Plumbing the levels of reading : An information processing model of literacy learning

John Munro, University of Melbourne[1]

For three decades the teaching of literacy knowledge has been hampered by the promulgation of two views of literacy learning that have been presented as competing and mutually exclusive. Both the top-down 'whole language' approach and the 'bottom up' phonics approach have claimed a research base and have demands faith-like adherence from their disciples. An alternative type of model that more effectively reflects the reading process, that inegrates the top-down and bottom-up directions of information flow during reading and that is more useful in explaining reading disabilities are the infomation processing models of reading.

When writers write text, they organise the information at a number of levels (Just & Carpenter, 1980; Haberlandt, 1988):

- at the text level; the text has one or more integrated topics or themes- a text doesn't usually consist of randomly selected ideas.
- at the conceptual level; the topics are defined by a network of concepts / ideas / meaning units. These are introduced gradually in systematic, predictible ways according to particular conventions.
- at the word level; each concept / meaning is represented by a word or phrase- this is its label.
- at the sentence level; concepts are related to others. This relationship is a proposition. Each sentence contains a proposition.
- at the dispositional level; the text has one or more purposes, for example, to persuade, to scare, to teach, to show how a set of ideas is interesting or useful.

Readers 'make sense' of text, that is, process it semantically, at these levels. While each is mentioned separately, readers do this interactively (Haberlandt, 1988). Readers learn to use a semantic cuing system when processing text. There are several levels of semantic relationships in text; what indidual words mean, the meanings of sentences and the conceptual network that underpins the ideas in the text.

Information processing models of reading focus on how readers map the visual-symbolic information that comprises text into a personal understanding and sometimes, into a change in personal knowledge. They do this by developing detectors for collecting each type of information from the text and search the text for information at each level. These models ask questions about the information-knowledge transformation, such as

- the knowledge units readers use to detect and interpret units of information in the text,
- the nature of the information processing activity
- the amount of information readers use at once,
- the procedures readers use to manipulate the information
- the conditions that initiate and maintain an information processing episode

The information processing models of reading usually begin with an analysis of what skilled reader do and then examine developmental trends to this. This 'cognitive analytic' approach provides a basis for identifying points at which reading disability might arise. This has obvious implications for diagnosis and remediation.

Information processing models of reading

---

[1] This is a summary of the Keynote presentation to the Biennial Conference of the Australian Resource Educators Association, Melbourne, June 1999. It was published as *Plumbing the levels of reading: An information processing model of literacy learning* Munro, J. (1999a). Plumbing the levels of reading: An information processing model of literacy learning difficulties. pp. 57 - 78. In D. Barwood, D. Greaves and P. Jeffrey (Eds.) Teaching Numeracy and Literacy: Interventions and strategies for 'at risk' students. Melbourne, Vic: AREA

The knowledge that readers have can be thought of in terms of various metaphors. One model, relevant to the study of reading, is the 'semantic-network' model, in which ideas or 'units of meaning' are linked in networks. To get an idea of how the processing system works, read the following text in order to retell it:

You may have heard a lot about strokes that are grooved. The idea behind this actually very simple. Again the chance of you moving like this increase every time you move in a particular way. In hits yaw earnlyou motor patterns that become part of your play. Disengroovement occurs during prolonged unuse.

One of the things you probably found yourself doing early in the reading is to discover its topic or theme. Within our networks, the units of meaning are organised into topics or themes. The set of ideas a reader has about any topic is sometimes referred to as a 'schema'. Ideas in each topic area have stronger links with each other than they have with ideas in other topic areas.

Each unit of meaning has one or more more 'labels' or names by which it can be contacted. For a particular reader, some units of meaning will have a 'spoken' or 'phonological' label while other units may have both a spoken label and a written or 'orthographic' label; these are the written words the reader can read. These labels provide doors into the network of meanings by collecting information about the text. They are assumed to work as follows.

During reading these labels detect or collect information from the text. They, and their linked units of meaning, operate as 'knowledge sources' (Rumelhart , 1981). Your orthographic units for the written words *heard* , *strokes* and *grooved* would have collected information from the text. They would have becomes 'stimulated' or 'triggered' by the text. The meanings you link with *strokes* and *grooved* will depend on what you have stored in your existing knowledge.

