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ABSTRACT

The current focus on high level planning and abstract goals runs the risk of misrepresenting the contributions that cognitive psychology could make to the study of writing if it neglects important linguistic features that distinguish the writing of natural language from other problem solving tasks. An alternative perspective on writing emphasizes psycholinguistic processes involved in generating sentences and linking them into coherent text. The problem solving models of writing, developed out of work in cognitive science, are hierarchical in nature. While some hierarchical planning is done in writing (such as working from an outline), writers commonly begin with something and follow it to a preplanned next idea, or to a newly discovered thought or to a dead end. Words already written can drastically affect what follows them. Then, the interaction between the text-level processes and the planning-level processes can be seen. Understanding the linguistic text features, such as the "top down" approach to reading (an emphasis on the reader's knowledge and its schematic organization) and the "bottom up" approach (an emphasis on lower level linguistic processes) is important to the writer's effectiveness in communicating ideas to the reader and in solving writing problems. (EL)

# LEARNING RESEARCH AND DEVELOPMENT CENTER

## WRITING AS A LINGUISTIC PROBLEM

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# Writing as a Linguistic Problem

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This article presents a psycholinguistic view of writing that focuses on the processes of translating concepts into sentences. The current research emphasis on planning is discussed in terms of its theoretical roots in artificial intelligence models of planning and the limited applicability of such models for writing. A case is made for viewing writing not only as a planning problem but as a linguistic problem that can benefit from work in reading and speech production.

As writing has become an area of cognitive inquiry, the related research has acquired a peculiar character. Some of the best known cognitive work compares the composing process with problem solving (Collins & Gentner, 1980; Hayes & Flower, 1980; Nold, 1981), and within the problem solving framework, writing has become yet another domain in which the importance of high level planning can be demonstrated. Thus, writing is clustered with physics and other problem solving domains and separated from linguistic processes such as speech production and reading to which it intuitively seems related. Much of the cognitive work on writing has focused on high level planning and abstract goals (e.g., Burtis, Bereiter, Scardamalia, & Tetroe, in press; Flower & Hayes, 1980, 1981a; Matsuhashi, 1982; Scardamailia & Bereiter, 1982), to the extent that problem solving heuristics are advocated to students as ways to improve their writing (Flower, 1981).

This article will argue that the current focus on high level planning and abstract goals runs the risk of misrepresenting the contributions that cognitive psychology could make to the study of writing if it neglects important linguistic features that distinguish the writing of natural language from other problem solving tasks. Planning — as it is frequently discussed — seems to end just where much of the real problem of writing begins, and little attention is given to the on-line processes involved in linear sentence generation. Left unspecified are the processes that make writing a unique problem: the generation of extended, coherent language.

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## Contributions and Limitations of Current Approaches

The problem solving framework has enabled important insights into writing as a process, and perhaps the most important of those insights have concerned the interactive nature of the writing process (Hayes & Flower, 1980). So much recent empirical work, however, has centered on planning that other processes which interact with planning have been neglected. This is not to say that these other processes are totally ignored by researchers. In much of the work cited earlier and in other cognitive work (e.g., E. J. Bartlett, 1982; Beaugrande, 1982; Bereiter & Scardamalia, 1981; Flower & Hayes, 1984; Shuy, 1981), there are numerous acknowledgements of the importance of language-based processes in writing. Flower (1981) allots eight pages of her tutorial on writing to such linguistic concerns. However, the problem solving perspective and its emphasis on planning are so dominant in the popular perception — formed by treatments such as Flower's (1981) — that little attention is given to the *varied* ways in which cognitive science can inform the study of writing. Planning is certainly important in writing, but a well-planned text is not necessarily a well-written one.

In what follows, an alternative perspective on writing is developed — one that emphasizes psycholinguistic processes involved in generating sentences and linking them into coherent text. However, before that perspective is presented in detail, the potential

limitations of too narrow a focus on planning need to be understood. We begin by tracing the theoretical roots of the problem solving approach, in order to explain its somewhat natural emphasis on planning, and by examining the applicability of planning models to writing.

