Research Report DCSF-RR031

Effective Teaching of Inference Skills for Reading

Literature Review

Anne Kispal
National Foundation for Educational Research

department for
children, schools and families

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Executive summary

Introduction

In 2007, the Department for Children, Schools and Families (DCSF) commissioned the National Foundation for Educational Research (NFER) to conduct a review of research evidence on inference skills for reading, including the skills that constitute inferencing and how to teach them.

Background

The ability to make inferences is, in simple terms, the ability to use two or more pieces of information from a text in order to arrive at a third piece of information that is implicit. Inference can be as simple as associating the pronoun 'he' with a previously mentioned male person. Or, it can be as complex as understanding a subtle implicit message, conveyed through the choice of particular vocabulary by the writer and drawing on the reader's own background knowledge. Inferencing skills are important for reading comprehension, and also more widely in the area of literary criticism and other approaches to studying texts. The National Curriculum lays much emphasis on the skills of inference, especially at Key Stages 2 and 3.

Findings

A key finding of the review was that the ability to draw inferences predetermines reading skills: that is, poor inferencing causes poor comprehension and not vice versa.

Are there different skills within inference?

Different researchers have identified many different kinds of inference; however, there is no general consensus in the literature about the number of types of inference, or how they should be named.

The most frequently cited inference types have been defined and exemplified below. It should be noted that there is some overlap between these categories.

Coherence inferences (also known as text-connecting or intersentence inferences). These maintain textual integrity. For example, in the sentence *Peter begged his mother to let him go to the party*, the reader would have to realise that the pronouns 'his' and 'him' refer to Peter to fully understand the meaning.

Elaborative inferences (also known as gap-filling inferences). These enrich the mental representation of the text, e.g: *Katy dropped the vase. She ran for the dustpan and brush to sweep up the pieces.* The reader would have to draw upon life experience and general knowledge to realise that the vase broke to supply the connection between these sentences.

Local inferences. These create a coherent representation at the local level of sentences and paragraphs. This class of inferences includes:

1. coherence inferences (described above).

2. “case structure role assignments”, e.g. *Dan stood his bike against the tree.* The reader needs to realise that the tree is assigned to a location role.

3. some “antecedent causal” inferences, e.g. *He rushed off, leaving his bike unchained.* The reader would need to infer that Dan was in a hurry and left his bicycle vulnerable to theft.

Global inferences. These create a coherent representation covering the whole text. The reader needs to infer overarching ideas about the theme, main point or moral of a text by drawing on local pieces of information.

On-line inferences: inferences drawn automatically during reading.

Off-line inferences: inferences drawn strategically after reading.

How can pupils best be taught to use inference skills?

The research evidence reviewed suggested that, in order to be good at inferencing, pupils need to:

- be an active reader who wants to make sense of the text
- monitor comprehension and repair misunderstandings
- have a rich vocabulary
- have a competent working memory

Inferencing skills are also facilitated by:

- having a wide background knowledge
- sharing the same cultural background as that assumed by the text

Some of these factors are more pertinent to certain types of inference than others. For example, having a wide background knowledge does not influence the ability to draw coherence inferences to the same degree as it does elaborative or global inferences.

Although the characteristics of good inferencers have been identified, there is limited research evidence to suggest how teachers could best improve the inferencing abilities of their pupils. Available research evidence points to the importance of:

Teacher modelling of inferencing:

- teachers "thinking aloud" their thoughts as they read aloud to pupils
- teachers asking themselves questions that show how they monitor their own comprehension
- teachers making explicit the thinking processes that result in drawing an inference.

Word level work:

- developing fluent basic reading skills (e.g. practice in decoding print)
- vocabulary building: aurally and in reading
- lexical training, e.g. in local cohesive devices (such as pronouns and connectives).

Text level work:

- making explicit the structure of stories
- discussing the role and usefulness of a title
- emphasising that fiction allows multiple interpretations and inference making.

Questioning by the teacher:

- asking *'How do you know?'* whenever an inference is generated in discussion of a text
- asking questions about relationships between characters, goals and motivations
- asking questions that foster comprehension monitoring, such as *Is there information that doesn't agree with what I already know?*
- ensuring that pupils are not interrupted in their reading by asking questions during reading time, or launching into questioning too soon afterwards.

Questioning by pupils:

- training pupils to ask themselves *Why*-questions while reading
- teaching the meaning of the question words '*who'*, '*when'*, ' *why'* etc.
- asking pupils to generate their own questions from a text using these question words.

Activation of prior knowledge:

- asking pupils to generate associations around a topic, and discuss and clarify their collective knowledge.

Prediction and contextualisation:

- working on predictive and contextualising skills for example via cloze and similar exercises.

Aural work:

- listening to stories and story tapes
- listening comprehension activities
- practising inferential questions on aurally presented texts.

Choosing the right texts:

- taking care not to choose texts that are too easy for classwork: very explicit texts provide few opportunities for inferences to be made.

Cross curricular work:

- discussion of texts in curricular areas outside literacy.

What strategies are most effective in teaching inference skills to pupils of different ages/abilities? What does progression in inference look like and how can it be supported?

No evidence which directly answers these questions was identified.

On the subject of pupils' age, it was apparent that inference can be seen in children of all ages and can even be practised with pre-readers using picture books. This suggests that inferencing can be practised outside the domain of reading with pupils of all ages and that one way of cultivating these skills in young readers and reluctant readers is to do it in discussion, orally.

However, at the same time the research indicates that pupils are most receptive to explicit teaching of inference skills in their early secondary years.

Methodology of the review

This review was carried out between August and December 2007. The aim was to uncover what was known about the teaching of inference by looking through the most robust work conducted in the UK over the last 20 years and from the USA over the last decade. The search was guided by four research questions:

- Are there different skills within inference?
- How can pupils best be taught to use inference skills?
- What strategies are most effective in teaching inference skills to pupils of different ages/abilities?
- What does progression in inference look like and how can it be supported?

Overall, few studies explicitly investigating best methods for teaching skills were identified. The conclusions of this review should therefore be considered as indicative rather than comprehensive.

1. Introduction

This work was carried out under contract to the Department for Children, Schools and Families (DCSF) in response to a request to review literature on inference and deduction. From Key Stage 2 onwards, inference is at the centre of the reading curriculum. Skills of inference are needed not just to be able to 'read between the lines,' to detect the unspoken hidden meanings that enrich overall understanding of a text or to draw one's own personal conclusions about a text. They are needed for all the other tasks that teachers want their children to do in handling texts: to understand the effects achieved through choices in vocabulary, to recognise what the writer is trying to accomplish through the whole text and to appreciate what the impact on the reader may be. Almost any reading activity that goes beyond literal understanding involves some degree of inference.

The research questions guiding the review were:

- Are there different skills within inference and deduction?
- How can pupils best be taught to use inference and deduction skills?
- What strategies are most effective in teaching inference and deduction skills to pupils of different ages / abilities?
- What does progression in inference and deduction look like and how can it be supported?

The evidence base

The search was targeted at British research dating from 1988 and international literature published in the English language from 1999. The aim was to seek out information relating primarily to pupils in Key Stages 2 and 3. As a result of the searches conducted by the methods described in Appendix 1, roughly one hundred publications were identified as relevant to the investigation. Upon inspection, 41 of these were read and reviewed. The aim was to read both the seminal works, which tended to date from the 1980s and early 1990s, and recent publications to trace the evolution of thinking in the area and to determine the current 'state-of-play'.

Most of the literature published has tended to be quite narrow in scope in comparison to that of the two major players: Graesser *et al*. and McKoon and Ratcliff. Of all the publications reviewed, Graesser *et al.* (1994) produced the most in-depth and comprehensive discussion of inference. Although it should be stated that they were not particularly focused on pedagogy, nonetheless, teaching implications emerged from their work. Of all the literature, this appears to be the most frequently cited publication. Subsequently, researchers have conducted smaller-scale investigations, often looking at a single narrow aspect of inference. Gygax (2004), for example, examined readers' inferences of characters' emotions in narrative texts. Van den Broek (2001) was interested in the most opportune moment for asking pupils inferential questions during and after reading. Over the past 30 years, Cain, Oakhill

and Yuill have reported on various very small-scale studies they conducted (often on no more than one classful of children) testing various hypotheses on inference or comprehension. It is interesting to note that the authors (McGee and Johnson, 2003) of the only recent school-based trial of an inference training intervention referred exclusively to literature published in the 1980s in their bibliography. This leads to the impression that not much direct testing of inference training has been carried out. More recently, there has been a renewed interest in the link between reading and aural work and in the relation between inference in reading and inference in listening.

In order to cover the divergent nature of the research questions (with the first one being very abstract in content, while the remaining three are practical) the reviewed material tended to fall into three provinces:

- Psychology
- Pedagogy on comprehension instruction
- Small scale research into aspects of inference instruction

As so few studies into inference teaching were identified, some publications were retained and reviewed although they did not meet the strictest of the selection criteria. These had other merits that supported their inclusion. As a result of the decision to limit the review to English language publications, the European tradition of thought on these questions has been largely omitted.

The remit, therefore, was to review all that is known about inference and deduction. Those who are involved in the field of teaching reading and who are familiar with the National Curriculum and the Literacy Strategy talk almost daily of ‘inference and deduction.’ They are always mentioned in tandem, as a seemingly inseparable pair of skills. However, one of the first things to strike the researcher is that neither the national nor international research literature ever speak of deduction. All the discussion and investigation in this area refer exclusively to inference. The most recently published National Primary Strategy document ‘Developing Reading Comprehension’ (DfES 2006), which devotes a sizeable section to inferential skills, also fails to mention deduction. Even amongst researchers who have distinguished a surprisingly large number of different types of inference classes, deduction does not feature in their lists. If asked, experts can offer plausible definitions which distinguish between the two (deduction generally interpreted as somewhat narrower than inference) but deduction does not appear to be the subject of much academic investigation or discussion. This would suggest there is no useful distinction in the cognitive processes that underlie the two and this report will therefore follow the established tradition by referring only to inference.

2. Are there different skills in inference?

2.1. Different types of inferences: What are inferences used for?

Whether experimental or review in purpose, most studies have laid out meticulously detailed analyses of the types of inference that exist in their authors' view of comprehension. The literature has been prolific in distinguishing various types and categories of inference, ranging from thirteen, described in Graesser *et al*. (1994), nine in Pressley and Afflerbach (1995), to the more usual two, adopted by many more researchers. Even amongst those experts who have identified essentially the same single distinction between two types of inference, there is an assortment of labelling. Commenting on this variety in the naming of inferences, Graesser *et al*. (1994) concluded *researchers in psycholinguistics and discourse processing have proposed several taxonomies of inferences* [cites eight publications] *but a consensus has hardly emerged,* (p. 374).

