

## Conceptual Development in Technical and Textbook Writing: A Challenge for L1 and L2 Student Readers.

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# Conceptual Development in Technical and Textbook Writing: A Challenge for L1 and L2 Student Readers

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## *Abstract*

*The paper argues that the decoding skills that first year university students – both L1 and L2 students – bring to the kinds of technical writing typically found in textbooks or in academic articles are much more sophisticated than many available accounts suggest. Students need to, and do, ‘go beyond the text’ in a number of ways, and decoding is an inadequate term for the skills involved. Students frequently need to use prior knowledge of the field – including what Martin [33] calls its ‘technicality’ – to contextualise and explicate concepts found in their reading; so they need to obtain that knowledge and bring it to their reading. The obvious circularity of this condition is a key part of the problem, and solutions are suggested. Readers need to be able to handle higher order abstractions, and they need ‘forward inferencing’ skills to bridge the gap between what is said and what is going to be said, supplementing the backward looking processes of anaphoric reference and bridging inferences. These reading strategies reflect the dynamics of the writing process.*

**Keywords:** *reading comprehension, forward inferring, scaffolding domain knowledge*

## **1. Introduction**

Joan Turner has recently [1] reminded us of some fundamental but often forgotten truths. The current approach to EST and EAP in many of our tertiary institutions, aiming at relatively low-levels of ‘functional’ proficiency, to be achieved in the minimum possible time, ignores everything we know about “the developmental nature of language use” [1]. It fails to take into account facts about language acquisition that are widely known and accepted by professionals in (at least) the three intersecting fields of linguistics, psychology and education. Language proficiency develops gradually and in fact rather slowly, through

repeated effortful use in meaningful contexts. And the complex meanings that tertiary level students need to manipulate in science and technology demand sophisticated encoding and decoding skills, as these are often called. The developmental stages that native speakers of English go through as they move through the Australian education system, in order to acquire the advanced literacy skills needed for university level studies, have recently been described in some detail [2]. Students only very *gradually* master the levels of structural and functional complexity that will eventually enable them to cope with their further studies. Can non native speakers be assisted towards this level of literacy in a year or two?

While remaining skeptical with regard to this possibility, the urgency of the issue encourages writers and teachers like ourselves to investigate the textual features that make reading more or less difficult for novices, and strategies that may be of immediate use. In this paper, I will focus on two interrelated factors which, although widely discussed in the psychological literature, are not often mentioned in applied linguistics and language teaching. I will argue that these factors play important enabling roles in the comprehension of scientific and technical writing. The two factors are: a) prior knowledge, particularly what is called domain knowledge, and b) the ability to ‘forward infer’ meaning. In scientific and technical context, this ability relies heavily upon the reader possessing some degree of domain (or field) knowledge. I argue that these two factors are crucial for readers needing to cope with accreting layers and types of abstraction, with increasingly complex nominal syntax, and with the often unforeseeable development of specific concepts across texts.

Conceptual development is an expression that is meant to focus attention on the evolving meanings that are encoded by increasingly complex nominal

groups (NGs). By virtue of their complexity, nominal groups can support several lexicosemantic chains at once (see below), each of which presents the author(s) with choices as to what will be topicalized next. Nominal groups in technical and/or textbook writing often contain several premodifying elements and several postmodifying structures, mainly prepositional phrases and relative clauses (see below). They typically incorporate one or more abstract and analytic ‘pro-heads’, such as ‘aspect’ and ‘approach’ in ‘a neglected *aspect* of this *approach* to radiation therapy’. The term ‘pro-head’ is meant to capture the ‘projected’ nature of abstract nouns that act as grammatical head of a nominal group, preceding a relatively more concrete entity – the Thing – and focus the reader’s attention on these abstract and analytic aspects of the Thing.

I will explore the nature of the aforementioned complexity, then discuss strategies that writers and teachers can adopt to facilitate readers’ interactions with and comprehension of texts, but also impart sufficient domain knowledge to assist readers to carry out specific reading tasks. First, then, I will examine the nature of the challenges that both L1 and L2 readers face when confronted with increasing levels of abstraction, along with increasing lexicogrammatical complexity, in academic, technical and scientific writing, as described directly or indirectly in [2] [3] and [4]. I will next discuss the need for inferencing strategies and the paradoxical need for pre-existing domain knowledge (based on [5], as well as other research into the psychology of discourse), giving some illustrations, before offering some solutions.

## 2. Complex constructions; reader strategies

The first research considered here [2] focused on the development of grammatical skills in teenage children, focusing on the increasing use of and control of abstraction in school writing.<sup>1</sup> The children included native English speakers and speakers of English as an additional language. Detailed text analyses of the work of individual students at different ages [2], show how, at around

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<sup>1</sup> Clearly, passive comprehension precedes active production, but this account of the gradual development of actively controlled grammatical structures serves to illustrate the sequence in which ever more complex and abstract structures are acquired.