In the fourth sentence, the letter string *earnlyou* didn't match a words you know, while *hits* , and *yaw* are words that would not seem to match either the meaningful or grammatical contexts of this sentence. Sometimes when readers don't have a written label for a letter sting, they can convert it to a spoken form to know what it means. Trying to convert *earnl* to a sound code may help if you guess that it sounds like *learn* and *earnlyou* might be intended to be *you learn* . Other times readers may use the context of the text to work out the word. This is when other linked meanings have been stimulated and have strong links to that meaning.

You may not have seen or heard earlier the words *disengroovement* or *unuse* . By making analogies between them and familiar words and transferring the sound and meaning properties of the words, looking at the grammar and context of their sentence and topic, you can infer their meanings and how to say them. *Disengroovement* is like disengagement. Our information processing system allows us to make these analogies without being aware that we are doing it.

A sentence is understood in the intended way when the ideas are stimulated in a specific sequence. Its grammar tells you the order in which to link theme. In the first sentence, the grammar tells you who did the hearing and what might have been heard. Processing the word order lets you know that the *strokes* were not hearing. In your existing knowledge, you may or may not have already linked *strokes* and *groove.* If you have, this sentence confirms what you know. Reading *strokes* may have led you to predict *grooved* . If you hadn't already linked these, you will form a temporary link between them. The links suggested by the grammar of a sentence confirm or challenge existing links. When they challenge existing links, 'alarm bells ring' and signal us to re-read and to change how we are analysing the data.

The third sentence is difficult to process at the sentence level; the overall relationship suggested by linking the meanings in order may not fit your existing knowledge. You can process it at the word level. Because you may have already guessed that the topic is about learning motor behaviours, if you select its key content words as *chance, moving, increase, every time, you,* and *move in a particular way* you might guess that the correct version is *Every time you move in a particular*

way you increase the chance of moving like this again.. You get to this by combining the information processing at the different levels.

Each collector triggered by the text has a two-way link to other collectors in the network and can affect them in two ways; either activating or arousing them, or by deactivating or suppressing them. Stimulating an idea, for example, 'water' would suppress other ideas at the same level that could not occur logically with it. The extent to which an ideas stimulates other ideas depends on the srength of their link. This has been learnt through earlier experiences the reader has had with the two ideas at onc. This is the "spreading activation" mechanism; whenever a collector is activated, the stimulation spreads to other collectors.

At an early arly point during reading a text, readers select some ideas to decide its topic. They use this to predict other ideas that might be mentioned. As the reading continues, they match the concepts encountered with what they expected.

The outputs from each collector are "best guesses" from the data they have gathered and are collected at a "message centre" where they are evaluated against other outputs and integrated. As you can see from our example, each level of processing is not a data base for higher levels but is synthesized with information gathered at higher and lower levels. Once this happens , each output ceases to exist independently; reading can be seen as an extract-and-discard operation. As readers read, they discard the precise meanings and and form an integrated summary of what the text says, that is, the theme unit remains stimulated. The text is comprehended when the accumulated evidence most strongly supports one interpretation.

The amount of information readers can process at any time, or their 'short-term working memory', is restricted. Information from all available sources in the text is processed; visual information, retained in a visual information storage, the meanings of recently read words, clauses and sentences, stored in a short-term 'scratch-pad memory, the representation of the text, assembled in a working memory and the reader's conceptual and linguistic knowledge, in long-term memory. Readers learn to automatize some aspects of the information so that they need only give their attention to other aspects. This makes the overall reading process more efficient. However, some aspects will need attention to be processed. The aspects that demand least attention, that is, are more automatic, require least capacity. Recognising words by seeing their spelling pattern uses less attention than converting the spelling to a sound code and then matching it with how the word is said. Using the meaning network to predict meanings and reading to confirm or correct these predictions and identifying redundancies in the text so that readers need to attend only to part of the information provided reduces the amount of short-term working memory needed. The saved space can be used for thinking about, and manipulating the ideas encoded.

