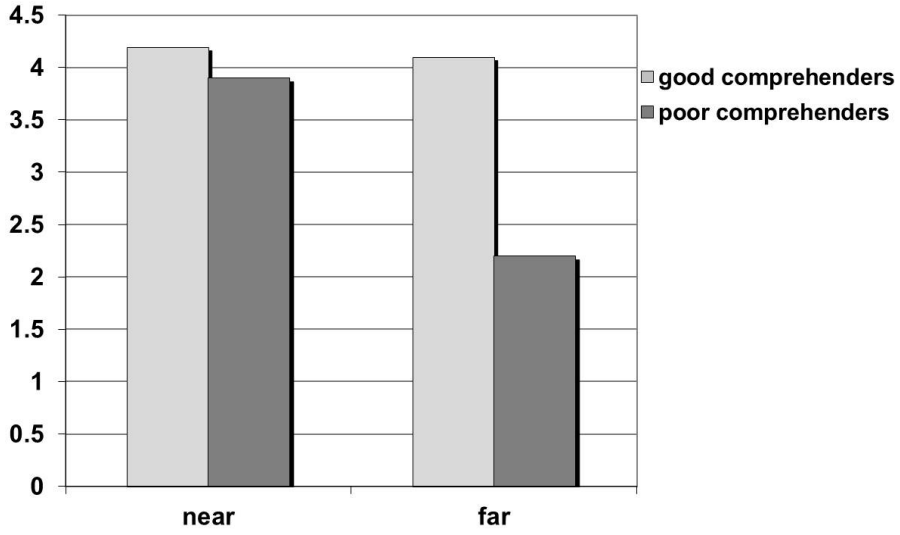

Figure 3. Ability to infer the meaning of nonsense words as a function of distance and comprehension skill

In another study of vocabulary learning from text we capitalised on some of the data from the longitudinal study mentioned above (Oakhill & Cain, 2012). The results of those analyses (reported in Cain & Oakhill, 2011) showed that even if good and poor comprehenders have rather similar levels of vocabulary skills at age 8 years, poor reading comprehension at 8 years results in poorer vocabulary 2-3 years later. The pattern of results was identical whether oral (British Picture Vocabulary Scale: Dunn, Dunn, Whetton, & Pintillie, 1982) or written (MacGinitie, MacGinitie, Maria, & Dreyer, 2000) vocabulary was measured. The pattern of results for good and poor comprehenders on the measure of written vocabulary is shown in Figure 4.

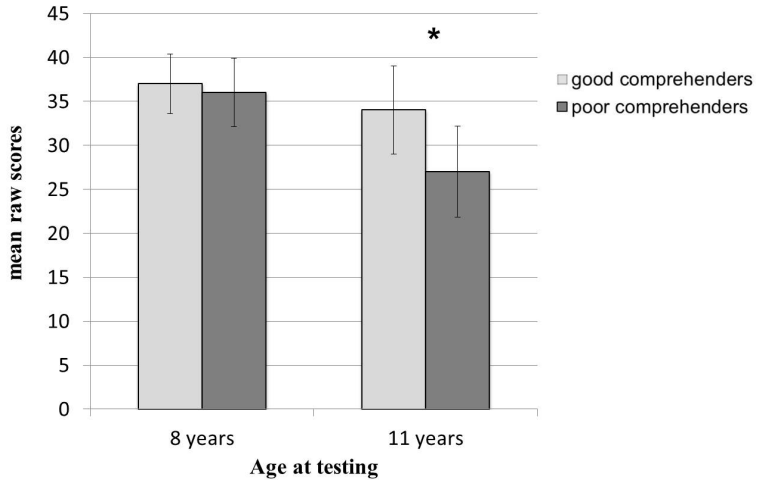

Figure 4. written vocabulary skills as a function of comprehension skill and age

Furthermore, to investigate the relations between reading experience and growth in vocabulary knowledge across time, a series of fixed-order hierarchical multiple regressions was conducted. These analyses were conducted on data from the entire data set, and not only the data from the good and poor comprehenders reported in the previous analyses above.