12 years, the structure of nominal groups is still relatively simple. There is almost no embedding at this stage (i.e. complex nominal groups). The use of prepositional phrases to specify circumstance is comparatively rare. However, there is some use of subordinate clauses, usually to specify circumstantial factors like time and place. The language is overall very ‘plain’, in that there is almost no use of productive nominalization (or ‘grammatical metaphor’).

The nominalization of processes (verbs) is one of the first types of abstraction to be mastered in first language acquisition. This is still a relatively low level of abstraction, at one remove from the structure and active meaning of a clause of material process. Nominalization can be as simple as a gerund (-ing form). However, when acting as the head of a nominal group, that gerund can be accompanied by traces of the erstwhile actor, goal and other participants, contained in prepositional phrases ‘embedded’ in the nominal group (e.g., *the killing of animals by farmers for their fur*). On the other hand, nominalization may also involve switching to a more sophisticated and more opaque type of abstract terminology (*the slaughter of ...*).

Examples analyzed in [2] show that nominalization begins to appear around the age of 14 or 15. We find, for example, *The pushing and shoving of the crowd*. At around the same time, embedded material appears in more complex nominal groups (i.e. defining relative clauses). “The effect of clause embeddings here is to *pack in* information in the nominal group structure, in a manner particularly characteristic of written language” [2, p. 55; emphasis in original]. This, of course, adds to the abstractness of the text. Prepositional phrases are also being used to convey important circumstantial information. Adverbs also appear at this point, especially in narrative writing.

The demands of *genre* become more demanding when students, at this age or a little older, are asked to write literary critiques. Typically, students now begin develop their ability to use abstract nominals and nominal groups through analyzing people, and writing about their motives and qualities. “The most notable of the changes are apparent in the writer’s capacity to employ abstractions, constructed either in the use of abstract nouns such as *qualities, determination, or reliability*, or

through the use of grammatical metaphor, creating nominal groups such as *her extraordinary resistance to emotion*" [2, p. 58]. At this stage, too, there is a marked increase in the use of metadiscourse (see Appendix 1) to express both intra-textual connections and authorial comment. What we learn from this is that the mastery of abstraction develops slowly in native speakers, over many years of concentrated practice on a variety of classroom genres designed to expand the students' writing abilities. As indicated earlier, the use of grammatical metaphor is just the beginning. Yet technical terminologies and academic and scientific lexis in general depend on the understanding and control of hierarchically arranged vocabularies built up largely out of words that are intrinsically abstract. Nouns are used as 'classifiers' (*fur* in *fur trade*, *insulin* in *insulin resistance*) in taxonomic technical or scientific discourse, a device which moves semantically salient information from the foreground (as postmodifiers, qualifiers) into the background (as 'identifying' premodifiers) within the structure of the nominal group. Prospective and retrospective 'packaging nouns' (like *reason*, *argument*, *understanding*, *issue*, *analysis*, *discussion*, *suggestion*)<sup>2</sup> are used; these allow the writer to classify rhetorical moves in a pre-emptive way, while making the interpretive burdens of the reader that much lighter; and Pro-heads (like, *mode of*, *facet of*, *dimension of*)<sup>3</sup>, which often imply whole analytic frameworks (how many modes, facets, dimensions?) and that, on a lexicogrammatical level, may entail complex case frames with prepositional cues ('the *effect of x on y*').

This description of the increasing grammatical competence in school-age writers can usefully be

<sup>2</sup> See Gill [8]. Gill uses the term 'labels' for nouns that 'encapsulate' segments of text and/or content. A label is "an inherently unspecified nominal element whose specific meaning in the discourse needs to be spelled out" [8, p. 83]. Gill compares her labels to Halliday and Hasan's [9] category of 'general nouns' (which in fact includes her 'labels'). She also distinguishes between 'advance labels' and 'retrospective labels'.

<sup>3</sup> Pro-head is my term for abstract grammatical Heads that compete for the reader's attention with what are usually more concrete 'Things' (e.g. the *effects* of the *disease*). See Halliday [10, p. 173-175] and Halliday and Matthiessen [11, § 6.2.6, pp. 331-335] on *Head and Thing*. See also below for further discussion.

supplemented by Lee's recent analyses of coherence, the demands it puts upon the writer and the cues it affords to the skilled reader [3], [4]. Coherence is a concept that for Lee subsumes cohesion (this is not always so for other authors). Coherence in a non-technical sense is a recognized characteristic of good writing [4], [6], [7], and is in fact taught in writing programs throughout the world. Definitions generally go something like this:

Coherence refers to the extent to which the flow of ideas in a paragraph is easily understood by the reader. For this reason, coherence is closely related to unity. When a writer changes main ideas or topics within a paragraph, confusion often results. To achieve coherence, then, a writer should show how all of the ideas contained in a paragraph are relevant to the main topic. (<http://faculty.washington.edu/ezent/impd.htm>)

Good writing – that is, optimally coherent writing – does not entail good reading, but it certainly provides the opportunity for it. Depending on the skills of the reader, a coherent text allows for a deep cognitive engagement with the subject matter and indeed with the mental processes of the author. We will assume that production of a 'coherent' text is one of the goals of the expert technical writer, and that the reader should accordingly be alert to the affordances of a maximally coherent text.