These theories see reading as parallel processing, in which readers use simultaneously several types of text information; what words look like, how they are said, what they mean, their grammar in the sentence, what the sentence means and the topic. They gather and integrate information from these sources. When information from different sources clash, for example, when what they expected the text 'to say' wasn't 'said', they are cued to switch attention to particular sources of information and to re-read or to take other 'remedial' actions.

There are various types of theories that explain reading in these ways. They differ in the level at which they analyse reading and the types of units on which they focus. Names for these types of theories are **schematic** or **interactive** models of reading, for example, Rumelhart's schematic model of reading, **parallel distributed models**, neural network models of reading and connectionist theories (Seidenberg & McClelland, 1989).

How readers acquire the capacity to process text in these ways

People learning to read need to learn how to process text at the various levels; their information processing system needs to be programmed to detect and use these. The capacity to process information develops gradually, in parallel with linguistic and cognitive development. It is not

possible, within the word restrictions of this article, to describe this in detail. It is described in greater detail in Munro (****). Readers need to learn

- how to detect each type of unit (learn the structural units in the text, the types of words, sentences, conceptual structures, topics or themes and values.

- how to manipulate and integrate the information from the detectors (a knowledge of the reading strategies or procedures used to transform and link the outputs).

- why each type of information is useful and when to use it (attitudes towards each type of information).

Examples of the types of reading behaviours at each level are shown in the following grid.

Levels of text	detectors or structural text knowledge	reading strategies	value of work at each level; reader's beliefs
word level	letter clusters, types of written words, word structures	how to read unfamiliar words by segmenting and recoding	why reading/ working out words is useful
sentence level	grammatical knowledge, sentence propositions	visualise sentence read paraphrase sentence	how imagining a sentence can make you feel
conceptual level	ideas linked together in networks	predict, anticipate infer ideas or feeling	why it is useful / interesting to predict
topic level	ideas linked to a topic or theme	link text with a topic area	how the topic of text can help you read
dispositional level	values, attitudes or beliefs communicated by a text	how to detect the attitudes in a text	why it is useful to detect attitudes or values .

Readers integrate the knowledge they have identified at the various levels to develop a set of expectations about the text and a framework for organising its information. This processing draws on their conceptual knowledge, knowledge of text structure and language, their goals and purposes for reading and their beliefs and self concept as readers. The set of processes is the comprehending process and its outcome is an abstract entity, the meaning of the text.

Developmental trends towards this knowledge: From a 'whole child' persepective, the knowledge needed for learning these information processing units, strategies and beliefs include knowing

- how words are said; the area of phonological and phonemic awareness.
- how to link written words and spoken words so that children can reade rapidly and accurately written words and use what they know about the letter clusters in some words to read others.
- how to write and spell words, the values and purpose of writing, its conventions, the structures of different types of texts and spelling.
- what words mean and how their meanings are linked.
- grammar and linking words in ways that match how we speak.
- concepts and how they are linked; they can be organised in verbal networks of concepts, in experiences and episodes and as action sequences.
- how to use a range of reading strategies and management and control strategies. These develop from egocentric speech. Children first learn to use in reading the strategies they already use in oral communication. They use them first when cued.
- how to use and to allocate their attention at any time.
- how to read and to see themselves as readers.

These areas of knowledge require in term access to appropriate visual, auditory or tactile-kinaesthetic sensory processes and motor processes for displaying knowledge.

How information processing models explain learning to process words

Word level processing - the attention-efficient, direct doorway to the network of meanings, often causes difficulty for reading disabilities. Hence we need to look at how information processing theories explain how the orthographic doorway is learnt. At the word level, the connectionist models (Seidenberg and McClelland, 1989) provide a more 'microscopic' explanation of theinformation processing trends in word recognition. To see these in context, it is useful to review briefly other explanations.

Earlier word reading theories The earlier stage theories, that all developing readers progress through the same three broad developmental stages; the logographic, phonological and orthographic stages (for example, Frith , 1985; Seymour & MacGregor, 1984) have been shown not to explain adequately individual differences in readers or variation in the types of words a reader can read at any time, for example, the observation that some children at least can use phonological codes and alphabetic skills in their earliest reading experiences (Stuart and Coltheart, 1988).