## Problem Solving Approaches

### *Theoretical roots*

The problem solving models of writing have developed out of work in cognitive science. These and other studies of human complex-problem-solving behavior (e.g., Hayes-Roth & Hayes-Roth, 1979; Jeffries, Turner, Polson, & Atwood, 1981; Larkin, McDermott, Simon, & Simon, 1980; Voss, Greene, Post, &Penner, 1983) have examined aspects of human behavior for which quantifiable specifications previously had been few. They generally have followed the example of artificial intelligence (AI) models of problem solving, which emphasize problem decomposition, with planning as an especially important subprocess. (See Cohen & Feigenbaum, 1982, for a detailed summary.) The importance of planning in most complex tasks is well recognized, and its central role in writing is emphasized not only in the work of cognitive researchers but in traditional rhetoric texts as well (e.g., Skwire, Chitwood, Ackley, & Fredman, 1975). However, when the nature of the planning involved in writing is compared with the planning done by AI models, some interesting differences emerge.

How well does writing fit typical planning models? To answer this question, let us examine first some AI models in which the underlying process assumptions are well laid out. Then we will examine how well these AI models describe human problem solving in various domains, and finally how well they describe writing.

*AI planners.* The most well-specified models are those planning systems developed in the area of AI, and these planners differ according to the number of levels of abstraction permitted in the problem representation. That is, how much of the problem solving is done in the abstract, before local details are specified? In this respect, there are important implications for models of human problem solving, and for writing especially. While AI models are not typically intended to be simulations of human processing, their feasibility as such is interesting to examine because, ultimately, any model of the writing process should be as well specified as these AI models.

AI planners conventionally described as *nonhierarchical* (e.g., STRIPS, HACKER, INTERPLAN; See Cohen & Feigenbaum, 1982) represent the problem at a single level and thus do no abstract planning. They begin solving the initial subgoal and continue working linearly, on the assumption that early decisions are independent of later ones. Because of their lack of foresight, they are generally less powerful problem solvers. In these systems, critical steps in the solution process are not distinguished from trivial ones, and a considerable amount of work can be done (i.e., many subgoals created and satisfied) before the planner confronts a critical goal that cannot be achieved because of a trivial early decision. This requires a good deal of extra processing: backtracking to a critical choice point, undoing and then redoing the solution process.

Other AI planning systems described as *hierarchical* planners (e.g., NOAH, MOLGEN; See Cohen & Feigenbaum, 1982; Stefik, 1981a, 1981b) avoid backtracking by working at multiple levels of abstraction in their initial plans. Planners of this type follow the least commitment principle, postponing decisions about details until a proposed abstract solution is shown not to result in interference among important decisions. Potential conflicts in the plan can thus be detected early and corrected before the costly work of solving subproblems in detail is done. These procedures, together with extensive knowledge of the specific problem domain (see especially MOLGEN, by Stefik, 1981a, 1981b), make hierarchical planners very powerful and thus quite popular in AI research.

*Human problem solving.* Only a few examples of human problem solving, however, seem as hierarchical in nature as the more powerful AI planners. Experts in software design (Jeffries et al., 1981) and physics (Larkin et al., 1980) seem to decompose complex problems into classifiable problem types with recognizable solutions (recognizable at least to these experts). Novices, however, lacking the rich knowledge base of the experts, are typically less successful in decomposing and classifying the problems and seem to be forced

into nonhierarchical planning, forced simply to begin wherever they can and see how their solutions work out.

In other problem domains, even expert problem solving looks less hierarchical. Voss et al. (1983) found that the solutions generated by their social science experts did not always emerge neatly out of hierarchical refinements of abstract representations. Often subgoals were unexpectedly encountered and solved during the evaluation of implications of another subgoal. Such multidirectional, "opportunisitic" problem solving characterizes other human problem solving performance (Hayes-Roth & Hayes-Roth, 1979). In these descriptions, human solutions evolve incrementally from subgoals at various levels rather than from orderly problem refinement at any given level, with low-level constraints sometimes being dealt with before more abstract ones.

### *Applications to Writing*

*Planning in writing.* What is the nature of the planning done by writers? Many traditional composition texts present writing as a task directly amenable to hierarchical planning, with multiple levels of problem decomposition (e.g., Skwire et al., 1975). This is reflected in the frequent suggestion to the student to first create an outline of the composition. A topic is to be chosen, and the paper divided into introduction, body, and conclusion. The body of the paper is further subdivided into paragraphs of thesis support, each making a main point stated in the paragraph's topic sentence and supported in its body. All that then remains is the "fleshing out" of the outline. (See also Emig, 1971, for a related discussion of rhetoric texts.)