A suitable starting point is perhaps the work of the British researchers, Cain, Oakhill and Yuill, aided over the years by numerous colleagues, who have been studying various aspects of comprehension since the 1980s. Their distinction (Cain and Oakhill, 1999) was between *text-connecting* or *intersentence* inferences and *gap-filling* inferences. The difference they specified was that *intersentence / text-connecting* inferences are necessary to establish cohesion between sentences and involve integration of textual information. *Gap-filling* inferences, by contrast, make use of information from outside the text, from the reader's existing background knowledge. Interestingly, in a more recent study published in 2001, these authors (like Barnes *et al*.,1996; Calvo, 2004; Bowyer-Crane and Snowling, 2005 and DfES, 2006) adopted the more current terms of *coherence* versus *elaborative* inferencing*,* which roughly equate to text-connecting and gap-filling respectively. *Coherence* inferences maintain a coherent text and involve adding unstated but important information such as causal links, e.g. *The rain kept Tom indoors all afternoon*. In this sentence, the reader understands that Tom wanted to go out but that the unpleasant weather conditions prevented this. They are seen being essential to constructing meaning, and as a result, only minimally affected by knowledge accessibility because cognitive activity will keep going until the necessary information to make the inference is found. *Elaborative* inferences embellish and amplify. As unnecessary to achieve comprehension, these inferences will be influenced by accessibility of knowledge.

Bowyer-Crane and Snowling (2005) have also espoused the current terminology of *coherence* versus *elaborative* inferencing in their analysis of inferential questions used in reading tests. They extended and refined the distinctions by adding *knowledge-based* and *evaluative*. The particular feature of the two additional inference types was that although they depend on the application of life experience and outside knowledge (like *elaborative* inferences) they were still deemed essential to the understanding of text. *Knowledge-based* inferences rely on the activation of a 'mediating idea' from the reader's own world-knowledge, without which the text is

disjointed. *Evaluative* inferences relate to the emotional outcome of the text, such as the emotional consequences of actions in a story. It is worth restating that the authors view *knowledge-based* and *evaluative* inferences as not optional to understanding and maintain that these inferences have to be drawn in order to achieve comprehension.

It is interesting to note that in one of the most recently published articles in this field, Cromley and Azevedo (2007) use none of the terms outlined above but refer instead to *text-to-text* and *background-to-text* inferencing which equate to the *coherence* or *text-connecting* and *elaborative* or *gap-filling* distinctions described above. In addition, they specify *anaphoric* inference as a separate category on its own. Previous researchers had assigned this type of inference to *coherence* or *text-connecting* as it generally involves cross-referencing between synonyms or between pronouns and their referents.

In other studies, the dividing line has been defined in different terms. There is, for example, the difference between *local* and *global* (Graesser *et al*., 1994; Beishuizen *et al*., 1999; Gygax *et al*., 2004) *Local* inferences create a coherent representation at the local level of sentences and paragraphs while *global* covers the whole text.

Graesser *et al*. (1994) necessitate special attention because of their comprehensive discussion of inference on many levels. The difference between the work of these researchers and others is that they identified several ways of categorising groups of inference types whereas others tended to focus on a distinction on one dimension between usually (though not necessarily) two types. The categories they recognised included both *text-connecting* / *knowledge-based* and *local* / *global*. They were, however, primarily interested in the *on-line* / *off-line* distinction, in determining which inferences are carried out automatically during reading (*on-line*) and which only arise if prompted (*off-line*). In the course of their work, they discriminated and coined 13 different forms of inference, which are listed in Table 2.

Interestingly Singer, who was one of the contributors to the comprehensive taxonomy in Graesser *et al*. (1994), also used the term *bridging inference* (Singer *et al.*, 1992, Singer *et al.*, 1997). This term does not feature in the Graesser *et al*. taxonomy, despite its thoroughness, and adds further evidence of the lack of consensus. *Bridging inferences* are cited in the Primary National Strategy document 'Developing Reading Comprehension' (DfES, 2006) as being a common way of referring to *coherence-preserving* inferences.

Table 1 lists the most frequently cited distinctions between different types of inference, while Table 2 overleaf lists the different inferences themselves.

Table 1 - Distinction between Different Types of Inferences

Author	**Distinctions identified**				
McKoon and Ratcliff, 1992	*automatic*		*strategic*		
Graesser *et al*.,1994 Long *et al.,*1996	*on-line*		*off-line*		
Graesser *et al*.,1994	*text-connecting*		*knowledge-based* or *extratextual*		
Graesser *et al*.,1994 Beishuizen *et al*., 1999 Gygax *et al*., 2004	*local*		*global*		
Barnes *et al.*, 1996 Calvo, 2004	*coherence*		*elaborative*		
Pressley and Afflerbach, 1995	*(unconscious)*		*conscious*		
Singer *et al*., 1997	*bridging*				
Cain and Oakhill, 1998	*intersentence* or *text-connecting*		*gap-filling*		
Bowyer-Crane and Snowling, 2005	*coherence*		*elaborative*	*knowledge-based*	*evaluative*
Cromley and Azevedo 2007	*anaphoric*	*text-to-text*	*background-to-text*		

2.2. Different types of inferences: How many inferences are there?

While most of the work conducted focuses on distinctions between two or three types of inference, two studies - Graesser *et al*. (1994) and Pressley and Afflerbach (1995) - stand out because of their detailed and thorough cataloguing of as many inferences as they were able to find. Table 2 below presents a summarised version of their lists. It should be added that due to their method of data collection, i.e. use of the think-aloud protocol, Pressley and Afflerbach described their list of inferences as those of which readers were consciously aware and which they were able to describe in their own words. As 'think-aloud' methodology involves questioning subjects during reading about the cognitive processes that they are carrying out, the implication is that there may be other inferences which readers carry out subconsciously and which are not therefore included in their list.

Table 2 - Inferences

Graesser, Singer, Trabasso	**Pressley and Afflerbach**
1. referential	1. referential
2. case structure role assignment	2. filling in deleted information
3. antecedent causal	3. inferring meanings of words
4. superordinate goal	4. inferring connotations of words / sentences
5. thematic	5. relating text to prior knowledge (further divided into 12 sub-types)
6. character emotion	6. inferences about the author (5 types)
7. causal consequence	7. characters or state of world as depicted in text (6 types)
8. instantiation noun category	8. confirming / disconfirming previous inferences
9. instrument	9. drawing conclusion
10. subordinate goal action	
11. state	
12. reader's emotion	
13. author's intent	

There is some overlap in the two lists, such as inferencing about characters and about the author but the two lists reflect different ways of looking at inference. Graesser *et al*. (1994) emphasise the focus of the inference (character, theme, instrument), whereas Pressley's list catalogues the processes (confirming, concluding, relating).

Despite the lack of unanimity about the range of inferences, how to refer to and categorise them, there is only one aspect that has excited a public disagreement. By no stretch of the imagination could this be termed a fiercely raging debate, but it does remain a source of contention. The divergence of opinion lies principally between those who ally themselves with Graesser *et al*. representing the 'constructionist' view and those that follow the 'minimalist' theory of McKoon and Ratcliff (1992). The constructionist theory assumes that the reader is engaged in a constant '*search*

(effort) after meaning' to build a situation model of the text that is coherent both at local and global level and will draw all the inferences needed to explain why things are mentioned in the text in order to achieve coherence. The minimalist view is '*that there is only a minimal automatic processing of inferences during reading…readers do not automatically construct inferences to fully represent the situation described by the text'* (McKoon and Ratcliff, 1992, p. 440). According to this model, *inferences that are not required to establish local coherence (i.e. elaborative inferences) are encoded only to the extent that they are supported by readily available world knowledge* (Long *et al*., 1996, p. 192). Long *et al.*'s own study did not help to settle the issue but only concluded that good readers carry out more inferences than the less able, as indicated in the closing remark of their article: …*Our data suggest that high-ability readers encode knowledge-based inferences that low-ability readers fail to encode…only high-ability readers encode topic-related inferences.* (p. 210)

As the main purpose of this review is to inform pedagogy throughout Key Stages 2 and 3, the debate is largely of academic interest. The question is what practical steps can a teacher take to get all readers to do more of what good readers usually do automatically and instinctively. Even the inferences that are not usually carried out during reading are of interest to English teachers, as these are often those that are involved in literary criticism and analysis. All inferences are therefore the subject of this review - whether or not they are carried out on-line.

2.3. What are the skills involved in inference?

The first aim of this review was to uncover what is known about the different skills in inference and deduction. One might argue that listing the plethora of inference labels and classes in sections 1.1 and 1.2 is not especially informative in providing answers to the first research question posed. However, in the absence of much evidence of the actual skills that readers need to be good inferencers, this information helps to shed some light on what is involved in an inference. The same is true of the cognitive processes.

While there seems to be little written about the inherent abilities and skills involved, the literature is revealing about the processes that are thought to take place in the instant of inferencing and there has been research and discussion of the preconditions that permit inferences to happen. This section will therefore reflect the available literature by outlining what is known about the cognitive processes and the other factors that influence inferencing.

Cognitive processes involved in an inference

Although there is no consensus about which inferences are drawn consciously or subconsciously, automatically or strategically, the following section will demonstrate that various experts appear to have arrived at similar conclusions about the cognitive steps involved in an inference.

What happens in working memory?

One of the most comprehensive works conducted in the field was that of Graesser *et al*. (1994). Not only did the authors identify a large number of inference types (as seen above), they looked at the constituent stages of inferencing and identified triggering processes that fire the production of an inference. Their analogy, in which they equate inferencing to the solving of a mental syllogism, was based on Singer's model (Singer *et al.*, 1992) and is frequently reflected in the literature. They proposed that the reader constructs a mental syllogism, from two available premises in the text, but with a third missing. The reader solves the syllogism by supplying the missing premise (a '*mediating idea*'), which is the inference. In supplying the missing premise, the reader:

1. searches for information in the long term memory and the working memory
2. searches in other places (perhaps looking further back in the text)
3. brings the content of the working memory back into play (ie reactivates the two premises that originally prompted the searches in 1 and 2)
4. checks that the inference adequately explains and agrees with the two premises held in the working memory.

In the work of Graesser *et al*. it is the importance of the capacity of the working memory that becomes apparent and is taken up again and again by other researchers. In their constructionist interpretation of reading, the authors believe that such is the need of readers to make sense of a text that they will even keep unsatisfactory explanations / inferences in play, until a more plausible explanation comes along.

With *text-connecting* inferences, the current clause is related to a previous explicit statement, which is then re-instated or re-activated and inferentially linked to the current clause. In the case of *knowledge-based* inferences, it is background knowledge, stored in long-term memory (such as: experiences, other texts or even earlier sections of the current text which have already been encoded in the long-tem memory), that becomes activated and encoded in the meaning representation of current text. If the *knowledge-based* inference is directly 'copied' from knowledge, then this can pose little demand on working memory. If, however, a novel knowledge-based inference is required, the demand on the working memory increases as it involve cycles of memory search and accumulating information from multiple sources.

In their 1997 article, Singer *et al.* explained how *coherence-preserving* inferences are constructed using a type of equation. They suggested that the stages involved are (p. 200):

1. formulating a thought along the lines of: What idea combined with fact A (from text) accounts for result B (in text)?
2. the mediating idea is compared with world / background knowledge in long-term memory
3. if the mediating idea coincides with knowledge, the inference is validated

Amongst other factors, Calvo (2004) also stressed the importance of the capacity of the working memory. It has to keep active a current mental representation of the relevant piece of text while processing subsequent information. If the working memory is good at holding provisional representations, it saves times integrating information as reading progresses.

The only authors who diverged slightly in their view of inferencing were Hannon and Daneman (1998), who saw it more as a process of reasoning, rather than settling inconsistencies or finding solutions. This is how they represented the stages involved (p. 152):

1. identify important passage words
2. activate important facts about those words
3. do reasoning about those facts, computing relationships between the words
4. the result is a coherent abstract discourse representation

Although they viewed inference as a different cognitive process to others described above, nonetheless it is clear that the four stages outlined here impose an equally heavy toll on the working memory.