After a review of the literature, Lee [3] identifies five key components of coherence: textual 'connectivity' (or cohesion), information distribution and topical development, explicit propositional development, and metadiscourse marking. To these she adds a sixth: "explicitness of purposes and awareness of audience and context" (see [4]), thereby (to my mind) embracing a very broad definition of coherence (compare McNamara, Kintsch, Songer & Kintsch [28] on "good texts"). The list Lee presents ([3, p. 140]) is designed to draw together both text- and reader-based features of coherence

1. Purpose, audience, and context of situation;
2. Macrostructure, or the overall structure of texts;
3. Information distribution – how information is distributed in texts (e.g. [12]);
4. Propositional development, i.e. how ideas are developed in texts (e.g. [13], [5], [14]);
5. Cohesion, or "devices that make a text cohesive" (e.g. [9], [15]);
6. Metadiscourse, or devices "that help writers produce reader-friendly texts" [16].

Lee [3] claims that coherence is “a teachable and learnable concept” and presents considerable evidence to support this claim ([3], [4]).

Neither Christie [2] nor Lee [3], [4] dwell upon the inferencing skills that are required for effective reading. It has been accepted for some time now (e.g. [17], [18], [13], [5], [15]) that good readers frequently need to make ‘bridging’ inferences in order to fully comprehend a text. Some kinds of bridging inference rely on lexicogrammatically encoded knowledge or beliefs, e.g. about what lexical relations are metonymic or taxonomic, for example, while others rely on culture-specific knowledge schemas that range from verb frames and lexical collocations to situational ‘scripts’. Some depend upon the possession of domain knowledge (i.e. knowledge of the field).

Bridging was traditionally taken to function endophorically (within texts) and anaphorically (in a backward direction), as the reader searches for some grounding concept, or antecedent, in the preceding text. Successful inferencing of this kind is what produces the impression of cohesion or coherence in a text. There is also a kind of bridging inference that depends upon general knowledge of the world and how it normally works. Both general knowledge and knowledge gained through personal experience are frequently accessed and retrieved in order to make sense of the texts we read [5]. This has been demonstrated by experimental research both in psychology and artificial intelligence. However, the reader’s need for domain knowledge – at least in certain contexts – is also asserted [5].

In line with current interactive models of reading, it is nowadays generally believed that *forward inferences* are as important as *backward inferences* (the latter are what are known as ‘bridging’ inferences; see [19]). These authors distinguish between predictive inferences and forward inferences. Predictive inferences “are about the state of affairs described by the text”, while forward inferences “are about what the author will say next in the text” ([19, p. 128]).

However, Schmalhofer et al [19, p. 126] argue on the basis of experimental research that bridging inferences and predictive inferences (or forward inferences) and are essentially the same, both with

regard to generation and to persistence. They claim that

the difference between a predictive and bridging inference is not the time at which they are generated or the mechanism by which they are constructed. Instead, bridging inferences may well originate as predictive inferences, but bridging inferences are later substantiated by a subsequent clause.

[19, p. 126]

This makes a lot of sense if we accept that both writers and readers have access to the same synchronic network of semantic relations and pragmatic knowledge. Lexical relations, viewed as synchronic links, independent of both the writing and the reading process, can be used to predict or to confirm. I reproduce a constructed example from Martin (15, p. 124):

He bumped into a branch; he hadn’t noticed the tree at all.

Martin’s ‘presuming’ anaphor (*tree*) can certainly in one sense be seen to depend on the ‘presumed’ antecedent (*branch*), but in another interpretation (at another point in time) the ‘antecedent’ *branch* allows the reader to forward-infer *tree*.

Before attempting to clarify the role of forward inferencing in relation to domain knowledge, I next describe (in very broad terms) an extremely influential model of reading comprehension that was developed by Teun van Dijk and Walter Kintsch ([5], [13]), and which finds fruitful application in the present context. According to this model, the reader constructs two separate mental representations: a text-based propositional model called the “textbase” and a “situational model” that is assumed to reflect a real-world state-of-affairs [5] [13]. The situational model “integrates the comprehender’s existing world knowledge with information derived from the text”. In reading for technology and science, world knowledge includes “domain knowledge”, or pre-existing knowledge of the field. Recent research [28] strongly suggests that domain knowledge is the key factor in enabling readers to comprehend authentic technical texts (i.e. texts that have not been manipulated to enhance coherence and readability). That is, it enables them to anticipate the directions in which the content may lead the writer. The obvious circularity of this argument, which to some degree

presumes the knowledge that the reader seeks, is addressed in due course below.