A key variable in the developmental trend in word reading is the amount and complexity of phonological information children can use to make increasingly complex analogies between written words and lexical knowledge. They move from making analogies using onset and rime through using the onset and part of the rime to using phonemes and groups of phonemes (Goswami, 1994). They use the one lexical analogy strategy throughout this development. Their phonological and orthographic knowledge interact throughout. Phonological knowledge initially constrains the orthographic development so that they learn the spelling patterns that match rimes. This then refines their phonological knowledge. Phonemic awareness develops from a combination of sources, including single-phoneme onsets and learning to spell (Goswami, 1994). Each episode with letter cluster-sound recoding provides a self-teaching mechanism for gaining word-specific orthographic knowledge (Share, 1995; Thompson, Cottrell and Fletcher-Flinn, 1996), with a knowledge of phonology providing the basis for the mechanism. Orthographic knowledge is gained primarily as a result of successful decoding.

The trend in orthographic learning is from simple letter-sound links to larger and more specific or unique letter cluster representations. Automatising the recognition of letter-sound matches in words provides readers with building blocks for learning increasingly larger letter cluster units that become more word-specific or 'lexicalised'. Readers' phonemic awareness, access to increasingly complex letter cluster information, sensitivity to contextual constraints of the word in prose, preparedness to try out multiple alternative pronounciations and access to feedback facilitate this learning.

Information processing models of learning to read words The connectionist models (Seidenberg and McClelland, 1989) provide a more 'microscopic' explanation of the information processing trends in word recognition. They propose that readers have access to a set of units for symbolising or coding letter strings (orthographic detectors) , a set of units for symbolising or coding sound patterns (phonological detectors) and a set of units that connect particular letters and clusters with sounds. Both of these sets of detectors provide a 'door' or 'path' to the network of concepts or meanings readers have. Each meaning can have a pattern of sounds linked with it (its spoken name or label) and a letter string (its written name or label). This is shown schematically in Figure 1.

Network of meanings linked in themes or topics

Units that link letters /clusters with sound patterns

Figure 1: Schematic representation of how the meaning network is accessed

In other words, thesemodels propose that readers are the capacity to code meanings, sounds and alphanumeric information. Prior to learning, the connections have arbitrary, random values. When readers hear how words are said, they are able to 'program' their phonological network. Seeing how words are written and hearing how they are said allows them to modify or 'program' the sound and letter connections so that they match patterns in the spoken and written language. This allows strings of letters such as regular, irregular, or nonsense words to be translated into a spoken form and vice versa. It replaces the need for the separate direct and indirect routes routes proposed by dual-route theories.

The matching letter and sound knowledge can be linked in different ways that lead to different ways of recoding written strings;

- single letters can be linked with single sounds; this allows the reader to use letter-sound recoding procedures
- groups of letters can be linked with sound patterns, for example,
    - letter and sound onsets can be linked and similarly with matching rime units; this allows the use of onset-rime recoding.
    - entire written words can be linked with their spoken form,
- groups of letters can be linked with one or more sounds as in the use of grapheme-phoneme correspondence mappings.

In this way these models explain the stage-like properties in learning to read as different types of linkages in the network.

Orthographic and phonological knowledge interact throughout this development to produce increasing complex and more specific orthographic -phonological links. Different word reading patterns are due to a single mechanism tapping into these changing sets of links. The trend from reading a small number of words learned by rote (logographic) to the decoding of novel items by using an alphabetic mechanism is explained as the output of a sole mechanism.

It is necessary to account for the 'human-ness' of human learning and to explain how the information processing detectors are gradually learnt. The connectionist computer is assumed to analyse its input into letters automatically, to work with the complete and ordered set of letters that comprises an input letter string at once, to link spelling and phonological patterns and to use these to recognise words. While readers may have the capacity to encode orthographic and phonological information, they need to learn how to do this (Rack et al., 1993), that is, to be programmed gradually. Young readers need to learn how these types of information are used in their cultures, that is, to align or 'fine -tune' these coding systems to their culture. When children begin to learn read they process only some of the letters in words, not all of them (Ehri & Robbins, 1992) and may encode their first words in terms of their appearance (Adams, 1994). As well, young readers may not have access to the consistent automatic corrective feedback and motivation build into the connectionist computer. As well, they acquire the working memory capacities built into the computer before it begins to process the letter string information.