Triggering processes

Throughout much of the discussion above, many have chosen to express inference as a need to solve or satisfy some textual inconsistency or to fill in the missing part of a textual equation. However, it is only in extreme cases that a reader is consciously aware of carrying out an inference, let alone formulating a query in order to infer an answer. Competent and fluent readers generate inferences as they go along without consciously experiencing any 'textual inconsistency'.

The work of Pressley and Afflerbach (2000) has been useful in outlining two schools of thought about how prior knowledge relates to the interpretation of text. Prior knowledge will be covered in detail in section 2.2.4 below, but it is relevant to mention here how one of these theories in particular, schema theory, explains the triggering of inferences. The central premise of schema theory is that *much of knowledge is stored in complex relational structures, schemata…once some small part of a schema… is encountered, the activated schema causes reasonable inferences to be made*. It is '*top down'* because *the higher order idea occurs first and affects thinking about the details of the situation.* For this to *affect text processing, a reader must have experiences permitting schemata to develop*; *the richer a child's world experiences and vicarious experiences, the richer the child's schematic knowledge base* on which s/he can draw (p. 549). Second, they describe the bottom-up 'propositional' theory of experts such as Graesser *et al.* (1994). According to this view, the reader *processes many individual ideas* or 'propositions' *and how the ideas are related to each other* to construct *a network of propositions and macropropositions*. In order to understand the current text, the propositions are not only related to each other, they are related to prior knowledge. In both models, therefore, background knowledge plays a part in constructing meaning, but in

schema theory it is also responsible for prompting the inferences that contribute to this process.

In their comprehensive 1994 publication, Graesser *et al.* proposed six triggering or 'production rules' for firing inferences, which are listed below in Table 3. They are 'fired' either by something present in the text or by having reached some threshold in working memory that activates it. The authors maintain that all *six production rules are evaluated and possibly fired at each comprehension cycle, as text is comprehended on-line, statement by statement* (p. 380). The first column of the table lists the stimulus present in the text that 'fires' an inference, while the second gives a succinct description of the cognitive processes that ensue. In the original article, this column is followed by a third which details elaborate descriptions of the cognitive processes involved.

Table 3 - Graesser *et al*. : Production Rules for Inferences

Production rule	Condition	Succinct Description
A	Explicit statement in text is an intentional action (A) or goal (G) of character.	Explain why the character performed action A or has goal G: looking for plausible superordinate motives.
B	Explicit statement in text is an intentional action (A) or goal (G) of character or an event (E).	Explain why the character performed action A, why the character has goal G, or why event E occurred: looking for plausible causal antecedents.
C	Any explicit statement (S) in text.	Explain why the writer mentions S.
D	Explicit statement in text is an intentional action (A) or an event (E).	Track the emotional reactions of characters.
E	Working memory contains a particular configuration(C) of goals, actions, events, emotions and /or states that meet some activation threshold.	Create global structures
F	Implicit statement or structure in working memory meets some activation threshold.	Construct inferences that receive high activation in working memory.

Preconditions to inference

In conducting this review, it was notable that many authors were interested in the precise cognitive steps involved in processing an inference but surprisingly few wrote about the initiation of an inference in the first place. The area that attracted the most interest focussed on the conditions that favour inferencing and why some readers appear to infer much more readily than others. This section will attempt to summarise the various factors that have been found to promote inferences.

Being an active reader

Stemming directly from the work of Graesser *et al.* (1994), the need to be an active participant in reading is seen as a major precondition to inferencing. Many authors share the view that the reader wants to and is actively engaged in the search for meaning and will invest effort in the search. As inferencing is a taxing activity, imposing a demand on the working memory, being actively engaged is indispensable, as suggested by Cain and Oakhill (1998) in this quotation about the possible reasons why poorer readers do not draw sufficient inferences in their reading: *They do not see reading as an active, constructive process: It is only when their incorrect answer and therefore inadequate understanding is brought to their attention and they are required to search for some information, that these children make such links* (p. 339).

Zero tolerance of inconsistency

Part of being an active reader is constantly checking one's own understanding. An active adult reader does not normally allow inconsistencies to pass unchecked and will fill gaps in understanding, as they arise, without thinking about it. Cain *et al.* (2001) hypothesised that *skilled comprehenders may generate more inferences than do less skilled because they regularly monitor their comprehension and see the need to make inferences to fill in the missing details* (p. 856).

Over the last quarter of a century, much of the work of Cain, Oakhill and Yuill has concerned the differences between good and poor comprehenders and the difficulties faced by those who are less successful readers. In their 1996 review of studies conducted into reading comprehension difficulties, Oakhill and Yuill looked specifically at comprehension monitoring**,** quoting the experiment conducted by Yuill, Oakhill & Parkin (1989). They used an 'anomaly resolution task' with stories containing an apparent inconsistency. They found all readers equally good at resolving inconsistencies when the inconsistency and the resolving information were in adjacent sentences, but less skilled readers' performance declined when the relevant pieces of information were further apart, when the demands on working memory increased.

In a later appraisal of reading comprehension difficulties, Cain and Oakhill (2004) cited the use of an 'inconsistency detection task' by Oakhill, Hartt and Samols (1996). They found that poor comprehenders were less able to detect nonsense words, anomalous phrases and pairs of contradictory sentences: problems which were all attributed to the capacity of the working memory. Good readers were seen to spend longer reading inconsistent parts of text and were more likely to look back: all evidence of the fact that better readers monitor their comprehension and sort out anomalies as they proceed. Cataldo and Oakhill (2000) demonstrated that good comprehenders regulate reading to match the goal they were set. To poor comprehenders it made no difference; they tended to approach all texts the same way.

Harrison (2004) hypothesized about the reason why young readers seem to be *much more tolerant of ambiguity or inconsistency. Perhaps because so much of what is encountered in their world seems inconsistent or is only partly understood, young readers, and particularly less proficient young readers, are … remarkably relaxed about dealing with nonsensical or contradictory information in a story*. Harrison speculated on two ideas to explain this tolerance for the incomprehensible in young readers. Perhaps young readers *simply update their schema to accommodate what for us would be a contradiction*. Or, more likely in the case of poorer readers, they are processing text mainly *at the phrase level and therefore consistency checks with the reader's internal models of the world just don't get done* (p. 89).

The consensus from these studies and reviews seems to be that less able readers are less aware. They are less aware:

- that a text should make sense to them
- that they should be monitoring their understanding for potential inconsistencies
- about strategies to adopt when embarking on a text
- about strategies to adopt when an inconsistency occurs
- about the need to draw inferences at all
- about the information that is relevant to the drawing of inferences (see following section below).

Background knowledge

The importance of background knowledge cannot be over-stressed. It would be possible to select apt quotations about its role in inferencing from every article reviewed. Instead, just a few will be cited here. *Studies demonstrate that access to world knowledge can be obligatory in the sense that a text cannot be completely understood without it* (Long *et al*., 1996). This *includes information about the real world referents of words, properties attributed to objects and knowledge about the situation* (p. 190). Referring to several studies including one by Marr and Gormley (1982), Cain *et al*. (2001) also underlined the indispensable role of general knowledge: *indeed, relevant background knowledge for a passage is a better predictor of fourth graders' ability to generate inferences from and elaborate on that text than is their comprehension skill* (p. 850). In his systematic coverage of both the 'top down' schema theory and the 'bottom up' propositional theories of reading, Pressley (2000) could not overstate the importance of background knowledge in permitting inferences to take place in either view of reading. The relationship between background knowledge and inferencing is not reciprocal. Elaborative inferences cannot be drawn without the prerequisite knowledge. However, just because a reader has that background knowledge does not automatically guarantee that the reader will necessarily make the inference. The knowledge may not be easily accessible or seem pertinent to the reader. This is fully discussed in the two following sections.

i Availability versus accessibility of background knowledge

Over the past two decades, thinking about the role of background knowledge in inferences has become more crystallised. In 1996, Oakhill and Yuill revealed some scepticism about the suggestion that less able readers make fewer inferences simply because they lack the general knowledge. *Such an explanation seems unlikely (we would expect a 7-year-old to know that a creature that flaps its wings is likely to be a bird)* (p. 73). In this quotation, they were referring to an earlier studies (Oakhill, 1984; Cain, 1994) in which they found that less able drew fewer inferences even when the pertinent information was made available to them. Subsequent work, carried out by Barnes *et al*. (1996) and Cain and Oakhill (1998), suggested that it was not primarily the availability of pertinent background knowledge that was crucial to *coherence* inferences but the accessibility of it. Information in memory is not all equally accessible: common properties of objects are more accessible than less common ones, for example. The way in which a reader's knowledge is organised (numbers and levels of connections between elements of knowledge) also affects accessibility. Barnes *et al.* found that less accessible knowledge is less likely to be used in inferencing. Their results showed that *quickly accessed knowledge was about twice as likely to be used in inferencing than was more slowly accessed knowledge* (p. 232), affecting not only the probability that the inference would be made but also the strength with which it was encoded.

It should be noted that the term 'background' or 'prior' knowledge signifies more than just the whole of a reader's life experience (personal and vicarious), world knowledge and all previous reading. It also denotes previous representations of earlier parts of the current text - encoded and stored in long term memory - to which all subsequent parts of text can be related.

It is clear that Cain *et al.* (2001) interpreted background knowledge in this way, stating that the more *integrated and embellished* the encoding and mental representation of the current text, the more favourable it will be to generating inferences in all subsequent parts of the text because it *serves to strengthen...memory of the knowledge base* (p. 857).

More than one study mentions the vicious cycle that inevitably impacts upon the ability to draw inferences. In their study of 1999, Cain and Oakhill demonstrated poor inferencing skills are likely to result in poor comprehension and not the other way around. This may be the predominant direction of the relationship between inferencing and comprehending in reading; however, if the ability to draw inferences depends, amongst other things, on the solidity with which text is decoded, interpreted and encoded as a mental representation, then reading ability will also affect inferencing.

ii 'Permission' to relate text to real life

Oakhill, working with Yuill in 1996 and with Cain in 1998, hypothesized that pupils have to know that it is 'permissible' or 'necessary' to draw inferences. They partly attributed the failure of poorer comprehenders to draw as many inferences as good readers to a misconception that one should not look outside the text for answers. They suggested that this was particularly responsible for the reluctance of the less able to generate *gap-filling* or *elaborative* inferences*,* which rely on background knowledge. In their 1998 investigation, they found that while the less able increased their production of *text-connecting* or *coherence* inferences, given prompting and favourable conditions, they did not do so when it came to inferences that draw on extra-textual information because they simply did not appreciate that it is legitimate to go outside the text to draw inferences. By 2001, Cain *et al*. had refined their understanding of the factors involved, referring not so much to pupils' feeling of the legitimacy in drawing on extra-textual information, but simply to a lack of awareness: *children were less aware of which information was relevant for elaborative inference generation than for coherence inference generation* (p. 858).

In a 2005 study of 20 pupils using two standardised tests NARA II and WORD, Bowyer-Crane and Snowling reconfirmed this finding, stating that the poor readers in their study were *in possession of the knowledge…but are unaware of the need to draw on that knowledge.* They concluded that the difference between poor and good comprehenders *lies in the strategies used during reading, and in the ability to use general knowledge to interpret a text* (p. 199).