There are limits, however, to the appropriateness of hierarchical models for writing. Recall that hierarchical planners operate according to the least commitment principle keeping variables unspecified for as long as possible. Only so much planning of a composition, however, can be done in the abstract, even by skilled writers. Relatively early the writer is forced to define variables (i.e., to actually write a sentence or a few words), and this often occurs before every paragraph is fully planned and waiting to be "dressed" in the appropriate words. Words already written can drastically affect what follows them; in fact, they must if smooth transitions and local coherence are to be maintained (Halliday & Hasan, 1976). With such early constraints on variables, the writer loses the power of the hierarchical planners. The writer is forced, at some point in the actual generation of sentences, to follow the linearity assumption typical of nonhierarchical planners, choosing to begin with something and following it, sometimes to a preplanned next idea, sometimes to a newly discovered thought, and sometimes to a dead end. The nonhierarchical aspects of writing are all too many, as data from Hayes and Flower's (1980; Flower & Hayes, 1981b) protocol studies reveal. Low level editing frequently interrupts the planning and generating processes, and in most research on writers' actual composing behavior, emphasis is placed on the interactive nature (in the psychological sense of multiple information sources) of the subprocesses of writing (E. J. Bartlett, 1982; Beaugrande, 1982; Burtis et al., in press; Emig, 1971; Hayes & Flower, 1980; Matsuhashi, 1982; Nold, 1981; Shuy, 1981).

*The interactive nature of writing.* The interaction between text-level processes and planning-level processes is well illustrated in the following excerpts from the protocol of a writer of a newspaper wine column. This writer began the protocol with a well formed plan concerning audience and style, even specifying the structure of his column about a tasting of wines from Chateau Latour: "The general structure has got to be, we've got to give them some information about Chateau Latour, make it kind of real to them, give them something to chew on, and then we're going to go through the tasting notes . . . ." Even with this plan, however, text-level decisions had to be made, as his protocol shows.

In Figure 1, the writer knows the content he wants to express, but it is the expression, in linearly structured sentences, that gives him trouble. (The section of text on which the writer is working is presented on the right side of the figure, and the writer's comments on the left.)

The writer's plan had specified that he give some information about Latour, specifically that 80% of the Latour vineyards are planted in cabernet grapes and that this is the source of the wine's longevity. However, an appropriate sentence structure coordinating those two ideas does not just fall out of his semantic plan, and we see the writer try one alternative after another. Constructing appropriate sentences is part of the writing task.

| PROTOCOL | TEXT |
|---|---|
| | . . . Probably one of the major reasons for the longevity of the wines lies in the 80% cabernet sauvignon grapes |
| That doesn't read too well at all, but it's the right idea. So why not break it up . . . | |
| | (edits) . . . lies in the vineyards of Latour. 80% |
| Now we can get the 80% in, OK? (reads) "80% of the grapes? Cabernet? 80%" I want to say it's the vineyard that's cabernet, but we just said it's the vineyard, and that gets boring with too many "vineyards." . . . So why not just make it a nice run-on sentence . . . That way we don't have to repeat. | |
| | (edits) . . lies in the vineyards of Latour, 80% of which are given over to the cabernet grape. |

*Figure 1.* Adult writer's protocol and text as the writer works out sentence syntax.

| PROTOCOL | TEXT |
|---|---|
| | . . . the vineyards of Latour, 80% of which are given over to the cabernet sauvignon grape. (types) This is the grape used in the hardest |
| Well now, how would one describe the grape? Wildness? See, what we have to do now is tell them why it is that cabernet sauvignon gives it the longevity. Why does it? Because it is a hard grape. It takes a long time to come around. OK . . . (reviews) "This is the grape that . . ." ah, "provides backbone . . ." | |
| | (edits) This is the grape that provides backbone . . . |

*Figure 2.* Adult writer's protocol and text as the writer uses the text to refine conceptual plan.

The protocol continues in Figure 2, and here we can see that the writer's linear generation processes have outrun his plan for content. He then uses the text he has written to better formulate his idea and help retrieve content.

It is probably not a coincidence that the word "hard," appearing first in the written text, is used as a prompt in a memory search for better descriptors. Here the processes of writing connected sentences has led the writer to a point where his high level plans were not well specified, and his written sentences actually help achieve the goal by providing a prompt, a jumping-off point from which to begin some new semantic planning. In these two excerpts we see different types of text-level processing, and the interaction among them is striking. In Figure 1 the writer knew the

concepts that he wanted to express and even many of the specific lexical items; however, he had not worked out the syntactic frames for those lexical items. In the course of the protocol we see the writer work out an appropriate syntax, guided by constraints from the lexical level, constraints against too much word repetition.