The aim of these analyses was to explore the extent to which reading experience and earlier reading comprehension (both measures taken at age 8) accounted for individual differences in vocabulary growth, once cognitive ability (non-verbal IQ) had been taken into account. Separate analyses were conducted to assess the predictors of written vocabulary skill at a later age (either 11, 14 or 16 years) as the outcome variable. In each analysis, the predictor variables were the measures taken at the first time point, when the children were aged 8. Cognitive ability was entered at the first step, followed by vocabulary. At the third and final step, either the score obtained on a reading questionnaire (which assessed amount of independent leisure reading as a measure of "reading experience") was entered or (in a separate analysis) the score obtained on the reading comprehension assessment. The results of these analyses are presented graphically in Figure 5. They show that reading experience explained later vocabulary competence over and above general cognitive ability and an earlier measure of vocabulary. In addition, reading comprehension also explained later vocabulary even after the same controls

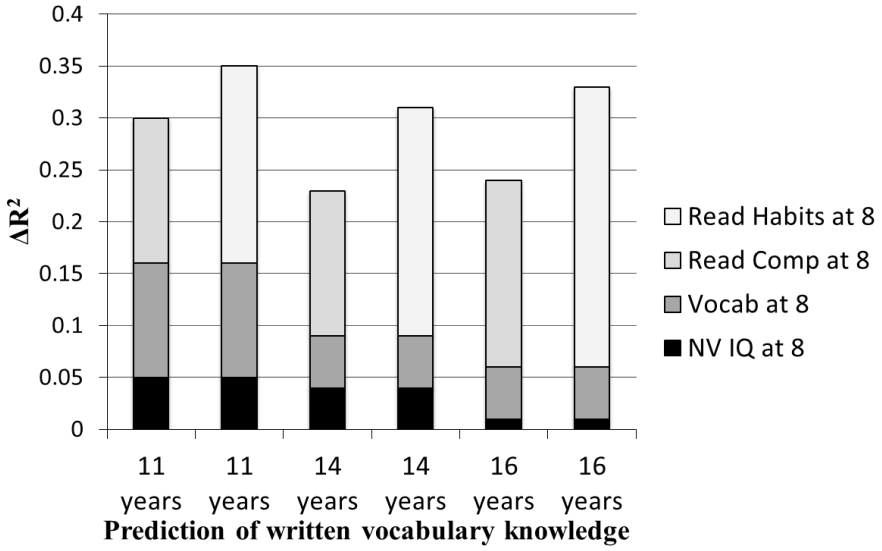

Figure 5. amount of variance accounted for in written vocabulary knowledge by different variables at three time points

Thus, to summarise this section, poor comprehenders are not good at deriving plausible meanings of new vocabulary items from context. This difficulty is probably related to the poor comprehenders' inferior inference skills, and seems to be exacerbated when the task requires integration of information across several sentences in the text (and is, therefore, more memory demanding). There is also evidence that comprehension level influences vocabulary development across several years. In particular, poor reading comprehension at age 8 was predictive of poorer vocabulary 2-3 years later and not only reading comprehension ability, but also amount of reading experience, predicted the children's later vocabulary competence.

The role of vocabulary in inference generation

The section above explored the way in which inference skills might support vocabulary development. In this section, we consider the evidence for a link in the opposite direction and consider the role that vocabulary knowledge can play in supporting inferences. First, it is necessary to make clear the distinction between different aspects of vocabulary: so-called breadth vs. depth of vocabulary knowledge. Roughly, breadth corresponds to how many words a person knows (and is what is typically measured in vocabulary assessments, such as the Peabody, or the UK equivalent, the British Picture Vocabulary Scale), whereas depth corresponds to what is known about those words (e. g. knowing multiple, or more subtle, meanings; being able to provide synonyms or definitions). Thus, a reader might be able to match up a word with a picture (breadth), but might have rather little idea about the broader meanings and uses of that word (depth). Let us consider, as an example, the word platypus. You may not have any detailed knowledge of the meaning of this word, but might at least know that it is an animal and that it has a "duck bill": probably sufficient knowledge to pick out a picture of a platypus from an array of pictures of animals. So, in one sense (breadth of knowledge) you know the meaning of the word. However, you may know very little about the character and habits of the platypus. For instance, more in depth knowledge would include the knowledge that the platypus is indigenous to Australia, and that it is