In sharp contrast, Pressley (2000) quoted the work of earlier research (Williams, 1993) which suggested that one of the ways in which *weak readers undermine their comprehension is by relating to texts which they are reading prior knowledge that is not directly relevant … making unwarranted and unnecessary inferences* (p. 550).

Those who are involved in teaching children will probably find that both these findings strike a familiar chord: some children fail to draw what might seem like obvious inferences while others introduce ideas that seem entirely irrelevant. Part of teaching inferencing, therefore, will be to guide children between these two extremes.

Word-level knowledge

All the publications reviewed acknowledge that word-level processing has some bearing on inferencing. What is not known is the exact relationship between the lexical level of processing, in all it facets - decoding print, word recognition, speed of accessibility, breadth of vocabulary etc - and inference. Some authors, such as Graesser *et al.* (1994), see vocabulary as the starting point in the activation of background knowledge. The recognition of *explicit content words, combinations of content words, and interpreted text constituents* is crucial to knowledge-based inferences (p. 347)*.* Others are less certain about the role it plays and have conducted investigations to pin down not only the impact of vocabulary on inferencing but the reciprocal relationship: the importance of inferencing in the

comprehension of vocabulary. In 1996, Cain had argued that of all sources of comprehension failure, the most pervasive are lexical-based problems with vocabulary or decoding print. In 2004, Cain *et al.* expressed a slightly different view indicating that aspects of comprehension and word knowledge may be highly correlated but that does not indicate a causal relationship. Instead, they preferred the explanation that a common variable underlies development of vocabulary and comprehension. They share the same skills and processes: inference making and working memory.

Calvo's investigation on 72 undergraduates (2004) specifically looked at the role of vocabulary and working memory span in elaborative inferences. His conclusions differ from those of Cain *et al*. (2004). He interpreted his findings as evidence that much depends on vocabulary prior to any inferential step taking place. Only after accessing word meanings, combining meanings, encoding them into a coherent situation model did an inference happen. Speed of access to vocabulary, of course, impacts upon all reading whether or not it contains an inference. Moreover, drawing upon the empirical evidence he had gathered, Calvo (2004) suggested that the developing mental or situation model is refined into a linguistic format (e.g. something like a word) and that this involves searching for a word in the mental lexicon. *Readers with large vocabularies will be more likely to find in their memory words with which to represent the inference that they are drawing* (p. 62). Likewise, he found that working memory played an indispensable part in inferencing, in the integration of activated inferences with the text-based representation in order to construct a situation model.

Finally, in the most recent study reviewed, Cromley and Azevedo (2007) investigated the contribution of five different factors to comprehension, working with a sample of 177 year 9 pupils. These variables were: background knowledge, inference, word reading, vocabulary and strategies. All, with the single exception of strategies, were shown to impact upon comprehension and various interactions between them were also demonstrated. The three dominant contributors to comprehension, by order of magnitude, were: reading vocabulary, background knowledge and inference. Recognising the limitations of their own study, the authors nonetheless suggested that strong skills in background knowledge and vocabulary are needed and that good inference skills are wasted without pre-requisite levels of knowledge or vocabulary: *knowing the meaning of a word is sometimes crucial for being able to draw an inference that is necessary to comprehend the text* (p. 312).

Being on the same wavelength

As indicated in all sections above, it is widely understood that background knowledge contributes to understanding of text and plays a part in inference. Narvaez (2002) emphasized the desirability that the reader and writer share the same background knowledge for a successful communicative act to take place. She recapped studies which demonstrated the disadvantages experienced by readers from other cultures who do not share the same schemata as the writer. *Low domain knowledge prevented readers from forming an adequate mental model, which led to erroneous*

elaborations and inferences (p. 161). Her argument extended to the 'sociomoral cognitive development' of the reader and arrived at the conclusion that *cultural influences on reading often transpire without awareness* (p. 165). Narvaez found differences in recall of a complex narrative (soap-opera type episode) according to the 'moral judgement' of reader. As the moral judgement of the reader is likely to be strongly influenced by background, she concluded that the degree of match between cultural assumptions of reader and text would effect the inferences drawn by the reader: *cultural-ideological background can influence moral inferences while reading* (p. 165). This highlights the importance of the teacher's sensitivity in understanding the possible root cause of inference failure in children from other cultures. Narvaez does not imply that using texts from the pupils' own culture is the solution. Instead, the suggestion is that a preliminary discussion with the class which will give the pupils the requisite socio-cultural knowledge is the best remedy. This may involve a conversation about such topics as differences between teenagers in different cultures, respect for adults, different views about honesty, obedience, individualism / collectivism, the family: all of this is interesting subject matter for a Key Stage 3 classroom.

2.4. Conclusion

The purpose of this chapter was to report on what is known about the different skills in inference and deduction. The literature has provided ample information to be able to trace out the cognitive mechanics of what is happening in the mind during an inference and to discern the conditions that pre-dispose a reader to inferencing. With the exception of having a proficient working memory, however, it has been much harder to identify the practical skills or abilities that a reader should possess and practise in order to become good at inferences.

2.5. Summary

Very many different types of inference have been identified. These are the main categories that are frequently mentioned in the literature:

Name	Example	Explanation
Coherence *or* **intersentence** *or* **text-connecting**	*Peter begged his mother to let him go to the party.*	Maintains textual integrity. The reader would have to realise that the pronouns 'his' and 'him' refer to Peter to fully understand this sentence.
Elaborative *or* **gap-filling** *or* **knowledge-based**	*Katy dropped the vase. She ran for the dustpan and brush to sweep up the pieces.*	Enriches the mental representation of the text. Drawing upon life experience and general knowledge, the reader would have to realise that the vase broke to supply the connection between these sentences.
Local Includes: 1. coherence inferences 2. case structure role assignments 3. antecedent causal inferences	 As above *Dan stood his bike against the tree.* *He rushed off, leaving his bike unchained.*	Creates a coherent representation at the local level of sentences and paragraphs. As above The reader would realise that the tree is assigned to a location role. The reader would infer that Dan was in a hurry and left his bicycle vulnerable to theft.
Global	Inferences about the *theme, main point* or *moral* of a text.	To create a coherent representation of the whole text, the reader would infer over-arching ideas by drawing on local pieces of information.
On-line **Off-line**	*Superordinate goals* of characters or *causal antecedents* that explain why something is mentioned in the text. Forecasting future episodes in a text.	These inferences are necessary to understanding and are drawn automatically during reading. Inferences drawn strategically after reading, usually during a later retrieval task. Not essential to understanding.

Cognitive processes involved in drawing an inference:

Start: An inference is prompted

- Either by the activation of a whole schema
- Or by firing one of Graesser's 'production rules'

Middle: a mental puzzle or syllogism is formed

- Either through construction of an unsolved equation
- Or by noticing an inconsistency in the text

End: An inference is produced

- The 'mediating idea' or the 'solution' to the equation is the inference
- The inference is verified by a 'reality check' against background knowledge

This information is akin to knowing the mechanics of riding a bicycle, which alone do not make the rider a good cyclist. Knowing these steps is not sufficient information to prepare a teacher to improve inferencing in her pupils, nor would explicit explanation of the cognitive processes necessarily help pupils to carry them out.

Factors common to those who are adept at automatic inferencing:

- a competent working memory
- being an active reader who wants to make sense of the text
- monitoring comprehension and repairing inconsistencies
- a rich vocabulary
- a wide background knowledge
- sharing the same cultural background as that assumed by the text

Some of these are more amenable to improvement, and therefore teacher intervention, than others and the following chapters will be devoted to the practical steps that can be taken to help develop these skills.

3. How can pupils best be taught to use inference skills

3.1. An inference training success story

Underpinning the research reviewed is the assumption that pupils must be explicitly taught the skills they need for comprehension. They cannot be left to pick them up through simple exposure to texts, or through the natural process of maturation. …*independent reading is necessary but not sufficient* … Byrnes (2000) *teachers will not enhance student achievement simply by allocating more time to silent reading: rather they need to provide instructional scaffolds.* (Baker, 2002, p. 90)

Against this background and the fact that inference and deduction are high profile skills in Key Stages 2 and 3, it is interesting to note how few experimental studies there have recently been specifically targeting inference instruction. One major study stands out: that carried out by McGee and Johnson in 2003.

In their article, they attributed much of their thinking to research conducted during the 1980s. They reviewed the work of Dewitz *et al.* (1987) who demonstrated the advantages of explicitly targeted inference training. In a study comparing two types of instruction, an 'active' group of pupils were trained to derive all the implicit meanings themselves (through teaching and practice in integration of prior-knowledge with text concepts) while a 'passive' group were given all the inferences in an overview by the teacher. The active group outperformed the passive in answering test questions. They quoted the publications of Hansen and Pearson (1983), Carver (1987), Brown, Palincsar and Armbruster (1984), Paris, Cross and Lipson (1984) and Yuill and Joscelyne (1988), all of whom conducted research that shed some light on inference instruction. In particular, however, McGee and Johnson spotlighted and chose to replicate the 1988 work of Yuill and Oakhill.

They increased the size of the original sample to include a wider age range (between six and ten years) and produced results that exceeded expectations. The 1988 study had resulted in a marked improvement in the reading ages of the less skilled comprehenders (an increase of over 17 months on the standardised Neale Analysis of Reading Ability test) but the authors had expressed reservations as a control group of less skilled readers had also improved significantly after a course of traditional comprehension exercises (by almost 14 months). In the 2003 repeat study, inference training raised performance in less skilled comprehenders by 20 months, while comprehension practice had resulted in an improvement of 10 months. It could be said, therefore, that there is evidence to suggest that this is a successful inference training scheme.

The inference training delivered by the researchers in both 1988 and 2003 consisted of the following steps:

- **lexical training**: explaining the function and added meaning of individual words. For example, in the following: 'Sleepy Tom was late for school again,' attention was drawn to the additional information that can be gleaned from 'again' (habitually), 'sleepy' (up late the night before), 'Tom' (boy).

- **question generation**: after instruction on the meaning of the question words 'who', 'when', ' why' etc, pupils were given examples of how questions can be derived from a text. Then pupils generated their own questions from a text and others answered

- **prediction**: sentences were obscured from a text and pupils guessed the missing segments by inference and deduction from the surrounding text.

The conclusions drawn by McGee and Johnson (2003) were that this programme enabled pupils to make links between text and its meaning and to discover for themselves how meaning can be derived from surface features. They attributed its success to the fact that it encourages active involvement, helps internalise the strategies and prompts their spontaneous use. These are practices that are thought to be typically lacking in poor 'inferencers'. Furthermore the authors believed that they could be used, without disruption to the curriculum, in the classroom: *The techniques used in the study would not require that more time be spent on comprehension within an already crowded curriculum, but rather suggest that a change of focus from a passive answering of preset questions to children having a more active role in making inferences would represent a constructive use of time currently allocated* (p. 58).

The success of both trials would suggest that this is a 'ready-made' inference training course. Further support for the model can be found in the article by Nation and Angell, as recently as 2006. However, the steps listed above are just three of many that have been associated with improvement of inference and comprehension skills and research has more to add to the three procedures outlined above.