In Figure 2 something slightly different occurs. There is a general semantic plan for the section (i.e., to explain the connection between cabernet grapes and a wine's longevity), but the writer has neither the specific syntax, concepts, nor the lexical items to express them. As we see in the sentence fragment that ends the first segment of text, the writer seems simply to begin the new sentence, building it on the sentence just completed, and he goes as far as he can with it. His first pass at the sentence is not in the form he will actually use, but that first expression gets him into the appropriate semantic field and enables further refinement of the semantic plan.

In this second excerpt we see an example of "text-based" writing used to its fullest advantage by an expert writer, and it illustrates how truly interactive writing can be. This writer began with a well-formed plan of the general structure of the column and of the audience who would read it. Even experts, however, cannot plan in advance every elaborative detail that might become appropriate as the text develops. As we see in Figure 2, the text itself can influence phrasing and can even prompt the writer to pursue an idea that was not salient in the initial plan.

Thus, to accurately describe the behavior of writers, planning systems such as those developed within AI must be altered substantially. The hierarchical models that are powerful enough to solve relatively complex problems do not fit very well the task of generating coherent texts. Even descriptions of human experts performing the superficially similar task of software design (Jeffries et al., 1981) seem quite different from expert writing performance. The solution processes of software design experts seem somewhat hierarchical in nature, while those of writers are much more interactive. The differences are probably due to the symbolic codes required in the two tasks. Writing computer code is not like writing natural language because the syntax of computer code is fixed. Once the general semantics of a computer program have been worked out, translation into code may be a rather trivial problem, at least for programmers of reasonable skill. For the writer of natural language, however, syntax is not fixed. There are a variety of lexical and syntactic forms that can be used to express the same general semantic concepts (as our columnist demonstrated). Most important, those various syntactic forms render the semantic concepts no longer exactly equivalent. A passive construction, for example, signals a different sentence focus than does an active construction. Because natural language permits nuances of meaning that computer codes do not, rearranging syntax can result in subtle changes in theme or foregrounding that can affect the reader's comprehension (Chafe, 1972; Halliday, 1967; Halliday & Hasan, 1976; Lesgold, Roth, & Curtis, 1979).

In writing, unlike some tasks, decisions at the most detailed level of word choice and sentence construction can have large effects on abstract goal outcomes such as tone, perspective, and audience. This is because those goals are fully achieved only at the most local level. For example, our wine columnist proposed to continue his explanation of wine's longevity with a discussion of esters and aldehydes. Reconsidering his purpose and audience, he chose instead to refer to "smells and flavors," because he wanted only a brief reference to those concepts. The concepts themselves were not ruled out by his general plans, but the writer had to decide on which aspect of the concepts to focus (on their chemical basis or their perceptual qualities) and on the corresponding lexical labels ("esters and aldehydes" or "smells and flavors"). Inappropriate choices at that final level of specification could have undermined his plans concerning audience and purpose.

## Language-Based Approaches

Because of the distinctive features of natural language production, linguistic tasks may be much more like one another than they are like other problem solving tasks. Thus, work in reading and speech production may provide additional models for studying writing. In work on reading comprehension, two perspectives have emerged, and while they are often viewed as adversative, they are actually rather complementary. The "top-down" approach emphasizes the importance of the reader's knowledge and its schematic organization, while the "bottom-up" approach emphasizes lower level linguistic

processes.[1] The model emerging from reading research reconciles these approaches by emphasizing interactions among processes at all levels. Thus, both top-down and bottom-up processes have been shown to contribute to successful comprehension, and there may be corresponding contributions, as well as interactions, at each level in the case of writing.

### *Top down Processes*

*Top down approaches to reading.* Top-down information plays an important part in reading, for example the role of schemata in guiding comprehension. A schema is a hypothesized knowledge structure that connects events or concepts in some organized arrangement. Popular examples of such schemata are the collections of events that typically make up a story (setting, characterization, complication, and resolution) or a visit to a restaurant (ordering, eating, paying, and leaving).

The usefulness of the organizational properties of schemata for comprehension and recall has been repeatedly demonstrated. Texts ordered according to typical narrative schemata are consistently better recalled than those with unusual orders (Stein & Nezworski, 1978; Thorndyke, 1977), and recall of discourse that does not follow the ideal schematized order tends to be restructured more in accordance with that order than the actual order of input (Bower, Black & Turner, 1979; Mandler, 1978; Stein & Nezworski, 1978; Thorndyke, 1977). Recall also suffers when appropriate schemata are unavailable (F. C. Bartlett, 1932; Bransford & Johnson, 1972), and recall is better when events in stories are logically related rather than loosely temporally ordered (Anderson, Spiro, & Anderson, 1977, in Anderson, 1978; Black & Bern, 1981; Brown, 1976; Kintsch, Mandel, & Kozminsky, 1977).