### 3. Developing topics – ‘zoom-in’ & ‘zoom-out’

Norman [20] has recently dealt with the anaphoric consistency of naming in scientific texts, i.e. topic maintenance. This, it will be noted, is the opposite of topic *development*, which implies topic change. In the work just alluded to [20, p. 117], note is taken of “*all significant anaphoric references*” in his study. Halliday and Hasan [9] had taken much the same approach to cohesion, which they saw as being formed from a combination of referential and semantic ties, arguing that this approach gives a better picture of the *overall coherence*, or topical unity, of a text. But Norman is more inclusive than his predecessors and, influenced by work on text annotation for computational purposes [21], he includes a category that was not considered by Halliday and Hasan [9] and “is implicitly *rejected*” as a category of repetition by Hoey [22, p. 69-70] on the grounds that the anaphor contains new information. This is what Norman calls *zoom-in reference* and what Martin and Rose [23] refer to as *instantiation* – an example would be the term *mouse* referring back to *rodent* [20]. In Norman’s system, the anaphoric use of more general or inclusive terms is called “zoom-out”. Norman also includes ‘nominalized’ anaphors and abstract retrospective labels for concepts or rhetorical processes, both of which he refers to as examples of packaging anaphors. These “occur very frequently in scientific texts”, and often some form of repetition is included [20, p. 124].

Norman [20, p. 117] touches upon cohesive links that are of more interest to us here when he notes that

the nominal groups of scientific writing are often very complex, and a single group may contain several anaphoric references. For example, a premodifier of a nominal group X may refer back to another nominal group Y, without the head of X itself being anaphoric (as with “*Plasmodium falciparum*” in “a *Plasmodium falciparum* trophozoite cysteine proteinase” ... ). Similarly, a premodifier may refer back to one antecedent and the head of the group to another, while at the same time the group as a whole makes packaging reference to an entire sentence.

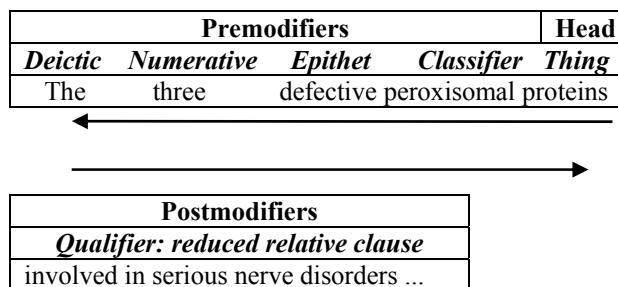
In other words an adjective can link back conceptually to a noun, and vice versa. I take this to mean that in theory any component of a nominal group can *link forward to* – can be *taken up by* – a conceptually related head noun, which thereby becomes the new topic.

### 4. Nominal groups, lexicosemantic chains

Explicit cohesive ‘ties’ [9] or ‘links’ [22] add to the coherence of a text. Ideally, they allow the reader to connect back to antecedents in the text that ground new information in old. But these relations can also be exploited in the ‘online’ situation of reading to predict lexical items and clauses. Using domain knowledge, especially knowledge of the kinds of issues domain experts are typically concerned with, plus a familiarity with typical rhetorical relations and typical goals in technical or scientific writing, it is possible to ‘infer forward’ and predict the direction a text will take. In other words, novice readers can learn to ask the same kinds of questions as expert writers.

Adopting Michael Hoey’s term [22], I take cohesive *links* to represent co-reference, partial co-reference, and lexico-semantic relatedness between items or constructions. Topic continuity can be traced by means of such links. If we focus on *partial co-reference*, topic development – or, conceptual development – can often be traced across the lexical elements that accompany head nouns. These come under the two general headings of premodifiers and postmodifiers.

The structure of a typical nominal group (from Text 2 below) can be represented functionally, after Halliday (1994) [10] and Halliday and Matthiessen (2004) [11], whose terms are used in Figure 1.



**Figure 1. Structure of a nominal group (NG)**

There is another kind of nominal group that interests us more particularly here, and that is one

in which an abstract head (or heads) is followed by a semi-adjectival *of*-phrase, or several *of*-phrases, with complements containing nouns that are usually more concrete than the grammatical head noun. For example, in the following nominal group, *aspect* is the grammatical head:

*a neglected **aspect** of the theory of price regulation*

The *of*-phrases that follow the head noun *aspect* are referred to as ‘postmodifiers’, and ‘qualifiers’ [10], [11]. Other postmodifiers are defining relative clauses, as well as other kinds of prepositional phrases/groups. However, increasingly lengthy treatments of the potential ambiguities involved in such constructions (in [10], and again in [11]), testify to a growing awareness of the problems they pose for analysis, and no doubt processing. It is accepted that there will be tension between the ‘Thing’s’ role in the transitivity structure and the Head’s role in the mood system [11, p. 333]. Tension is also implicit in the statement that “what is being construed is a phenomenon that from one point of view appears as a single entity and from another point of view as two” [11, p. 334].

In the following fragment from a research article, there are three potential topics, any one of which could have been taken up in the following sentence: *advances*, *understanding* and *human insulin resistance* (two pro-heads preceding the semantic head *resistance*). However, the writer chose to ‘develop’, and expand upon, the nominal sub-group (embedded, in fact, in a relative clause) that describes the method used (i.e. the “technique”, to use the author’s rewording):

..... some recent **advances** in our **understanding** of **human insulin resistance** that have been made using **nuclear magnetic resonance spectroscopy (NMR)**.