While scrutinizing the evidence, it became clear that implications for teaching fell into two groups:

What to teach: what teachers need to cover to improve their pupils' inference skills

How to teach it: what methods are best for conveying these. There is considerable overlap with methods used to teach all comprehension skills.

3.2. What to teach

Word level work

It has generally been agreed that out of the various sources of comprehension failure, lexical-based problems with decoding or vocabulary are the most pervasive (Cain, 1996, p. 170).

Vocabulary

Many researchers emphasize the importance of vocabulary development as a foundation to the higher level skills such as inference. Cain (1996) claimed that attention had to be focussed at word level as poorer readers have difficulty in the use and interpretation of local cohesive devices, such as pronouns and connectives, which are crucial in the production of local coherence inferences. These deficits were found to be missing not only in reading but also in listening activities leading to the conclusion that poor inferencing skill was a root source of difficulty in comprehension and not *vice versa* (Cain and Oakhill, 1998).

Using eye movement measurements as a gauge to the speed with which inferences are generated, recent work with undergraduate students also posits a dependency of inference on vocabulary. Having conducted a prior assessment of the vocabulary and working memory span of his subjects Calvo (2004) concluded that during reading *available vocabulary knowledge makes a direct and specific contribution to inferences (*p. 62) *The availability of vocabulary knowledge is involved in later search and selection of words that are contextually relevant to represent an emerging (although not yet completed) inference* (p. 63).

An indication of what a teacher can do to address word level instruction is given in the McGee and Johnson's study described above. In brief, the researchers trained pupils to explain what individual words and phrases contribute to sentences. Pupils saw demonstrations of how words contribute to meaning. They were then trained to look for the clue words in sentences for themselves. They were encouraged to act as 'word detectives' in choosing key words and evaluating what information these words convey. The researchers admitted that when pupils were asked to do this for themselves, they did initially choose 'useless' words (e.g. 'was') but they soon discovered what types of words carry most meaning.

Harrison (2004) also underlined the importance of vocabulary development. He referred to the 'Matthew Effect' as described by Stanovich (1986) according to which the 'rich get richer and the poor get poorer:' Good readers augment their vocabulary through prolific reading while the vocabulary of the reluctant reader falls behind. Harrison maintained, in his chapter entitled 'Developing Reading Comprehension - what we have learned from research,' that the inevitability of the 'Matthew Effect' can be mitigated by the teacher reading aloud and / or the playing of story tapes. Almost all enjoy listening and the less able profit from orally introduced vocabulary building.

Decoding practice

Citing the outcomes of work conducted by Tan and Nicholson (1997) Pressley, in his influential publication of 2000, also stressed that improvement in word-level competencies leads to an increase in comprehension. His interpretation of word-level competencies included not only vocabulary knowledge but also the ability to decode print with ease and the development of sight words. *The more skilled the decoding, the less conscious effort required for it, and the more conscious capacity left over for comprehension of the word, including in relation to contextual clues* (p. 548). This was confirmed by the work of Nation and Snowling (2004), to be discussed later, and corroborated one of the most surprising and unexpected findings of the 1988 Yuill and Oakhill inference study with seven-year-olds. In that enquiry, the skilled comprehenders who were given decoding practice improved more than those under the other training conditions. They experienced an increase of ten months in reading age, compared to five months when exposed to inference or comprehension training. This can be interpreted as an indication that teachers must exercise judgement in targeting different types of reading activity at different abilities and that there is a case for 'going back to basics' for short periods of 'speed reading' practice even for the ablest of readers.

To re-cap, therefore, in this review evidence has been found to support the following types of word-level work to bolster improvement in inference:

- Decoding print
- Vocabulary building
- Attention to meaning: both denotation and connotation and
- How individual items of vocabulary contribute to the meaning of a sentence

While there is support for word-level work underpinning progress in inference, pupils themselves have to be encouraged to divert their focus from word or phrase-level understanding to whole text. As indicated in earlier sections, the failure of poorer readers to draw inferences has been attributed by many to their reluctance to consider the 'big picture' and to be focussed very much at the word and phrase level of interpretation. *One reason for the less skilled comprehenders' initial failure* [to draw inferences] *may be that they approach the task of reading with a different set of aims to the skilled comprehenders, focusing more on word reading accuracy rather than comprehension monitoring.* (Cain and Oakhill, 1999, p 501). The following sections will, therefore, look at research evidence on promoting skills above word level.

Text level work with narratives

In reading narrative texts, readers rely on the presence of conventional features and the familiar structure centred around setting, theme, plot and resolution. Familiarity with the structure is part of the background knowledge that the reader brings to the text to allow reasonable inferences to be made.

Working with young children on narrative texts, Cain (1996) found that the support provided by these structural features was profitably exploited only by abler readers. The results of her study showed that poorer comprehenders do not realise how stories are causally linked through elements such as: desires, motives, actions, goals and consequences. They were less likely than better readers to *impose such a structure on a story during reading or listening, because they will not be linking up the individual events and actions through the use of these elements* (p. 187). This suggests the need to develop pupil knowledge about story structure. The significance of other conventional features of a story also needs to be stressed. Cain (1996) cited the work of Yuill and Joscelyne (1988) who showed that less skilled comprehenders understood abstract stories better when provided with a title describing the main consequence of the story. They argued that *the more informative sort of title provides a framework in which to interpret the text which aids the less skilled comprehenders more than the good comprehenders because this latter group are already more skilled at selecting and organising ideas in text* (p.183). Pupils need to be shown the value of a title, perhaps by reading a paragraph with and without the title, to show how much more they can infer and understand when they are alert to it.

The importance of the work conducted by Cain (1996) and Yuill and Joscelyne (1988) was in showing how aspects of story structure, sometimes more closely attended to in writing instruction, feed into comprehension skill. Cain's work led her to make a link between poor inferencing ability and an immature understanding of stories as fiction. *If children believe that stories are true depictions of events… they will be less likely to bring outside knowledge to bear on their interpretation of story events…* (p.181) and they may be unwilling to impose their own interpretation, make their own unique inferences.

The results of the work done by Gygax *et al.* (2004) shows that this is not true of adult readers. Between infancy and adulthood, readers learn that any inference is valid. Adults can draw unique and different inferences and deductions from the same text, arising from the variety of background or prior knowledge that they bring to their interpretations. Gygax *et al.* worked with undergraduates in determining how specific their inferences about characters' emotions were while reading narratives. In four experiments it was found that during reading, readers appear to be only vaguely aware whether characters are undergoing negative or positive emotions and that they do not usually refine these impressions to specific inferences of guilt, relief, anguish, etc., unless they are explicitly asked questions about it. This work also generated three other interesting findings, which may have teaching implications for teachers of literary criticism:

1. Longer stories allowed readers to formulate more specific inferences about the characters' emotions off-line, i.e. in discussion after reading

2. The more ambiguous the text, the more specific the inferences drawn about emotions.

3. There is a great variety in inferences that can be drawn from a single piece of text. Even in reacting to texts that were deliberately designed to result in unanimity in the inferences it generated, there was no consensus. In fact some readers inferred emotions that were the precise opposite of that intended. Though not explicitly stated in Gygax's research paper, it would seem that this variety in inferencing may be a point of discussion in Key Stage 3 classrooms in raising awareness of the nature of inference.

Question asking and question generation: the right question at the right time

Questions constituted a major component of the successful pilot studies carried out by Yuill and Oakhill (1988) and McGee and Johnson (2003). The use of questions, both those posed by the teacher and those generated by the pupil, is a technique that receives coverage and support in the research literature and will be investigated not only here in this section but also in section 3.

Although Graesser *et al.*'s (1994) work was not specifically conducted with pedagogy in mind, there is occasional reference to aspects that might be of direct interest to those involved in teaching reading to children. They determined that competent adult readers ask themselves questions tapping potential knowledge gaps, anomalies or contradictions. They established that their comprehension is guided by *why*-questions, rather than *what-happens-next, how, when* or *where* questions. This conclusion corroborated their constructionist view of reading because the answers to why-questions expose superordinate goals and causal antecedents and these are precisely the inferences types that the authors claimed were produced automatically by readers during reading. This does not invalidate the use of other questions but ascribes a particular role to why-questions that is not shared by other questions types, as they are useful for prompting the sorts of inferences that occur naturally in good readers. When used by teachers, why-questions may nudge less skilled readers into making these inferences as well. How-questions expose subordinate goals and actions and causal antecedent events; while what-happens-next-questions expose causal consequences. Teachers may find these useful and valid in relation to the particular text they are reading, but, according to Graesser *et al*. the sorts of inferences they generate are less crucial to the overall construction of a coherent understanding of a text.

This view was supported by Pressley (2000). He stated that *why*-questions were particularly beneficial to pupils in years 4-8 and recommended that teachers *encourage students to ask themselves why the ideas related in a text make sense.* Drawing on a study by Wood *et al*. (1990), he maintained that pupils who are trained to ask themselves *why*-questions, automatically relate what they know to ideas in the

text. This method helps *by orienting readers to prior knowledge that can render the facts more sensible, hence more comprehensible and memorable* (p. 553).

Drawing upon a large body of empirical research, Baker (2002) listed a series of questions that teachers should ask themselves aloud in modelling comprehension-monitoring techniques. The following pertain most closely to inferencing: *Is there information that doesn't agree with what I already know? Are there any ideas that don't fit together (because of contradictions, ambiguous referents, misleading topic shifts)? Is there any information missing or not clearly explained?* Baker explained that *teachers can use authentic texts to illustrate this purpose or may choose to modify simple texts to contain inconsistencies, difficult words, conflicts with prior knowledge, ambiguous referents and so on.* Teachers then model how they would go about answering those questions *using fix-up strategies such as rereading, looking ahead in the text for clarification, or consulting an outside source* (p.85). As will be seen in section 3, teacher modelling is regarded as the first step in training children to ask and answer questions of this type of themselves.

Richards and Anderson (2003) published an article about the question *'How do you know?*' They explained how this question forms the core of the strategy they devised to help young readers make inferences primarily from picture books. Some reserve should be exercised about their claims as their article was based on very small numbers and cannot be described as a rigorously conducted piece of research. In addition, their experience is that of teaching emergent readers, so their work is, strictly speaking, outside the remit of this review. However, their model would not be out-of-place in year 3 and 4 classrooms. In brief, they suggest that when an inference is drawn in discussion of a text, it should be routinely followed by the question '*How do you know?*' Teachers should attempt to find texts rich in inferencing possibilities and to have in mind which inferences they will elicit in discussion. *Our think-aloud questioning strategy helps … readers learn how to make connections between given and implied information. It helps them examine their thinking and reasoning so they can verbalise how they arrived at their assumptions and conclusions* (p. 292). It depends initially upon the teacher modelling her own thinking processes to show pupils how she makes inferential leaps from text, and, as will be seen in section 3, this is entirely in keeping with currently recommended strategies. The authors claim that in bringing out into the open the assumptions upon which pupils make their inferences, one narrows the *cultural and linguistic distance between the backgrounds of ethnically diverse students…student discussions about their inferences provide opportunities for second language learners to … consider peers' disparate views and thinking*(p. 292).