In addition, a concept's probability of recall or inclusion in a summary increases when that concept is judged (by various indices) to be more important or more central to the schema (Brown & Smiley, 1977; Johnson, 1970; Omanson, 1982; Rumelhart, 1975). Similarly, the schema instantiated during comprehension can have dramatic effects on which concepts are recalled and on their interpretation (Anderson, Reynolds, Schallert, & Goetz, 1977; Pichert & Anderson, 1977, in Anderson, 1978). Comprehension has, in fact, been defined by some as instantiating the appropriate schema and mapping the incoming information onto the various slots (Collins, Brown & Larkin, 1980; Rumelhart & Ortony, 1977; Schank & Abelson, 1977). While others argue that there is more to comprehension and reading skill than top-down knowledge (Perfetti, in press; Perfetti & Roth, 1981, Stanovich, 1981), it is generally acknowledged by researchers from all perspectives that schemata are quite useful in organizing new information, in relating it to the reader's general knowledge during reading, and in accessing that information during recall.

*Schemata in composition: applications and limitations.* The role of schemata in memory access and retrieval during reading suggests that schemata may also be useful in writing. There is some suggestion that schemata can act as regulators for the arrangement of text elements in original text generation, as well as recall (Paris, Scardamalia, & Bereiter, 1980, in Bereiter & Scardamalia, 1981; Stein & Glenn, 1979; Waters, 1980). Meehan (1981) has found schemata to be necessary knowledge components of his story-generating computer program, and Black, Wilkes-Gibbs, and Gibbs (1982) describe how schemata (and deviations from them) can help a writer determine an appropriate level of detail to focus interest, create drama, and hold interest.

Certainly a key role for schemata during writing is the activation of relevant schematic content. Schemata may be very much involved, therefore, when writing becomes a process of discovery of ideas rather than mere transcription, and there may be something to that common observation, "I don't know what I think until I write it down." Schemata may aid in memory search, since they contain pointers to yet unaccessed information in the writer's memory and thus facilitate retrieval of topic relevant information.

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[1] The bottom-up approach to reading has often been characterized as primarily emphasizing decoding and other word-level processes, and much of the work on individual differences in reading ability has indeed focused on the importance of such low-level processes (e.g., Hunt, Lunneborg, & Lewis, 1975; Perfetti & Lesgold, 1979). This, however, has led to a misconception: that in the bottom-up approach, decoding is all there is to comprehension. On the contrary, these lower points in the verbal processing chain are emphasized only as potential processing weaknesses that can, if not automated, drain cognitive resources away from the text-level, integrative processes that are critical for comprehension (Perfetti, in press; Perfetti & Lesgold, 1977).

Once relevant semantic content is activated, there still remains much for the writer to do in terms of translating clusters of semantic knowledge into actual text. An attractive feature of schemata is that they deal with semantic information at an abstract level. However, the processes of translating semantic concepts and relations into grammatical natural language sentences are not well specified in the schema-oriented work. Semantic relations are well expressed by propositions — relations between predicates and nouns — but even when relations among semantic concepts have been organized into lists of propositions, there is still no natural language text. The utility of a propositional representation is that it can be mapped into a variety of linguistic expressions, all paraphrases of each other (see Kintsch, 1974; Kintsch & van Dijk, 1978). Generating those linguistically specified alternatives and choosing the one most appropriate in a given linguistic context comprise much of the writer's job, and that job is often not an easy one.

As our wine columnist found, it is not always easy for the writer to choose the linear syntactic arrangement that best expresses the conceptual relations and still honors local constraints, especially since the writer is rarely generating a single sentence in isolation. The writer usually tries to generate a connected discourse and is thus foced to deal with how extended texts "work," that is, how the specific wording of the message places some concepts in the foreground, others in the background, and integrates them all. Thus, in addition to the insights into writing gained from schema-oriented, top-down models of comprehension, there is much to learn from work that focuses on how meaning depends on the specific wording of texts and how specific wordings can affect processing.