The types of orthographic and phonological symbolic units that readers have at any time can vary in from single letters through letter groups to whole words (Van Orden 1987; Van Orden, Pennington, & Stone 1990). Links are formed first at the word level. They later learn to use subword units in rule-likes with continued use of the written words. The sound and orthographic

units at any time need to match in size. Learning involves ' adjusting the weights' linking matching orthographic and phonological symbols. The matrix of weights shows how the orthographic and phonological information covary (the 'covariant learning hypothesis'). This is continuous rather than being either at the letter-sound or whole word categorical levels as in Dual Route Theory. The same learning algorithm can account for both word-specific and rule-governed learning, as in Seidenberg and McClelland's (1989) model. The hypothesis explains how word recognition can be learned inductively from experience with words without explicit teaching in letter cluster-sound covariances. However, not all children abstract these covariances inductively. Many children benefit from deductive learning in which teachers explicitly draw their attention to these covariances.

According to connectionist models, trends in word reading are word-based rather than stage based, influenced by factors such as the likelihood of encountering particular written words and the ease and success with which they can be read. This prediction is supported; frequency of exposure to words and characteristics of the word type such as consistency, regularity, and size of orthographic neighbourhood explain trends (Laxon et al, 1994).

The orthographic self-teaching mechanism draws on various 'knowledge sources' to read any word; sublexical relations, GPCs acquired independently of print word sources, analogy cues and the context of the stimulus word (Thompson, Cottrell and Fletcher-Flinn (1996). The correct word reading response assists in linking the letter string with the stored lexical item. As familiarity with the printed word grows, stored orthographic knoweldge is used to identify the word and the four knowledge sources are not necessary for that word. The trend from reading words by means of GPCs learned independently of print word sources to using orthographic representations of words was called the 'developmental bypass hypothesis' (Van Orden et al. 1990). It is at this time that the child can learn the links between phonological and orthographic components for that type of words.

The 'knowledge sources' theory predicts that young readers can use orthographic knowledge derived from lexical sources to read some words and nonlexial letter cluster-sound recoding to read others. The predictions that lexica lorthographic knowledge is available only after the use of nonlexical GPC procedures and onset-rime level processing necessarily precedes subrime phonemic level processing are word type specific.

Connectionist models can be modified to explain individual differences in learning to read by proposing that multiple links exist between corresponding orthographic and phonological codes of the same segment size (Berninger and Abbott, 1994). The phonological codes range from spoken words, phonemes, syllables and subsyllabic segments such as rimes while the matching orthographic codes range from written words, single letters and letter clusters. By specifying multiple codes between corresponding codes, different connections will be functional for different children. Each orthographic code and each phonological contribute unique increments of variance in reading real words and nonwords, and spelling words (Berninger , 1994). At best 44% of the variance in one orthographic code is explained by the variance in another orthographic code. Correlations showed that the multiple phonological coding procedures are not redundant in primary school children (Berninger & Abbott, 1994).

In summary, according to information processing models, readers learn word level knowledge through phonological and orthographic information interacting and with phonological information initiating the learning. Letter-sound knowledge with onset - rime segmentation allows the reading of simple words. With continued exposure to text, they become aware of more complex letter clusters that are linked with more complex sound patterns. Gradually they learn specific ordered letter patterns.

Where word reading disability might occur These models of word recognition acquisition can be used to identify points at which reading disability might occur (Munro **) :

- Difficulty encoding long term how words are pronounced affects reading ability. Many disabled readers have difficulty pronouncing accurately multisyllabic words (Catts, 1989) ; they juxtapose or substitute sounds or syllables, for example, "crinimal" for 'criminal'.

- Impairments to vocabulary development, including difficulty encoding word meanings, an restricted vocabulary or a less well-developed network of meanings influence reading ability. The size of a reader's vocabulary influences the number of words that can be recognized.

- Difficulty learning phonemic units restricts phonological recoding and hence both orthogrpahic and later phonemic development. These models require readers to become aware of phonemic units, to segment words into phonemes or into onset and rime and to synthesize a sequence of sounds into a sound cluster. Phonological knowledge predicts later word recognition performance (Ellis, 1989).