a mammal. Greater depth of knowledge might include the information that the platypus is a very unusual type of mammal because (although it is warm-blooded and does lactate) it lays eggs, rather than giving birth to live young. Even greater depth of knowledge might include the fact that the platypus is the only venomous mammal. Both Ouellette (2006) and Tannenbaum et al., (2006) showed that assessments of depth and breadth of vocabulary were distinguishable and made separate contributions to comprehension skill. Depth of vocabulary knowledge is likely to be more important than breadth in supporting inference making because rich and well-connected semantic representations of words will permit the rapid activation not only of a word's meaning but also those of related concepts.

A specific example can serve to illustrate how greater depth of vocabulary knowledge might facilitate relevant inferences. Supposing a reader encounters the following short text: “The platypus was reluctant to move. She was curled round the eggs protectively”. Depending on the reader’s knowledge they might interpret this text differently. If the reader does not know anything much about the platypus and, in particular, does not know that it is a mammal, then they are likely to assume that the platypus is curled round its own eggs and will not have any problem with the text. And, if the reader knows that the platypus is an egg-laying mammal they will also assume that she is protecting her own eggs. However, a little knowledge can be misleading. So, if the reader knows something about the platypus (it is furry and warm blooded and a mammal), but does not know that it is a very unusual mammal (in that it lays eggs), and they are trying to link these sentences, then they will encounter a problem since “eggs” does not fit with their (insufficient) knowledge of “platypus”. In such a case, the reader might infer that, contrary to what they previously believed, the platypus lays eggs (and is either not a mammal, or an odd one: in this case the reader might learn from the text) or they might reason that the eggs the platypus is curled round are not her own eggs, but perhaps some taken from a bird’s or reptile’s nest, which is keeping safe to eat later.

These ideas about the relation between word-level knowledge (in this case knowledge about word meanings) and successful reading comprehension is closely related to Perfetti’s Lexical Quality Hypothesis (e.g. Perfetti, 2007; Perfetti & Hart, 2001; Perfetti, et al., 2005). The crucial idea is that a low quality lexical code, which is retrieved with effort, can interfere with comprehension processes that are dependent on a high quality code. The concept of Lexical Quality includes a range of knowledge about word forms (phonology, orthography, grammar) and also meaning. The focus here is on that last aspect: the quality of a word’s meaning representation. Thus, the availability of associative links between words-the consequence of a rich (deep) vocabulary-might add comprehension by supporting inference making. In particular, depth of vocabulary knowledge is likely to be more important than breadth: rich and well-connected semantic representations will permit the rapid activation not only of word meanings, but also of concepts, and this activation of semantic networks will provide the underpinning for inferences (see Perfetti, 2007; Perfetti, Yang, & Schmalhofer, 2008). We hypothesise that, in children, a rich (deep) vocabulary knowledge will aid inference making in comprehension because many of the local cohesion and global coherence inferences in text are dependent on semantic links between words in the text (some more specific examples are provided below). This activation of semantic links can then provide the basis for many of the inferences that are crucial for the construction of a coherent representation of a text.

Some preliminary work with children provides evidence that depth of knowledge is strongly related to making global coherence inferences from text. In a recent study, we showed (Oakhill, Cain, & McCarthy, 2015) that depth, but not breadth, of vocabulary knowledge was an important predictor of global coherence inferences, and that this relation held even when word reading skill and literal memory for the text had been taken into account (in multiple regression analyses). A recent study of children aged 6 to 10 years also indicates that vocabulary is a more important predictor of global coherence inferences than inferences required to link adjacent sentences in text (Currie & Cain, in press).