### *Bottom up Processes*

*Role of linguistic text features in reading.* The bottom-up approach to reading comprehension has focused on the text itself and has emphasized many concepts developed in linguistics. For example, linguistic ideas of sentence perspective have been discussed at length by Halliday (1967; Halliday & Hasan, 1976). Halliday (1967) distinguished several related concepts: *information focus*, which is indicated by tonal groups in speech; *thematization*, realized by order of clause constituents; *identification*, realized by special markings of "identified and identifier" in cleft and pseudocleft constructions; and *given/new*, which is based solely on whether or not specific information has been previously presented in the discourse. Many of these ideas have been incorporated into theories of comprehension (e.g., Just & Carpenter, 1980; Perfetti & Lesgold, 1977), and they have been the subject of empirical investigation.

In one such line of research, Clark and Haviland (1977) proposed a model of connected sentence understanding which they call the *given/new* strategy. The listener or reader attempts to match the given information in each sentence with some information already in memory. If that match is successful, the new information is added to memory. If, however, the match is unsuccessful, added processing is required to make a bridging inference or restructure the original given/new assignments in the sentence. Reading times lend plausibility to such a hypothesis. Reading times were found to be shorter when syntactically indicated sentence parsings were appropriate to the given/new semantics of the passage. Similarly, Hornby (1974) found indications that cognitive processing was influenced by the linguistic presuppositions of the sentence syntax, and Sanford and Garrod (1981) have proposed a model of comprehension that deals, at the level of specific wording, with such text-based processes as inferencing and assigning pronominal reference.

Chafe (1972) discussed the related concept of foregrounding, which entails the linguistic "staging" of certain lexical items and allows their being treated as given in the following utterance. Translated into cognitive processing terms, foregrounding helps to mark some lexical items for inclusion in STM while others are backgrounded. Thus, reading times should decrease for foregrounded information, and this was found to be the case (Lesgold et al., 1979; Sanford & Garrod, 1981).

*Lingusitic text features: implications for writing.* The implications of this work for writing are two-fold. First, the writer should want to create texts that most effectively communicate ideas to the reader. Thus those linguistic features of text that affect a reader's processing should be important to the writer as well. It may not be the case, for stylistic or other reasons, that the writer consistently

makes the reader's job as easy as possible. However, as the writer searches for various syntactic constructions, he or she should be continually aware, at some level, of the subtle changes in thematization or information focus that are cued by alternative syntactic constructions. A writer's control over local text features can thus affect the quality of the written product, and analyses of local text coherence has shown that such local control seems to contribute to developmental differences observed in writing by children (McCutchen & Perfetti, 1982) and to perceived quality differences in writing by college students (Witte & Faigley, 1981).

The second implication of these linguistic text features concerns the processing of the writer rather than the reader. The writer, after all, becomes a reader during the repeated cycles of generating, translating, and reviewing that comprise the process of writing (Hayes & Flower, 1980), and thus the writer can be affected by many of the same text features. Perfetti and Goldman (1975) observed that readers' preferences for syntactic alternatives was indeed influenced by the syntactic thematization of sentences that preceded them. We also saw evidence of this interaction between the developing text and the writer's more general semantic plans in the writing of our wine columnist (see Figure 2).

The writer's realization of how a text is working linguistically can be very useful. With this information, the writer can understand the syntactic reasons why a text seems to be "going nowhere" or even going somewhere the writer does not intend. Understanding the syntactic reasons for the problems, the writer may then know better how to solve them.

The ability to ultimately solve such writing problems may critically depend on the writer's fluency in the processes of linear sentence generation: encoding concepts into actual lexical items, formulating clause-level syntactic arrangements, and then morphologically manipulating the lexical items to fit the syntactic frames. It is fluency in linear sentence production that aids manipulation of sentences and thus ideas. Just as the imposition of high level schemata may organize information in interesting and sometimes unexpected ways, lexical and syntactic manipulations at the local text level may also result in fresh juxtapositions of concepts that the writer can then evaluate for style, clarity, direction, or even plausibility.

Only with reasonable fluency and cognitive efficiency in processes at the local text level, however, can the writer afford to play such experimental linguistic games with the text. "Writing as discovery" is simply too cognitively expensive for the writer with limited fluency in linear sentence processing. Young writers might be at a special disadvantage here not only because of their limited syntactic fluency but also because of their limited syntactic repertory. Even when children can recognize flaws in their writing, they often cannot propose alternative constructions that remedy the problems (E. J. Bartlett, 1982; Bereiter & Scardamalia, 1981). The writer may even, in some sense, know alternative word choices or syntactic constructions, but when sentence production is cognitively inefficient the generation of sentences may proceed on a "first come, first served" basis, regardless of appropriateness within the specific linguistic context. This too can be problematic, especially for the young writer, since studies by Bracewell and Scardamalia (reported in Bereiter & Scardamalia, 1981) showed that children have particular trouble linguistically recasting sentences when alternative linguistic forms of the sentences are present. Thus, if text-level processes are not well under control, the writer may simply not risk local manipulations, and if they are attempted, faulty local processing may result in the errors so typical of problem writers (see Bartholomae, 1980; Daiute, 1981; Shaughnessy, 1977).