- Difficulty representing orthographic information about letter strings influences reading efficiency directly. A poorer knowledge of orthographic subword units restricts the ability to recognize functional letter groups in words and to read words directly. Exposure to text and a preparedness to engage in reading are critical for learning orthographic knowledge.

Sentence level processes

Several aspects of psycholinguistic development interact to explain the comprehension of sentences; knowledge of syntax, verbal-semantic networking and a range of information processing and organizational strategies such as visualizing and paraphrasing. Syntactic knowledge facilitates both word recognition and text comprehension. This can assist readers to anticipate particular words or to recognize that some words are more likely than others. Readers who can use their knowledge of syntax reasonably automatically are more able to comprehend the text.

Syntactic impairments, both receptive and expressive, predict later reading disability (Catts, 1989). The average word length of sentences used by four year olds predicts reading at age eight (Bishop & Adams, 1990). Dyslexic students have difficulty comprehending syntactic knowledge in oral language comprehension tasks (Morice & Slaghuis, 1985; Wiig & Semel, 1977) and complex sentence structures such as embedded clauses, relative clauses (Byrne, 1981; Morice & Slaghuis, 1985; Wallach, 1984). They show a lower level of syntactic awareness than reading-matched, younger better readers (Tunmer, Nesdale & Wright , 1987) and are also more likely to show syntactic and morphological difficulties in expressive language (Morice & Slaghuis, 1985; Purcell & Liles, 1985) with a higher proportion of simple sentences with fewer embedded clauses.

These readers do not use efficiently information processing and organizational strategies such as visualizing, paraphrasing and verbal-semantic networking (Giesen & Peeck, 1984). Chan, Cole & Morris, 1990). They are less able to use a knowledge of text structure as a template for generating expectations prior to reading and for organizing textual information while reading, less likely to generate questions to assist them to comprehend and remember the text read, less able to elaborate and infer while reading (Holmes, 1984) or to summarize as readily (Brown & Day, 1983; Jenkins Heliotos, Haynes, Stein & Beck, 1986; Jenkins Heliotos, Stein & Haynes, 1987)

Implications for RD

how is network of ideas organised - in ways that easily match the links used in text or in more visual-imagery ways ?

sufficiently well developed vocabulary and meaning links to support reading
does reader have access to appropriate grammatical knowledge
stwm
motivation to read

Concept and topic level processes

These processes relate to the organisation of the concepts (or units of meaning) in the reader's semantic network. The units of meaning can be linked in various ways:

- in terms of linguistic-type links, with ideas linked with more specific and more general ideas, cause-effect, with synonyms and antonyms.

- in contextual ways, with ideas that have occurred in the same context linked.

The ease with which readers can comprehend a text is determined in part by how easily they can match the propositional links in the text with the links they have made between ideas in their existing conceptual knowledge; the construction of the text representation at any time is influenced by what readers bring to the reading situation in terms of knowledge of the content and of text properties (Berkowitz & Taylor, 1981; Lipson, 1982, 1983; Pearson, Hansen & Gordon, 1979).

Theme level processes When beginning a reading task, readers scan the text to select key ideas. They use these to tap into their network of meanings and decide the likely theme or topic. They use this to decide a framework of ideas which, if confirmed by ideas they encounter in the text, they will use to make sense of the text. Whether disabled readers have difficulty either encoding experiences or remembering what they learnt has been a point of dispute. They may, for example, have difficulty organising verbal information in semantic memory (Swanson , 1986). They comprehend what they read better when they are cued to use advance organizers that trigger or stimulate their existing knowledge (Risko & Alvarez , 1986) and semantic mapping techniques (Sinatra, Berg & Dunn, 1985). A knowledge of text structure facilitates text comprehension. Readers who comprehend the structure of a text better are more able to comprehend it, and ability to use text structure increases with age (Ohlausen & Roller , 1988). Less able readers have greater difficulty activating and using text structure information (Cook & Mayer, 1988; Idol, 1987; MacLean and Chapman, 1989). .