**This technique** .....

(determiner + general noun; anaphoric; ‘labeling’ a NG)

The nominal group shown above illustrates the way in which a single element from among several qualifying structures has been selected by the writer, above the others, as a new topic. The core nominal group is reproduced in isolation below and subsequently ‘unpacked’ for presuppositions:

*some recent **advances** in our **understanding** of **human insulin resistance***

If we unpack some of the implicit propositions, i.e. presupposed ‘domain’ knowledge, contained in the above we have at least the following:

- Scientists have had an understanding of human insulin resistance for some time;
- Advances have been made in their understanding of human insulin resistance;
- Scientists have used a technique called nuclear magnetic resonance spectroscopy (NMR) to make these advances.

## 5. A sample text

In this section I illustrate the role of lexicosemantic chains in conceptual development by means of an authentic mini-text, reproduced below. Note that this is a complete text: it is contained in its entirety in a stand-alone ‘text-box’ in an up-to-date histology textbook [24].

This text answers the question: *Why/how do defective peroxisomal proteins cause physical disorders?* I consider the answer to this question to be the topic of the text. A general answer is given in the first sentence, in the end-position in the subordinate clause beginning with *because*.

Throughout the text this answer is expanded, and examples are given. However, the text is difficult, even for an experienced reader, to read and to fully comprehend.

Cohesion is present, in the form of lexicosemantic chains based on

- a) synonymy, and
- b) substitution.

However, these chains are picked up by lexical items belonging to different word classes. Moreover, the items are frequently fulfill quite distinct grammatical functions in a succession of rather complex nominal groups (see above).

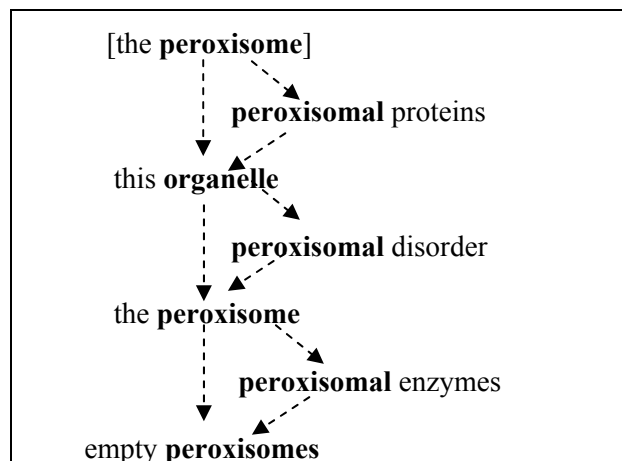
*Italics*, **bolding** and **bold italics** have been used to trace the course of the three main lexicosemantic chains in the text-box, which I reproduce below, as it originally appeared.

**Medical application**

A large number of *disorders* arise from defective **peroxisomal** proteins, because **this organelle** is involved in several metabolic pathways. *Probably the most common peroxisomal disorder* is X-chromosome-linked *adrenoleukodystrophy*, caused by a *defective integral membrane protein* that participates in transporting very long-chain fatty acids into the **peroxisome** for  $\beta$ -oxidization. Accumulation of these fatty acids in body fluids destroys the myelin sheaths in nerve tissue, causing *severe neurological symptoms*. Deficiency in **peroxisomal** enzymes causes the *fatal Zellweller syndrome*, with *severe muscular impairment, liver and kidney lesions, and disorganization of the central and peripheral nervous systems*. Electron microscopy reveals empty **peroxisomes** in liver and kidney cells of these patients.

**Figure 2. Sample mini-text taken from histology textbook**

In the box below, lexicosemantic links *across word class boundaries* are shown in a schematic display.



**Figure 3. Lexicosemantic repetition – here across word class boundaries**

In the next box (Figure 4), the main lexicosemantic chains have been compiled for the reader’s convenience. It is clear from these examples, that upon occasion *there are no cohesive links* between the exemplars of a particular chain, i.e. there are no clear *lexical connections*.

**1<sup>st</sup> lexicosemantic chain (x 8)**

A large number of disorders  
the most common peroxisomal disorder  
X-chromosome-linked adrenoleukodystrophy  
severe neurological symptoms  
the fatal Zellweller syndrome  
severe muscular impairment, liver and kidney lesions, and disorganization of the central and peripheral nervous systems

**2<sup>nd</sup> lexicosemantic chain (x 4)**

defective peroxisomal proteins  
a defective integral membrane protein [that participates in transporting very long-chain fatty acids into the peroxisome for  $\beta$ -oxidization]

**3<sup>rd</sup> lexicosemantic chain (x 3)**

several metabolic pathways  
transporting very long-chain fatty acids into the peroxisome for  $\beta$ -oxidization

**Figure 4. Lexicosemantic chains**

It is widely accepted that cohesion does not create coherence (e.g. [25, p. 83]). Coherence depends on world knowledge and more particularly, here, domain knowledge. As for the domain knowledge that is assumed, or presupposed, by the present text, a ‘good’ reader would be expected to know (at least) that:

- The peroxisome is an organelle (within the cell)
- The compound “very long chain fatty acid” (VLCFA) is a technical term;
- $\beta$ -oxidization metabolizes very long chain fatty acids;
- body fluids are outside and around cells; they can transport VLCFAs;
- something called “myelin sheaths” protect nerves;
- there is a central and a peripheral nervous system; and also that
- the peroxisome contains proteins; and
- enzymes are proteins.