This claim is especially interesting in relation to Narvaez's article (2002) in which she summed up the years of research she and others had. Her view was that inferences are heavily dependent upon a shared cultural background between the text and the reader. The schemas of readers from other backgrounds are the product of their own cultural influences, expectations and conditioning and may result in their drawing 'incorrect' inferences. Narvaez lists a series of inference-generating questions that teachers of older second language learners could be asked in relation to narrative

and expository texts (p. 167). These cannot all be reproduced here, but a selection (relating to narratives with a moral theme) is given to exemplify the nature of her approach.

1. Assist students' awareness that some demands in a story may conflict with others, e.g. by asking: *What was the problem? What was the worst thing the character faced? Were there differences in what the characters wanted?*

2. Increase students' moral sensitivity to the configuration of the situation. *What was going on? Who was thinking about what was going on? Who could be affected? Who was affected?*

3. Help students reason about possible actions. *What could be done*? *What would happen if? How might people react*?

Though intended to support second language learners in particular, this form of questioning is consistent with what is regarded as typically good practice in mainstream literacy work, especially in upper Key Stage 2 and Key Stage 3. In addition to Narvaez's article, there is other evidence that questioning of this nature enhances inferencing. McGee and Johnson (2003), for example, quoted the work of Sundbye (1987) who found that asking inference questions about relationships between characters, goals and motivations enhanced story understanding as effectively as if the story had been modified so that all this information were explicitly stated.

One of the most detailed studies to be conducted into the asking of questions in relation to inference-making was carried out by Van den Broek *et al.* in 2001. They were interested in the teaching potential of questions in reading comprehension. The literature they referenced (Hacker, 1998; Van den Broek *et al.*, 1995; Raphael and Pearson, 1985) proposed that questions can support construction of the causal network on which the understanding of a narrative text is based. The authors wanted to identify the exact role of questions: do they 'raise the game' by increasing the overall attention of the pupil wanting to give good answers, making him / her invest more effort into understanding text as whole or do they encourage specific connections only between the parts of the text targeted by the questions? Either way, it was assumed that questions are beneficial. In a large study, working with 240 children spread across years 4, 7, 10 and undergraduates, they addressed questions to their subjects both during and after reading short narrative texts.

The results are unsettling because they show that teachers must exercise caution when asking questions otherwise they may actually interfere with inferencing. Inferences are drawn when two text portions are attended to simultaneously in order to arrive at a third piece of implicit information. If the teacher increases the burden on the working memory by introducing yet another piece of information to be processed (namely a question), this may be detrimental to inference making. Questions posed during reading - and even immediately after reading - compete with other ongoing processes for the limited cognitive resources which are heavily involved in *word*

identification, syntactical decomposition, as well as *self-generated comprehension* processes (p. 526). This is especially relevant in younger readers. Of the four age-groups tested (the equivalent of Y4, Y7, Y10 and college students), it was the youngest pupils whose comprehension and recall suffered the most from questions asked both during and immediately after reading. The only group who consistently profited from questions (both during and after reading) were the college students, who were quick and efficient at transferring all information and connections into their mental representations of the text and for whom the extra cognitive burden of the questions was not especially damaging. In fact, for more proficient readers in the study, recall was enhanced for those segments of the text featuring in the questions and especially in the answers.

Teachers often ask questions in order to help less able readers, thinking that this will focus pupil attention on a particularly difficult or significant portion of text, but this study would indicate that this is detrimental. Van den Broek *et al*. (2001) suggest that *questioning might benefit younger children provided that the attentional demands of the comprehension task are reduced. Indeed, when the need for decoding is eliminated via aural presentation of the stories, even very young children's comprehension may benefit from questioning* (p. 526).

The evidence produced by Van den Broek *et al*. (2001) seems to contradict the general research consensus and could have worrying implications for common classroom practice. However, the two views can be reconciled. The message from the Van den Broek study appears to be:

- not to interrupt pupils by asking questions during reading time
- not to launch into questioning too soon afterwards. The teacher must allow time for consolidation of what has been read as a mental representation
- practise inferential questions on aurally presented texts

The implications relate to teachers asking questions of pupils and probably to pupils asking questions of each other in peer-group work. It does not impinge on the practice of teacher modelling of questions or self-questioning during reading or to self-paced comprehension exercises.

In their major work, Graesser *et al*. (1994) determined that 'author intent' inferences (class 13, in their taxonomy) are not generated during reading because the author of text remains largely invisible to the reader. Similarly, they felt that the status of 'reader emotion' inferences (class 12) was unclear. However, both of these areas are regarded as legitimate material in traditional comprehension exercises. When considered alongside the findings of Van den Broek *et al.* (2001), it becomes clear that caution is advisable, as having to make class 12 and 13 type inferences during reading may interrupt ability to achieve global coherence, which is essential to a full understanding of the text. The implication for teachers is that questions which assess

these areas may be appropriate only after reading, after the reader has had a chance to secure a firm mental representation of what s/he has read.

Activation of prior knowledge

In a study with just under sixty year 2 children, Cain and Oakhill (1998) eliminated memory or general knowledge deficits as a source of inferencing failure. They arrived at the conclusion that *knowing when and how to relate … general knowledge to the text, in order to fill in missing details, was more likely a source of problems* (p. 341). Although this factor was identified at least 20 years ago, and its importance has often been reiterated since, the reviewed literature has produced little to advise teachers on how to activate prior knowledge to benefit inferencing skills.

McGee and Johnson (2003) recognised the role of prior knowledge in inferencing, but did not attempt to include it in their own programme. They quoted Hansen and Pearson (1983) who *developed a method of teaching inferential skills that was intended to encourage children to relate textual information to their own previous experiences. Before starting to read a text, the children were encouraged to use their own experiences in relation to the topic as a source for generating hypotheses about the text* (p. 50). The text was followed by ten inference questions which were answered and discussed to foster the generation of global inferences (superordinate goals, causal consequences, main theme). On comprehension tests, the programme improved the performance of poorer readers up to the level of their abler peers. As they were re-running the trial as Yuill and Oakhill had devised it, McGee and Johnson did not include a prior knowledge activation component in their trial and we have seen no recent evidence on how this operation might work.

The failure to find much advice on the activation of background knowledge may be because this aspect of inference is seen as largely an automatic process, executed unwittingly. Pressley (2000) contrasted the *automatic relating of text content to prior knowledge* with those processes that are *conscious and controllable.* The implication may be, therefore, that there is not very much a teacher can do to influence what is outside the control of the reader himself. Nonetheless, he then continued to say that *whether a reader uses relevant schematic knowledge depends somewhat on unconscious and automatic processes of association but also on many conscious reading processes, ones that can occur before, during and after reading* (p. 551). Of the nine processes that Pressley identified as being under the conscious control of the reader, there are three that apply to prior knowledge (p. 550):

- *Making associations to ideas presented in a text based on reader prior knowledge*

- *Evaluating and revising hypotheses that arose during previewing or occurred in reaction to earlier parts of the text, revising hypotheses if that is in order*

- *Revising prior knowledge that is inconsistent with ideas in the text, if the reader is convinced by the arguments in the text (alternatively, rejecting the ideas, when they clash with prior knowledge).*

Other than asking oneself *why*-questions during reading, Pressley did not provide other such concrete suggestions for how else the teacher might induce pupils to draw on their background knowledge. However, in his résumé of instructional approaches, he seemed to favour the *transactional strategies* model of teaching. In this approach, the teacher would demonstrate the practice of self-administered *why*-questions and the three processes outlined above in relation to a real text and show how she draws on information extrinsic to the text in order arrive at its implicit meanings. The model will be described more fully in the next section.

Harrison (2004) looked back more than 20 years to find a model of prior knowledge activation to advocate. According to Harrison, the work of Langer (1981) and her three-phase model for eliciting and classifying prior knowledge (the 'Pre-Reading Plan') had impressive results. The plan worked because it *makes learning more meaningful, activates schemata onto which new knowledge will be mapped … increases provisional understanding, processing and recall. … a class discussion of both the associations and the hierarchies shared by the members of the group are brought out into the open, then those with fewer associations and less well organised strategies will benefit the most, but everyone has the opportunity to extend and update their own schemata before the new knowledge, vocabulary and concepts are encountered* (p. 92).

Langer's Pre-reading Plan consists of the following three phases:

- *pupils generate initial associations*

- *they discuss and clarify their collective knowledge*

- *they reformulate knowledge, clarifying what they now know as a result of discussion.*

More information about prior knowledge activation may be found in sources that are not narrowly focused on inference skills but more widely on teaching and learning. These have not been deliberately trawled in the course of this review and it is possible therefore that some rich sources for obtaining this information have been overlooked. However, Lewis and Wray, who wrote for teachers wishing to develop literacy via other curricular subjects in their publications '*Extending literacy*' (1997) and '*Literacy in the Secondary Schoo*l' (2000), described generic strategies for

activation of prior knowledge. This stems from their work on the Nuffield Extending Literacy (EXEL) Project, in which they worked with secondary teachers in a number of cities, boroughs and counties. They *amassed dozens of teaching ideas and a fair sense of what works and does not work* (p.ix). In brief, they indicated that existing knowledge should be elicited from pupils through (*Literacy in the Secondary Schoo*l, p. 29):

- *Discussions*
- *Brainstorming / concept mapping*
- *Using visual sources*
- *Using artefacts*
- *Using grids for organising the outcomes*

Lewis and Wray claim that one of the advantages of work such as this is that pupils *share and value different experiences and knowledge from a range of backgrounds and cultures and key ideas and vocabulary can be introduced within a supportive context* (p. 30). If this is the case, then the strategies described in the points above would also help to alleviate some of reasons for the inferencing difficulties experienced by second language speakers, as described by Narvaez (2002).

Advice for teachers on the benefits of activating background knowledge is ambiguous. The research conducted by Barnes *et al*. (1996) and Cain *et al.* (2001) suggests that knowledge acquired just prior to reading is not as useful for inferencing as that which is well embedded in the reader's long-term schemata. Cain *et al*. arrived at the conclusion that *…even when they had the requisite knowledge base from which to generate an inference, the less skilled comprehenders did not make these inferences as readily as their skilled peers did. Knowledge availability is therefore not a sufficient condition for inferencing* (p. 857). Barnes *et al.* (1996) hypothesized that knowledge was more useful to the reader if it were *taught using a more protracted…type of acquisition phase* (p. 235)*.* They claimed that knowledge does not consist of facts alone but is made up of facts and the set of connections between facts: a whole network of associations. The number of times and in what contexts a reader has already encountered this network will influence inference generation. Barnes *et al.* (1996) suggested that the natural growth of the knowledge base as we grow up, repeatedly being tapped into, in different contexts, may be responsible for the increase in elaborative inferences with age. *It may be that the growth of the knowledge base itself, with ensuing changes in knowledge accessibility, is responsible for age-related increases in elaborative inferencing* (p. 237). As Pressley (2000) also intimated by the stress he put on the importance of background knowledge, there seems to be no substitute for having a rich resource of knowledge of one's own.

There is no argument that prior knowledge is an important prerequisite to inferences. However, the value of trying to activate prior knowledge is unclear. The work of Cain *et al*. and Barnes *et al.* suggests that its efficacy in promoting inference production is limited. It would seem to benefit mostly those children who know quite a lot and who can readily integrate new information into the networks of the schemata they have

already constructed. Harrison (2004), Lewis and Wray (2000), by contrast, have provided successful models for knowledge activation and are advocates in their use. It is claimed that its main advantage is to those whose knowledge of the world is less well developed. In their discussions, however, the emphasis is on learning, recall and comprehension in general rather than inferencing specifically. It is hard to see any detriment to the sharing of background knowledge, especially before embarking on an expository text. Even if not of immediate benefit to the interpretation of the text in hand, it may be in the future.