Reading disabled students are less likely than their peers to use spontaneous procedures that facilitate reading comprehension (Baker and Brown, 1984). They are less likely, for example, to detect errors in text, study the main ideas or organize text material in recall as well as more able-reading peers (Davey, 1987; Paris & Myers, 1981). Even though they may know about particular strategies, these students may not understand how or when to use them (Lipson & Wixson, 1986; Lorsbach & Gray, 1985; Rottman and Cross, 1990). They are also less likely to use effective question-answering strategies such as re-processing selectively the text by looking back at it after initial reading (Garner, Hare, Alexander, Haynes & Winograd, 1984).

In summary, at the conceptual and topic levels, disabled readers are less likely to use advance organizers, to activate prior knowledge or to use text structure before reading. This knowledge facilitates the organization of text data in working memory and assists readers to infer and elaborate the information and to anticipate ideas and words.

Adams, M.J. (1994). Leanring to read : MOdelling the reader versus modelling the learning. In

Baker, L. & Brown, A.L. (1984). Metacognitive skills and reading. In P.D. Pearson, R. Barr, M.C. Kamil and P. Mosenthal (Eds.), Handbook of Reading Research. New York : Longman.

Berkowitz, S.J., & Taylor, B.M. (1981). The effects of text type and familiarity on the nature of the information recalled by readers. In M. Kamil (Ed.) Directions in reading : Research amnd instruction (pp 157-161). Washington, D.C. : The National Reading Conference.

Berninger & Abbott, 1994).

Berninger , 1994).

Bishop, D. & Adams, C. (1990). A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. Journal of Child Psychology and Psychiatry, 31, 1027 - 1050.

Brown, A. & Day, J. (1983). Macrorules for summarizing texts : The development of expertise. Journal of Verbal Learning and Verbal Behavior, 22, 1-14.

Byrne, B. (1981). Reading disability, linguistic access and short-term memory: Comments prompted by Jorm's review of developmental dyslexia. Australian Journal of Psychology, 33, 1, 83 - 95.

Catts, H. (1989). Defining dyslexia as a developmental language disorder. Annals of dyslexia, 39, 50-64.

Chan, L.K., Cole, P.G. & Marris, J.N. (1990). Effects of instruction in the use of a visual-imagery strategy on the reading comprehension competence of disabled and average readers. Learning Disability Quarterly, 13, Winter, 2-11.

Cook, L.E & Mayer, R.E. (1988). Teaching readers about the structure of scientific text. Journal of Educational Psychology. 80, 4, 448 - 456.

Davey, B. (1987). Postpassage Questions: Task and Reader Effects on Comprehension and Metacomprehension Processes. Journal of Reading Behaviour, 261 - 283.

Ehri, L. C., & Robbins, C. (1992). Beginners need some decoding skill to read words by analogy. *Reading Research Quarterly, 27,* 12 - 126.

Ellis, N. (1989). Reading, Phonological Skills and Short-term Memory. As yet unpublished.

Frith, U. (1985). Beneath the surface of developmental dyslexia In Patterson, K.E., Marshall, J.C., & Coltheart, M. (1980). Surface dyslexia. London : Lawrence Erlbaum Associates.

Garner, R., Hare, V.C., Alexander, P., Haynes, J., and Winograd , P. (1984) Inducing a look-back strategy among unsuccessful readers. American Educational Research Journal, 21, 789-798.

Giesen, C. & Peeck, J. (1984). The effect of imagery instruction on reading and retaining of literacy text. Journal of Mental Imagery, 8 (2), 79 - 90.

Goswami, U. (1994). Reading by analogy: theoretical and practical constraints. In Hulme, C. & Snowling, M. (Eds.) Reading Development and Dyslexia. Whurr : London, 18-30.

Haberlandt, K. (1988). Component processes in reading comprehension. In Daneman, M., Mackinnon, G.E. & Waller, T. (Eds). Reading research. Volume 6. San Diego : Academic Press.

Holmes, B.C. (1984). The Effects of a Strategy and Sequenced Materials on the Inferential Comprehension of Disabled Readers. Journal of Learning Disabilities, November, 542 - 546.

Idol, L. (1987). A critical thinking map to improve content area comprehension of poor readers. Remedial and Special Education, 8, 4, 28-40.

MacLean and Chapman, 1989).