The data reported in that paper also showed that vocabulary knowledge is more important for some aspects of comprehension than for others: vocabulary knowledge was related to inference skills, but not to literal memory for the text. Second, vocabulary in general was more closely related to performance on global coherence inferences than to local cohesion inferences.

We also have evidence that comprehension skill in children is related to ability to automatically derive themes in word lists. In a recent study, Weekes, Hamilton, Oakhill & Holliday (2008) used the DRM (Deese, 1959; Roediger & Mcdermott, 1995) false memory paradigm in which the children were

required to listen to, and to try to memorise, a short list of words. For example, one word list was: rest, bed, snooze, dream, tired, blanket. The children then completed a recognition test in which they were asked to differentiate between words that had/had not occurred in the lists they had been read. The results showed that the good comprehenders were more likely than poor comprehenders to falsely claim that sleep had been in the original list in the example given above, even though they did not have poorer word memory more generally. This result can be taken as an indication that the good comprehenders are more likely to automatically derive "themes" from the word lists (even though this is not a requirement of the task). This propensity to derive themes from word lists might well carry over to text comprehension because very often the main theme or the setting of a text can be derived from a number of specific words in a text. For example, if you were to read a text that contained the words: trolley, shelves, tins, packets, aisle, scan, bags, pack, till, you might reasonably infer that the text is situated in a shop or supermarket. No one of those words in isolation will support that inference about the setting, but taken together they connect up to provide a coherent overall indication of the setting of the text.

Summary

There is now substantial and reliable evidence that (among other problems) poor comprehenders have difficulties in making inferences from text. Furthermore, there is evidence that this relation is causal: the ability to make inferences supports the development of later comprehension skills, and that the difficulties with inference making cannot wholly be explained by problems with remembering the information in a text, or by lack of relevant background knowledge. Furthermore, evidence is emerging to suggest that vocabulary knowledge and, in particular, depth of vocabulary knowledge, supports inference skills in children, and supports reading comprehension more generally.

The evidence for a causal link between inference skills and reading comprehension suggests that training in skills that encourage the integration of information in text by making inferences and activating and using appropriate knowledge (even from single words) will improve comprehension and, indeed, there is evidence to support this suggestion (see, e. g. Yuill & Oakhill, 1988). Inference skills also support vocabulary development, so children can be encouraged to develop their vocabulary through inferential reasoning about unknown words. Depth of vocabulary knowledge in particular is related to comprehension and inference skill, so rich vocabulary knowledge needs to be developed and activated for successful comprehension.

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兒童的推論問題：原因與後果*

珍　奧克西爾
英國蘇薩克大學
心理學系

凱特　肯恩
英國蘭開斯特大學
心理學系

理解篇章不僅僅只要讀懂個別的字詞和語句，並且也要能建構一個有關通篇文章的統整模式，稱之為心智模式或者情境模式。在本文的第一部分，我們區分幾種讀者理解文章時會出現的推論：一種是必要性推論（包括局部與整體層次的推論），另一種是可以豐富讀者的理解，但是並非必需的〝單純精緻化〞推論。然後我們接著討論有特定理解困難的兒童問題（界定為他們識字能力達到該有的年齡水準，但是對於篇章的理解能力偏弱）。我們描述這類兒童在回答根據文章進行推論性問題的困難點，並且呈現證據說明這類的困難和理解技能具有因果關係，我們更進一步討論詞彙能力和推論技能的雙向關係。推論技能對於有助於讀者運用的文章脈絡線索推敲出不熟悉字詞的意義；反之，如果讀者具有深度的詞彙知識（即對詞彙所知的一切）與快速提取詞彙的能力，也有助於進行推論。

關鍵詞：理解困難、推論能力、詞彙深度

* 本篇論文通訊方式：J.Oakhill@sussex.ac.uk。