Aural work and listening comprehension

In 1998 and 1999, Cain and Oakhill established that problems in inferencing caused problems with comprehension and not the other way round: *poor inferential skill is more likely a cause of comprehension failure than a result of it* (1998, p. 338). This suggests that inferencing is a separate skill that can be divorced from reading and practised in other contexts.

McGee and Johnson (2003) noted that children carry out inferencing outside the classroom. They cited the evidence of Markman (1981) in stating *…some evidence suggests that making inferences per se is not an inherently difficult task* (p. 50). *Children routinely use inference during nonschool activities, for example, when deducing similarities and differences between new and familiar events, but classroom activity does not provide for the use of such skills* (p. 50, cited from Chouhare and Pulliam, 1980). This implies that teachers might recognise more opportunities outside the reading curriculum in which to practise inferencing. Listening activities seem to be the most favoured.

Cain *et al.* (2001, p. 858), for example, concluded that *less skilled comprehenders' difficulties with inference making are not just restricted to reading situations but are apparent in tasks involved in listening comprehension as well.*

In their study with 70 pairs of identical twins aged between 8 and 17 years, Keenan *et al*. (2006) demonstrated that listening comprehension shares significant influences with reading comprehension independent of IQ. They suggested that teachers should therefore focus on the processing deficits underlying listening comprehension, such as word knowledge and vocabulary.

Nation, in collaboration with Snowling (2004) and with Angell (2006), has put considerable stress on the relation between reading and listening comprehension. In 2004, Nation and Snowling reported the results of a longitudinal study conducted over four and half years in which they revisited 72 pupils at ages eight and 13, and tested them on a battery of language skills on both occasions. They claimed that *our data demonstrate that oral language skills influence reading development during upper primary and lower secondary years* (p. 354). Likewise, the concluding remark to the 2006 article was that *a large portion of the skills needed to comprehend text are shared with (or perhaps even parasitic upon) our spoken language skill … Thus*

strategies to foster reading comprehension can be usefully grounded in interventions designed to improve language (p. 86).

The outcome of the work conducted by Cain *et al*., Keenan *et al*., Nation and her colleagues is that inference is not tied to reading alone. Speaking and listening activities stand out as being particularly appropriate in this regard. Reluctant readers may be more willing to engage in inference and deduction if it is divorced from reading. Furthermore, there seems to be no need to remain tied to the language curriculum for the development of inferencing. Discussion in any curricular area has potential. The texts to which Narvaez (2002) referred to illustrate her stance on how to promote inference in multi-cultural classrooms particularly exemplify this, as they came from PHSE and social science domains.

Working memory

In chapter 1, it was clear that an area of strength or weakness that has a profound effect on inferencing ability is that of working memory capacity. Calvo's study in 2004 explicitly investigated the role of working memory span and concluded that, together with vocabulary knowledge, it has a direct influence on skill in this area. Many other researchers, whose focus was not specifically on working memory, still arrived at the conclusion that the differences in inferencing can be attributed to this single factor. In all the literature reviewed, however, not a mention was found about how this could be developed and nurtured to the benefit of inferencing during reading.

3.3. Summary

The following is a summary of all the specific suggestions that have been shown by research to have a place in inference instruction:

Word level work:

- developing fluent basic reading skills (e.g. practice in decoding print)
- Vocabulary building (denotation & connotation): orally and in reading
- Lexical training: local cohesive devices (pronouns, connectives)

Text level work:

- make explicit the structure of stories
- make explicit the usefulness of a title
- emphasise that fiction allows multiple interpretation and inference making

Questions asked by the teacher:

- *'How do you know?'*
  ask whenever an inference is generated in discussion of a text
- questions about relationships between characters, goals and motivations
- questions that foster comprehension monitoring, such as
  Is there information that doesn't agree with what I already know?
  Are there any ideas that don't fit together (because of contradictions, ambiguous referents, misleading topic shifts)?
  Is there any information missing or not clearly explained?

***Cautionary note about questions**:*

- not to interrupt pupils by asking questions during reading time
- not to launch into questioning too soon afterwards. The teacher must allow time for consolidation of what has been read as a mental representation
- practise inferential questions on aurally presented texts

Question asked by pupils:

- *Why*-questions
  train pupils to acquire the habit of asking themselves *Why*-questions occasionally while they are reading, as these are most supportive of understanding
- '*who-'*, '*when-'*, ' *why-'* etc questions,
  show examples of how all types of questions can be derived from a text. In small groups, pupils generate questions using these questions words from a text and group-members answer. Pupils take turns in asking and answering the questions.

Activation of prior knowledge

- pupils generate initial associations
- they discuss and clarify their collective knowledge
- they reformulate knowledge, clarifying what they now know as a result of discussion

Prediction and contextualisation

- cloze exercises, and similar

Aural work

- listening to stories and story tapes
- listening comprehension
- discussion in curricular areas outside literacy

4. What strategies are most effective in teaching inference and deduction skills to pupils at different ages and abilities

With little exception, research has not explored the methods of inference training that are appropriate to different ages or abilities. The evidence reviewed hitherto points to the fact that inference pre-exists reading and that it can, therefore, be seen in children as soon as they are learning to read. The most effective age, when pupils are most responsive to direct inference instruction, is quoted in the research as being in the early secondary years.

The information that can be useful in guiding teachers in approaches to adopt for inference instruction falls into two parts. The first focuses on texts and textual features that can influence inferencing. This will help raise teachers' awareness about features to look for when selecting texts for inference instruction. The second looks at strategies. It should be pointed out that these are not specifically devised or recommended for the exclusive purpose of inference instruction. They are, in fact, methods that have been developed for more general comprehension work in the classroom and that have the hallmarks of strategies known to be useful for imparting inference skills.

4.1. Materials

The literature has produced some guidance for teachers who are looking for texts that will generate prolific inferencing.

Narrative versus expository

There is a consensus regarding the relationship between text type and inference. Although narrative texts are more likely to produce abundant automatic inferences, expository texts have their place in inference instruction.

Graesser *et al*. (1994) stated was that inferences happen automatically in narratives because they have a close correspondence to everyday life. *Both narrative texts and everyday experiences involve people performing actions in pursuit of goals, the occurrence of obstacles to goals, and emotional reactions to events. Knowledge about these actions, goals, events, and emotions are deeply embedded in our perceptual and social experience. … The inferencing mechanisms and world knowledge structures that are tapped during the comprehension of everyday experiences are also likely to be tapped during the comprehension of narratives (*p. 372). The authors go on to say that expository text also has pedagogical use in inference training. These texts are usually written to *inform the reader about new concepts, generic truths and technical material.* As a result, inferencing is conducted more consciously and is therefore amenable to instructive discussion.

The findings of Singer *et al.* (1997) support this. In their study, their own results on narrative texts sharply contrasted with those conducted by Noordmann *et al.* (1992) on expository texts. In four experiments which measured eye movements at computer-controlled stations to determine whether or not and how long it took to draw inferences, they established that causal inferences are not made during reading expository texts even by undergraduate-aged readers. The reasons for the difference are those discussed above. Expository texts do not have familiar predictable structure like narratives do, so constructing meaning from them entails reliance only on what the reader can derive from semantic relationships and abstract rhetorical structure of the text, whether it be an argument, an account, an explanation about how something works. In narratives, by contrast, readers rely on the familiar structure centred around setting, theme, plot and resolution. However, as seen in section 2.2.2 (text level work with narratives), it cannot be taken for granted that all young readers will instinctively know how to use this knowledge to their advantage and will require explicit teaching of how to apply structure to the interpretation of both expository and narrative texts.

Likewise, Narvaez (2002) also noted that narratives are more conducive to inferences. She produced research evidence to support her view that narratives *elicit more interest*, prompt *more explanations and predictions*, generating nine times as many inferences as expository texts. She maintained that this was partly because readers have early and extensive practice in inferencing from narratives and partly *because everyday life is constructed much like a story.* Conversely, she stated that expository text evokes *more associative inferences, repetitions, evaluations and indications of knowledge-based coherence breaks* (p. 166). She exhorted instructors and students *to realise that associative inferences are not enough. Explanatory inferences are also vital* and *causal relations are central.* Narvaez maintained that students naturally perform these with narrative texts but needed *instruction in how to transfer strategies that they know and apply automatically to narrative texts to their reading of expository texts.* Instructors need to ask questions that will lead the reader to make inferences… *such as causal relations between elements of the text, predictions and explanations* (p. 169).

One way of doing this may have been identified years earlier by Barnes *et al.* (1996). They quoted evidence from earlier studies (Schneider *et al*., 1989 and Yekovich *et al*., 1990,) that *pupils with lower IQs make more inferences within an area of their expertise than do children with higher IQs who are naïve about the same area* (p. 217). The choice of subject matter can therefore influence the extent of inferencing and there many be a case for choosing texts that might otherwise seem unworthy of study, simply because the topic is one on which the pupils are experts. This strategy could apply particularly to expository materials. As an aside, it should be noted that IQ has been related to working memory capacity and that this may, therefore, be a way of encouraging inferencing in those who are lacking one of the fundamental prerequisites for inference.

Choosing texts

In the conclusion of the influential 'Effective Use of reading' (1979), Gardner commented that *teachers of English are engaged in a constant search for texts that capture the imagination of their pupils* (p. 300). They supported this untiring search for texts because they saw the text as central in engendering the pupil's *willingness to reflect*, a prerequisite to reading and inference. For independent reading, they recommended texts that avoid textual problems as this would lead to frustration. *Where the support of the teacher is available, different considerations apply* and the texts can be slightly more difficult (p. 302). They suggested that overly challenging texts therefore are not conducive to reading and the inferencing that arises from the *willingness to reflect.*

Years later in 1997, Singer *et al.*'s research supported this. They found that the complexity of some expository text is such that it impedes inference processing. The reasons, as seen earlier are partly to do with the newness of the information, partly the lack of supporting world knowledge to provide for inference making and partly the fact that they are much less predictable in form and structure than narrative texts. In this study (with undergraduates) *subjects sometimes examined the expository sentences for very lengthy periods, in spite of the instruction to read at a normal pace* (p. 205). Over the course of four experiments, the authors identified features that would promote inferences and which teachers could use in guiding their choice of (or re-writing) expository materials.

- Text wording: Caution in the use of synonyms: the more synonyms used, the greater the need for inference because the reconciliation of synonyms is demanding on cognitive resources. Repetition reduces inferences.

- Thematic status: information conveyed in the theme sentence is more likely to be used for inferences. Ideas introduced earlier in a paragraph receive more attention - have high 'thematic status' - than later ones and thematic ideas are more likely to be computed into inferences.

Hannon and Daneman (1998) would have added another point to the two above. By conducting three experiments (with undergraduate subjects), they endeavoured to pinpoint the features that would increase the frequency of knowledge-based inferences in poorer readers to the level of their abler peers. The variables they trialled were: key words, integrated questions and reading time. None of the variables had an effect on its own. The only condition that was found to significantly encourage inferencing was that of integrating questions into the text combined with allowing longer reading time. This tallies with the conclusions of Van den Broek *et al*. cited earlier, who also indicated that sufficient processing time is necessary to drawing inferences. These pieces of research highlight the text features that prompt inferences. This is useful for teachers in selecting texts when inference practice is the focus of the lesson plan, especially in the context of expository texts. Texts rich in inferencing possibilities will be useful when the teacher wishes to demonstrate through modelling the thinking processes that precede an inference. It is not suggested that these features be sought in the selection of all texts.