Jenkins, J.R., Heliotis, J.D., Stein, M.L.,& Haynes, M.C. (1987). Improving Reading Comprehension by Using Paragraph Restate-ments. Exceptional Children, September, 54 - 59.

Jenkins, J.R., Heliotos, J.D., Haynes, M.C., Stein, M.L., & Beck, K. (1986). Does passive learning acount for disabled readers ? Learning Disability Quarterly, 9, 69-76.

Just , M.A. & Carpenter P.A. (1980). A theory of reading : From eye fixations to comprehension. Psychological Review, 87, 329-354.

Laxon, V., Masterson, J., & Moran, R. (1994). Are children's representations of words distributed ? Effects of orthographic neighbourhood size, consistency and regularity of naming. *Language and Cognitive Processes*, 9 (1) 1-27.

Lipson, M.Y., & Wixson, K.K. (1986). Reading disability research : An interactive perspective. Review of Educational Research, 56, 1, 111-136.

Lipson, M.Y. (1982). Learning new information from text : The role of prior knowledge and reading ability . Journal of Reading Behavior, 14, 243 - 261.

Lipson, M.Y. (1983). The influence of religioous affiliation on children's memory for text information . Reading Research Quarterly, 18, 448-457.

Lorsbach, T.C. & Gray, J.L. (1985). The development of encoding processes in learning disabled children. Journal of Learning Disabilities, 18, 222-227.

Morice, R., & Slaghuis, W. (1985). Language performance and reading ability at 8 years of age. Applied psycholinguistics, 6, 141 - 160.

Munro, J. (1996). *Learning to read words ::The what of reading*. Melbourne : EdAssist.

Ohlhausen, M.M., & Roller, C.M. (1988). The operation of text structure and content schemata in isolation and in interaction. Reading Research Quarterly,XXIII / 1, Winter, 70 -88.

Paris, S. & Myers, M. (1981). Comprehension monitoring, memory, memory and study strategies of good and poor readers. Journal of Reading Behavior, 8, 5 - 22.

Pearson, P.D., Hansen, J., & Gordon, C. (1979). The effect of background knowledge in young children's comprehension of explilcit and implicit information. Journal of Reading Behavior, 11, 201-210.

Purcell & Liles, 1985)
Rack et al., 1993),

Risko, V. & Alvarez, M (1986) An investigation of poor readers' use of a thematic strategy to comprehend text. *Reading Research Quarterly*, XXI, 3, 298 - 315.

Rottman T.R., and Cross, D.R. (1990). Using informed strategies for learning to enhance the reading and thinking of children with learning diabilities. *Journal of Learning Disabilities*, 23, 5, 270-278

Seidenberg, M.S. & McClelland, J.L. (1989). A distributed development model of word recognition and naming. *Psychological Review*, 96, 523- 568.

Seymour, P.H.K., & MacGregor, C.J. (1984). Developmental dyslexia : A cognitive developmental analysis of phonological morphemic and visual impairments. *Cognitive Neuropsychology*, 1, 43 - 83.

Share, D.L.(1995). Phonological recoding and self-teaching : sine qua non of reading acquisition. *Cognition*, 55, 151-218.

Sinatra, R.C. Berg, D., & Dunn, R. (1985). Semantic mapping improves reading comprehension of learning disabled students. *Teaching Exceptional Children,* Summer, 310 - 314.

Stuart , M, & Coltheart, V. (1988). Does reading develop in a sequence of stages ? *Cognition,* 30, 139-181.

Swanson, H. L. (1986) Do semantic memory deficiencies underlie learning disabled readers' encoding processes. *Journal of Experimental Child Psychology* 41, 461-488

Thompson, Cottrell and Fletcher-Flinn, 1996)
Tunmer, Nesdale & Wright , 1987)
Van Orden et al. 1990).
Wallach, G. (1984). Later language learning : Syntactic structures and strategies. In G.Wallach and K. Butler, (Eds.), Language learning disabilities in school-age children, 82 - 102, Baltimore, MD : Williams and Wilkens.

Wiig, E.H. & Semel, E. (1984). Language assessment and intervention for the learning disabled. Second Edition. Columbus, OH : Merrill.