It is the very fluency of most writers' linear sentence processing, successful or not, that may make it difficult to identify their importance in the writing process. Our wine columnist was extraordinarily verbal about some of his text-level decisions, but this was not true in much of his protocol, nor in the protocols of many other skilled writers. In a study of pauses during writing, Flower & Hayes (1981b) found that higher level, rhetorical goals correlated better with pause-bordered episodes than did local, sentence-level decisions. This is not surprising. Especially for the adult writers in that study (several of whom were classified as expert writers), one might expect that sentence-level decisions would not account for large proportions of pause time, compared with rhetorical decisions. These writers may be so fluent with local text manipulations that those sorts of decisions are very rapid and not as available for report.

| PROTOCOL | TEXT |
|---|---|
| | 1) Roller-skating is fun and exciting.<br>2) Because you can skate with alot of people.<br>3) There's many different places to skate.<br>4) To roller-skate you use tennis shoes with wheels. |
| That doesn't sound good at all! . . . I'll have to start the sentence with different, um, different words because, um, it says "There's many different places to skate" and it really doesn't fit right there. "There's *also* many different places to skate." | |
| | (edits) |
| | 3) There's also many different places to skate. |

*Figure 3.* Fourth grade writer's protocol and text as the writer explicitly coordinates adjacent sentences.

*Text level processes in young writers.* For writers with less skill and less experience, however, such sentence-level decisions are not so fluent, and those decisions are observable parts of the writing process. A close look at a spontaneous editing session of a fourth grader gives some insights into her writing process and into aspects of performance not observable in more fluent writers.

In Figure 3 and 4 we see, on the right, the text produced so far in the writing session and, on the left, the writer's comments at that point. The sentences of the text have been numbered here for ease of reference.

In Figure 3, the writer has reread her first four sentences and is dissatisfied. She is struggling with local coherence problems between sentences 2 and 3, and she solves them with a strictly local, sentence-level change. She inserts the word "also" into sentence 3 to explicitly mark the coordination of ideas between sentences 2 and 3. As her protocol reveals, text-level decisions take much of this writer's attention as she tries to generate sentences that "fit" with their neighboring sentences.

In Figure 4, the writer has deleted sentence 4 altogether, after several attempts to reword it and "start it out different." Her comments show that she has decided what semantic content she would like to include in her next sentence, but the local decisions of "how to write it" are very difficult for her. She has decided to extend her discussion of "places to skate" by mentioning streets and hills, but she struggles at the level of phrasing and questions how explicit she must make the link between "places" and "streets and hills."

For this young writer, whose linear sentence processing is not fluent, text-level decisions are very prominent aspects of the writing process. In addition, young writers are notorious for their lack of high level planning (Burtis et al., in press; Scardamalia & Bereiter, 1982), and thus their text-level decisions might be even more difficult, operating without the guidance of superordinate plans. For older, more fluent writers, such text-based processing may no longer be prominent aspects of writing, observable in protocols, but they certainly must remain important parts of the process of sentence generation and thus important parts of writing.

### *Speech Production Processes*

The writer's job, in some respects, is not unlike the speaker's job: The goal of both is to generate a linguistic expression. Of course, unlike the speaker who produces a transient acoustic signal, the writer produces an enduring written transcript that can be reexamined and edited to improve its fit within a given context. With the luxury of revision, the writer can alter the text so as to most effectively communicate with the reader.

Like speech, however, the writing of sentences requires encoding semantic concepts

| PROTOCOL | TEXT |
|---|---|
| I'm trying to figure out how to write it—how to put it down—to fit with, um—See, it'll fit more with, um, "many different places to skate." It'll fit with that, like, 'cause, um, flat hills are different places—well *streets* are different places, *hills* are different places . . . I'm trying to get this sentence—well, it'll fit this sentence, but should I write um, "Hills are steep, and they're scarey"? Would that make sense—to make—with this sentence? Or just write "Hills are—Hills and streets are different places to skate"? | 1) Roller-skating is fun and exciting.<br>2) Because you can skate with alot of people.<br>3) There's also many different places to skate. |

*Figure 4.* Fourth grade writer's protocol and text as the writer works out syntactic frame for chosen concepts.

into actual lexical items and arranging them in grammatical sequences that best express their semantic relations. Research on speech production shows that the process is not one of direct translation. Linear sentence generation requires much interplay among semantic, syntactic, and lexical levels, as evidenced by speech error data (Fromkin, 1973, 1980; Garrett, 1981; Levelt, 1983).