The reader is also assumed capable of supplying **implicit propositions**. E.g., between the 2<sup>nd</sup> and 3<sup>rd</sup> sentences (in Fig. 2) we need to insert: “Very long-chain fatty acids accumulate in the body fluids”.

A reader more advanced in the field would recognize when the writer is describing the key metabolic pathways (despite the lack of cohesive links). They would already know of the two specific disorders mentioned, and their symptoms, but would also know what symptoms results from the destruction of myelin nerve sheaths, or ‘empty peroxisomes’ in the kidneys and liver. More importantly, perhaps, they would be aware that histology as a discipline is preoccupied with cell pathology, and would know that uppermost in the mind of the writer were questions like

- What can disrupt a metabolic pathway?
- What physical symptoms are produced?

It is the kind of background knowledge and the kind of questioning described above that allows the reader to *forward-infer*, both on the level of the clause and more globally. In the next section I suggest how writers and/or teachers can supply such information in a guided reading situation.

## 6. Strategies for writers and teachers

There are essentially three choices for writers: simplification, easification, or the scaffolding of concept knowledge. One can attempt to ‘simplify’ texts by enhancing their coherence. Psychologists have done this (using the Kintsch model described earlier) by making local coherence (or cohesion) more explicit in every way and by supplying any implicit propositions (see [26], [27], [28]).

Alternatively, one can ‘easify’ texts, by making their macrostructure (more) visible and providing explanatory commentaries or annotations (after Bhatia, [29], [30]). McNamara et al [28] used a mixture of these two approaches when modifying texts for experimental research, adding cohesive links as well as topic sentences and other summary statements (see Appendix 2). To take a third approach, one can aim to make it possible even for novice readers to predict – or to ‘forward infer’ – meanings by providing a carefully designed introduction to sections of the text in the form of scaffolded exercises, as mentioned above. In this last approach the writer becomes in part a teacher.

### a) Simplification: enhanced cohesion/coherence

V. K. Bhatia distinguishes between simplification of content and simplification of form [29]. In the former, content is not so much simplified as explained. The writer explains new technical terms

and/or concepts as they arise, in simple language, and elaborates on consequences and implications that might be merely alluded to in unsimplified text. In simplifying form, on the other hand, the aim is “to facilitate comprehension by making explicit not only the rhetorical value of individual utterances but also the propositional development in the text” [29, p. 43]. The writer can simplify his or her own text by providing cohesive (anaphoric) links wherever possible, and restoring any implicit relationships [29, p. 43]. This process can be extended to restoring “implicit propositions” [13]. Simplified texts also include explanations and exemplification. It is widely accepted that there are a number of problems with simplified texts: they are almost always longer than more authentic texts, they delay the time when students will confront and learn to cope with more authentic material, and many technical concepts resist expression in simple and/or everyday language [29].

Although the texts in question here lack the structure of clear-cut genres, typically being embedded in long explanatory text such as one finds in textbooks, specific segments of such texts can be analyzed in terms of a general-specific or problem-solution progression. The mini-text used above begins with a ‘topic sentence’ that predicts and ‘scaffolds’ much of the following text.

It has been pointed out [22] that ‘good’ text exhibits a high degree of parallelism, whereby similar syntactic structures recur, and given elements in these structures are repeated, so that when new information is given the reader encounters it embedded in something that is already familiar. Syntactic repetition thus acts as a form of syntactic scaffolding.

### b) Easification – enhancing structure

Easification contrasts with simplification. It is a term that was first introduced by Bhatia [29] to describe the process whereby the writer, or an associate of the writer, can “give learners an additional instructional apparatus by developing a kind of ‘access structure’ around the text” [29, p. 46], in order to “facilitate the learner’s intake without his [sic] having gone through the intervening stages of simplified materials” [29, p. 46]. Bhatia speaks of “a wide range of” such devices; most of these aim to surround texts with

preparatory, explanatory and sometimes interactive materials. Bhatia [29] illustrates a number of approaches:

- Provide introductory paragraph(s) to a text (or text segment)
- Provide a structural analysis ('tagging' sections) to a text (or text segment)
- Provide a schematic representation of a text (or text segment)
- Add annotations/explanations to the text (e.g. in-text boxes)
- Add metadiscursive commentaries (before, in the middle, or after)

The approach also includes questions to encourage interaction with the text [29]. Some "easification devices" are not dissimilar to the techniques and strategies that are used in the area of Instructional Design that deals with textbook layout.