Choosing the right text is a balancing act. While Lunzer and Gardner (1979), Singer *et al.* (1997) and Hannon and Daneman (1998) seem to warn against choosing hard texts, Gilabert *et al*. (2005) exposed the disadvantages of selecting a text that is too easy. Working with year 8 pupils and undergraduates he compared the effects of re-writing expository texts in two ways: 1. making the inferences explicit and 2. elaborating parts of text that would trigger inferences. He studied the effects of this on students with low and high background knowledge. What became clear was that making a text too explicit suppresses the performance of the reader. Redundancy produced by high background knowledge and a highly explicit text seems to cause passive processing, resulting in low inferencing and low understanding. In contrast, *increasing the connection among text ideas so that the reader's inferential activity is enhanced benefits the reader's understanding at both the deep and superficial levels* (p. 65). Revising texts to make them more explicit did not emerge as the best approach to promote understanding. Instead, his conclusions were that texts chosen should promote mental activity by allowing inferencing and that this would result in better comprehension overall.

4.2. Strategies for children of all ages

Little research which isolated strategies for the teaching of inference was found. The majority of researchers in the field indicate that strategies adopted for the wider teaching of comprehension are appropriate for inference instruction, too. However, two models were repeatedly mentioned and associated with inference teaching: 'reciprocal teaching' and 'think-aloud'.

Table 3 below outlines, in brief, the stages involved in these two prominent models of instruction.

Table 3 - Strategies associated with comprehension instruction

Reciprocal Teaching (Based on description by Pressley, 2000)	Teachers teach the following strategies over short period (e.g. 20 lessons): 1. prediction 2. questioning 3. seeking clarification 4. summarisation. After a text is read, a nominated pupil leader of a group: 5. poses questions for peers and peers respond 6. proposes a summary 7. invites peers to discuss, seek clarifications, pose questions of their own, make predictions about following piece of text.

Think aloud Israel and Massey (2005)	**Three pre-requisites**: 1. Pupils see the teacher model and understand what it means to think-aloud (speak freely, not well-structured / sequenced, reflect their thoughts and partial thoughts) 2. Practice 3. Activate comprehension strategies while thinking-aloud: pupils identify where comprehension is lacking and correct it **Six strategies to be taught:** **Before reading**: 1. Activate prior knowledge: hypothesis / prediction about text being read; teacher looks for evidence of existing schemas being activated during meaning construction **During reading**: 2. Relate text to text: relate important points (story grammar elements, cause and effect, points of comparison and contrast) in the text to one another to understand text as whole 3. Relate text to prior knowledge: pupils relate new material to what they already knew to construct interpretation 4. Infer: information critical to interpretation of text, use of internal and external clues to infer word meaning, elaboration and speculation of ideas re author's purposes, to fill gaps between text and pupil interpretation **After reading**: 5. Utilise strategies eg: summarise, predict, question, visualise, paraphrase, repeat text 6. Reflect: this may be evident if pupil voices acceptance / rejection of their understanding of the text or fitting parts of the text together.

4.3. Age-specific strategies: what progression in inference looks like and how it can be supported

The authors of the models described in Table 3, above did not specify age-groups for which they intended the use of their strategies. It is assumed that teachers would adapt the principles to the children they are teaching. Not very much has been written about age-specific methods so this section will introduce some background information on what children can typically do at different ages.

Perhaps one of the most interesting issues, though not one that falls strictly within the domain of this review, is when to start teaching conscious comprehensions activities, such as comprehension monitoring, which would naturally include the skills of inferring and deduction. Baker (2002) recounted the main points in the controversy, citing researchers such as Clay (1998) who maintained that teaching too young would create confusion and Chall and Squires (1991) who *suggested that direct instruction in metacognitive skills related to literacy may be inappropriate during the early years of schooling* (p. 88). She also referred to a survey conducted by Baumann *et al*. (2000), *which did not even inquire about comprehension monitoring instruction in grades pre-K to 2* (i.e. below Year 3) *implying that it is not or should not be taught*. Other authorities, such as the National Research Council (Snow *et al*., 1998) advocate explicit instruction from the beginning and are supported by the work of researchers such as Thomas and Barksdale-Ladd (2000, p. 79) who maintained that *an effective reader is an effective reader irrespective of age, and the ability to monitor comprehension is a hallmark of all successful readers.* Quoting evidence from Rosenshine and Meister (1994), Haller *et al*. (1988) and Chall *et al*. (1990), however, Baker suggests that the consensus seems to be that the most successful teaching of metacognitively-oriented strategies is with older students in years 7 and 8.

Studies conducted by Paris and Lindauer, 1976 and Paris *et al*., 1977), as cited in Cain and Oakhill (1998) showed that inference itself - as distinct from general comprehension monitoring - develops between ages of six and 12. They demonstrated that 11-year-olds were much better at determining the unstated consequence of a statement such as '*Mary dropped the vase*' (broke it) than eight-year-olds. They arrived at the conclusion that young children did not make as many inferences as older not because they were incapable, as they could produce the requisite background knowledge when asked, but they only made them when they were prompted.

Barnes *et al*. (1996) compared two types of inference and their rate of occurrence in 51 readers of different ages (between 6 and 15 years of age). At the outset they gave all the children involved a new fictional knowledge base and ensured, through questioning, that they had all acquired the same level of familiarity with the new information. This was intended to eliminate differences in pre-existent background knowledge, likely to affect the production of elaborative inferences. They found coherence inferences were more frequent in children of all ages, as even readers *as young as 6 years of age are sensitive to the causal constraints operating within*

stories even though inferences that restore coherence are actually more difficult for them to make than are inferences that elaborate on the story (p. 236). They determined that young children find inferencing difficult *per se* and that this was independent of reading comprehension skill. As pupils make more inferences when not having to process text (i.e. read), it may be advisable to practise and develop inferential skills in talk. This was felt to be an approach particularly appropriate to young children, who even in discussion make fewer inferences than older children. Barnes *et al.* (1996) pointed out that aural work is good at nurturing elaborative inferences because cognitive capacity is not occupied with the tasks of decoding print and drawing the necessary coherence inferences to make sense of text, so there are more cognitive resources available for imagining *what* a situation is like.

In the literature reviewed only one other implication seems to be relevant with regard to progression and support in reading. Cain, Oakhill and Lemmon (2004) conducted two small studies with nine to ten year-olds on the inference of vocabulary meanings from context. One of the conclusions they drew was that poor comprehenders encounter difficulty with inferring the meanings of new words if the contextual explanation from which they can make their inference is not in the immediate vicinity of the word itself. The authors suspected that pupils in the study, who had poor comprehension but good vocabulary, had probably acquired the vocabulary through controlled reading schemes. They cautioned that as soon as they went on to read more widely, vocabulary would not increase at the same rate as skilled comprehenders, due to the fact that they could not infer as well in 'far' conditions. As one of the underpinning bases of inference is vocabulary, the implication for teachers may be to keep their less skilled comprehenders on controlled reading schemes for longer. In making decisions about this important issue, teachers have to balance the advantage of steady support provided in reading schemes, where vocabulary is introduced systematically in contexts that are often more supportive of understanding than is usual in 'real texts,' with the motivational advantages that arise from reading more widely. As a broad diet of reading is also associated with vocabulary development, it may be that the role of the teacher is to be on hand in the selection of reading materials, making sure that the vocabulary demands are reasonable for the individual concerned. Another strategy, as seen in earlier recommendations, is for the teacher to enrich the diet of reading materials by reading aloud to the class, herself. This would have the advantage that vocabulary building can be done orally, as the unfamiliar items of can be explained by the teacher, *in situ*, as they occur.

Other age-specific references relevant to inference instruction were few and were mentioned incidentally rather than being the focus of the article reviewed. They will not, therefore, be included here.

4.4. Summary

Considerations when choosing texts

- Narrative texts generate more inferences but expository texts promote more conscious inference making
- Pupils make more inferences about topics on which they are 'experts'
- Explicit instruction needed on how to transfer narrative inferencing skills to expository
- The frequency of synonyms (the more synonyms, the more inference required)
- Do the key pieces of information which will generate inferences have high thematic status?
- Are there helpful inference-generating questions embedded in the prose?
- Do not choose texts that are too easy.

Strategies to show inference in use

- Model inferencing by asking relevant questions aloud and answering them. Think thoughts aloud to show how teacher arrives at an inference.
- Pair / group work so pupils share the thought processes that led them to make inferences.
- Aural work: the younger the children, the more aural work.

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FURTHER READING

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Appendix 1: Search Strategy

Parameters for Literature Review

1. Purpose of the research

The aim of the review was to survey recent and significant studies conducted on the teaching of inference and deduction skills, to evaluate them and to recommend effective methods in a full report. The intention was to investigate primarily the context of the reading curriculum but other subject areas were also explored in relevant studies identified. The scope of the study involved research relevant to Key Stages 2 and 3, both in the United Kingdom and abroad.

2. Key research questions

This survey addressed the following questions:

- Are there different skills within inference and deduction?
- How can pupils best be taught to use inference and deduction skills?
- What strategies are most effective in teaching inference and deduction skills to pupils of different ages / abilities?
- What does progression in inference and deduction look like and how can it be supported?

3. Search parameters

The survey involved a review of relevant literature. It drew on both empirical and theoretical studies, focusing mainly on

- Information from/including England from 1988 onwards
- Information from other countries from 1999 onwards to avoid duplication of the USA's National Reading Panel (2000), *Teaching Children to Read*.

4. Searches conducted

- Research databases and NFER Library databases; Applied Social Sciences Index and Abstracts (ASSIA), Australian Education Index (AEI), British Education Index (BEI), ChildData, Current Educational Research in the UK (CERUK), Educational Resources Information Center (ERIC), Linguistics Abstracts, and PsycINFO

- Other relevant web-based resources were also searched.

Search terms used

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research and Inference or Reasoning or Inferential reasoning or Comprehension or Understanding or Prior knowledge or Comprehension monitoring

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Reading comprehension

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Simple inference or Complex inference or Global inference or Local inference or Text filling inference or Gap filling inference

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Implicit meanings

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Cooperative learning

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Metacognition

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Inductive deductive reasoning

Reading or Literacy or Reading skills or Reading strategies or Reading ability or Reading achievement or Reading processes or Reading research **and** Think Aloud or Verbal protocol

Author searches conducted

Cain, Kate

Harrison, Colin

Lewis, Maureen

Nation, Kate

Oakhill, Jane

Pearson, P. David

Pressley, Michael

Snow, Catherine

Wray, David

Yuill, Nicola

5. Inclusion criteria

For empirical research studies:

- Focus on evidence of effective teaching methods
- Measure or evaluate comprehension as an outcome
- Have appropriate sample characteristics and analyses
- Include sufficient details of the teaching methodology
- Involve school-based enquiry

For theoretical research studies:

- Appear in a refereed journal
- Refer to empirical research

Using the ‘best evidence’ approach, other research was reviewed if there were pressing reasons for inclusion.

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