Using the easification method, one can compensate for both the generic-structural and conceptual density of technical and scientific texts – plus the knowledge-transforming aspects of the text production process – so as to decrease the difficulties experienced by novice readers. An ever-widening range of compositional devices and processes is being developed by Bhatia and others. Note that these all exploit the backward-looking mechanisms of coherence/cohesion in order to facilitate the uptake of new terminology and domain-specific knowledge.

### c) Scaffolding: providing domain knowledge

Scaffolding in the sense intended here means the provision of a series of carefully designed pre-task exercises (or 'activities') which allow students to familiarize themselves with concepts of increasing complexity and to explore these concepts in terms of their reactances and interrelations. This usually involves the manipulation of lexical items and grammatical structures in carefully planned ways, so that verbal skills are acquired in tandem with content knowledge and understanding.

Students actively explore the semantic affordances of technical terms in the guided, semi-guided, and then free production of meaningful text. (Technical terms are defined as terms with precise meanings, and that reflect a conceptual hierarchy capable of

accounting for all the phenomena in a recognized domain, or field.)

In the final stage, equipped with the language and the conceptual building blocks required for a given task, which may involve reading a specific text, the students solve a problem that is designed to allow them to utilize and reinforce their learning. We say that we have 'scaffolded' the understanding and expressive capabilities of such students.

The exercises suggested below, based on successful trials at Macquarie in 2002, are adaptations of the task-types used in language teaching and testing, but now designed to ensure that students focused on content rather than form. Exercises can be of the following kinds:

- Gapped Texts (varying degrees of difficulty; ± distractors);
- Sentence Completion (± some of the missing words);
- Propositional Clusters (± distractors);<sup>4</sup>
- Tables and Flow Charts (may be already filled in to a greater or lesser extent);
- Summary Writing, composing texts (critical-analytical reading; recognizing what is relevant; organizing information).

For the tasks, students were given extensive background information, and asked to consider:

- Recipient reactions;
- Purpose in writing;
- Standard formats/conventions.

The underlying rationale for this approach is that form is driven by meaning. Hence, an improvement in reading comprehension and overall language proficiency will accompany, or be accompanied by, improved understanding of content. This is viewed as a kind of 'bootstrapping' process wherein, by improving a capability on which other capabilities depend, one improves the dependent capabilities ([www.hypertext.com/DKR/glossary.htm](http://www.hypertext.com/DKR/glossary.htm)). It is moreover argued that these interrelated aims are achievable through a sustained *focus on meaning* in all activities and tasks.

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<sup>4</sup> Propositional clusters are sets of key words (which can be carefully chosen technical terms), usually nouns and uninflected verb forms. The student has to organise these into meaningful sentences. Words provided can be in the order needed or 'jumbled' to test the student more.

## 7. Discussion and conclusion

The present paper accepts the arguments for an ‘interactional’ approach to technical writing and reading, in which writer-based/text-based factors and reader-based factors “all interact in the construction of coherence” [3, p. 138]. Based on a review of psychological, psycholinguistic and applied linguistic research with a bearing on discourse, comprehension and learning, it is argued that expert readers, and particularly those with some degree of domain knowledge, will be more proactive in their interrogation of the text. They will use forward inferencing skills as well as backward inferencing (or bridging) skills. It is argued that the comprehension of technical texts in particular demands a modicum of pre-existing domain knowledge. An analysis of complex nominal groups, which are typical of technical writing, with their abstract and analytic pro-heads and frequently complex premodifying and post-modifying structure, is used to demonstrate the multiple opportunities these constructions typically provide for topic shift and elaboration, referred to in this paper as conceptual development. By the same token, such constructions assume a reader who will be able to recognize the different possibilities for development, just as the writer could. In the face of the structural and lexicosemantic complexity described above, and the knowledge-based demands of technical texts, a reader will benefit significantly from any prior knowledge of the field.

The kinds of strategies employed by expert readers can be compared with those used by expert writers [34]. The broadest composing strategy of novice writers has been described as ‘knowledge telling’, while the dominant composing strategies of expert writers are described as ‘knowledge transforming’ [35] [36]. The expert reader works to explore and transform the semantic potentialities of the content just as the writer does, *and in anticipation of the writer*. This is forward inferencing (or forward inferring).

Since we cannot expect student readers to already have the required domain knowledge, this paper has suggested an approach that can be adopted by teachers and to some extent writers – i.e. the ‘scaffolding’ of domain knowledge (along with grammar and vocabulary) by means of specially

designed exercises and activities that are completed in preparation for reading a particular text or in the lead-up to a reading task [31], [32].

Technical writers may wish to investigate further the easification devices developed by Bhatia [29] [30]. This approach is rapidly winning advocates and is especially important in providing students for whom English is an additional language with access to legal texts.

On a textual level, work in experimental psychology has shown that enhancing coherence and/or cohesion can make texts easier to comprehend, or recall, especially for less skilled readers and those with less domain knowledge ([26], [27], [28]; and see Appendix 2). Coherence/cohesion can be enhanced either during the writing process, by the writer, or afterwards, as a separate process, by an editor. However, we need to bear in mind that, for more skilled readers and those with some domain knowledge, the simplification or the enhancement of texts may militate *against* learning. This finding is what led McNamara and his colleagues [28] to ask, “Are good texts always better?”

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## About the Author

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## Appendix 1

### METADISOURSE

Metadiscourse includes a wide range of words, expressions and sentences we use to make a text not only easier to follow but also easier to interpret. Hyland has defined written metadiscourse as those "aspects of a text which explicitly organise the discourse, engage the audience and signal the writer's attitude" ([16], p. 437). He there states that

metadiscourse focuses our attention on the ways writers project themselves into their work to signal their communicative intentions. It is a central pragmatic construct which allows us to see how writers seek to influence readers' understandings of both the text and their [the writers'] attitude towards its content and the audience.

Hyland distinguishes between **textual metadiscourse** – or "devices which allow the recovery of the writer's intentions by explicitly establishing preferred interpretations of propositional meanings" (p. 442) – and **interpersonal metadiscourse** – which "alerts readers to the author's perspective towards both the propositional information and the readers themselves" and as such is "essentially interactional and evaluative" (p. 443).

There is considerable evidence that interpersonal metadiscourse results in more engagement, better recall, and deeper learning.

The following table summarizes (and to some degree adapts for present purposes) Hyland's 1998 taxonomy of metadiscourse markers.

### Table 1: Metadiscourse marking

#### Textual metadiscourse

##### Logical connectives

express logical relations between main clauses:  
in addition / but / therefore / and / thus / although

##### Frame markers

explicitly refer to stages of the argument/analysis:  
finally / to repeat / our aim here / we try

##### Endophoric markers

refer to specific parts of the text itself:  
as noted above / see Fig 1 below / in Table 2

##### Evidentials

refer to the sources of information, e.g. other texts:  
according to X / (Y, 2001) / Jones states that /  
apparently / it seems

##### Code glosses

help readers grasp meanings of ideational material:  
namely / e.g. / in other words / such as

#### Interpersonal metadiscourse

##### Hedges

show degree of (un)certainty; withhold  
commitment:

might / perhaps / it is possible that / approximately

##### Emphatics

add to the force of a message:

in fact / definitely / it is clear / it is obvious that

##### Attitude markers

indicate writer's attitude to propositional content:  
surprisingly / fortunately / I agree that /

##### Relational markers

explicitly construct a relationship with the reader:  
frankly / please note that / as you can see

##### Person markers

refer explicitly to the author(s):

I / we / my / mine / our

## Appendix 2

### ‘SIMPLIFIED’ TEXT

McNamara et al [28] illustrate how the coherence of texts may be modified, using Kintsch’s model of comprehension. Anaphoric links are supplied or suppleted or made explicit; synonymous items are replaced; nominalized verbs are ‘de-nominalized’, and their missing arguments are supplied; background information left unstated in the original text is now supplied as additional clauses or sentences.

Studies in the U.S. have demonstrated that such changes produce substantial increases in recall in fifth-grade and college students [26], [27]. In fact, it also seems that modified/simplified texts failed to engage readers who already have some knowledge of the domain and thus result in less learning [28].

The first paragraph of the unmodified text is given first:

#### Heart Disease

The heart is the hardest working organ in the body. We rely on regular blood supply every moment of every day. Any disorder that stops the blood supply is a threat to life. Heart disease is very common. More people are killed per year in the U.S. by heart disease than by any other disease. [55 words]

The same paragraph of the modified text can be compared with the above. Italics below

#### Heart Disease

The heart is the hardest working organ in the body. We rely on *it* to supply blood regularly *to the body* every moment of every day. Any disorder that stops *the heart from* supplying blood *to the body* is a threat to life. Heart disease *is such a disorder*. *It* is very common. More people are killed every year in the U.S. by heart disease than by any other disease. [70 words]

If we look at what happens next, we can see how a clear structure has been added to the modified text by means of summary sentences and sub-headings

(all additions are underlined). The unmodified text (first paragraph and start of second) is given first:

#### Heart Disease

The heart is the hardest working organ in the body. We rely on regular blood supply every moment of every day. Any disorder that stops the blood supply is a threat to life. Heart disease is very common. More people are killed per year in the U.S. by heart disease than by any other disease.  
A congenital disease is a one that a person is born with. Most babies are born with .....

In the overview of the modified text that is given below, as noted, structure has been added in the form of summary sentences and sub-headings (underlined):

#### Heart Disease

The heart is the hardest working organ in the body. We rely on regular blood supply every moment of every day. Any disorder that stops the blood supply is a threat to life. Heart disease is very common. More people are killed per year in the U.S. by heart disease than by any other disease.  
There are many kinds of heart disease, some of which are present at birth and some of which are acquired later.

##### 1. Congenital Heart Disease

A congenital heart disease is a *defect* that a *baby* is born with. ....

##### 2. Acquired Heart Disease.

Some heart diseases are acquired after the baby is born. .....

##### 3. The Treatment and Prevention of Heart Disease.

Since the mid-1960s, medical science has made .....

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<sup>i</sup> Single quotation marks indicate a *quotative stance* towards an expression; actual quotations are given in double quotation marks.