Various kinds of speech errors suggest that there are multiple stages in the process of sentence production. For example, word exchanges, as in sentences (1) and (2) (from Garrett, 1981), tend to be between words of the same grammatical category, suggesting some syntactic framing had occurred prior to the point at which lexical items were inserted into the frame.

(1) Older men choose to tend younger wives.
(intended: tend to choose)

(2) Write a request for tickets at two for the box office.
(intended: tickets for two at the box office)

Other errors, called stranding errors, suggest that the bound morphemes marking grammatical function are partly independent of the lexical items with which they are paired and are perhaps connected more intimately with the syntactic frame itself. In these errors, word stems exchange places but leave behind, "stranded" in the original syntactic position, the bound morpheme that serves as the grammatical marker. Further, as shown in sentence (3) (from Garrett, 1981), very late in the production process those stranded morphemes are accommodated to their *new* phonological environment.

(3) It waits to pay.
/s/
(intended: pays to wait)
/z/

Such errors have prompted theories of speech production that involve several rapidly executed stages in which general semantic content is chosen first, then individual concepts or "lemmas." Then clause-level syntactic frames are specified, individual lexical items retrieved (corresponding to the semantic lemmas), and finally some morphological adjustments made to fit the words into the specified frame.

Protocols from writers such as our wine columnist also suggest the existence of several levels in the sentence production process. In the excerpt in Figure 2, the writer was searching for semantic concepts and words to capture them, while in Figure 1, he had the concepts, words, and much of the syntax but was working on subtle syntactic refinements that avoided word repetition.

Although we do not usually see word exchanges and stranding errors occurring in writing, speech production models have been applied to writing with some interesting results.

For example, one theory of speech production (Bever, Carroll, & Hurtig, 1976) explains many syntactic errors, such as sentence (4), in terms of overlapping syntactic frames that, when combined, result in an ungrammatical merging of two potentially grammatical sequences. Sequences (4a) and (4b) are both grammatical, but when connected via their common segment, "I understand," they violate syntactic rules.

(4) I really enjoyed flying in an airplane that I understand how it works.

(4a) I really enjoyed flying in an airplane that I understand.
(4b) I understand how it works.

Daiute (1981) has applied similar analyses to students' written sentence errors and was able to account for a large proportion of the students' syntactic errors.

## Conclusions

The argument presented here has some precedents. (See Bracewell, 1980, for a related discussion.) In fact, a similar point has been made by Flower and Hayes (1981b), major proponents of the problem solving approach to writing whose recent work focuses primarily on the role of planning in writing skill:

> an important part of being a skilled writer is knowing not only how to do this rhetorical planning, but how to embed sentence-level planning within it — how to turn intentions and knowledge into text.

So much empirical attention, however, has been focused on the planning component of their problem solving model that the translating component often seems trivial in comparison. Studies in speech production and reading comprehension remind us that generating language, even with the help of appropriate plans, is a nontrivial task and that linguistic features of the text affect processing in important ways. Thus the translating of plans and goals into text is an important part of the writing process, and the interaction between higher-level plans and linguistic features of the developing text are a worthy research focus.

A focus on the linguistic nature of the writing process will prompt research to address questions that are different from those posed in a planning-oriented view. For instance, does sentence generation during writing follow the course hypothesized in speech production studies? It may be the case that the slowed pace of writing and the reflection it permits, combined with the written transcript it leaves behind, alter the process. In the less transient environment of written text, sentences occurring earlier in the discourse may affect on-line productions in ways that spoken sentences cannot. On the other hand, writing might not substantially change the process; it might simply make it easier to track and thus help refine theories of sentence production.

When the focus is on how semantic content is translated into language, issues also arise as to how (and how well) coherence among the semantic concepts is represented through coherence in the text itself. Such issues include how do linguistic devices maintain textual coherence and how intimately are such linguistic devices tied to the semantics of the content. Since skilled writers seem to be able to transfer at least part of their skill across knowledge domains, one might be tempted to hypothesize that some aspects of coherent writing are independent of content. This implies that, in an effort to create a coherent text, the good writer somehow recognizes areas of ignorance and (a) either avoids or "writes around" them, or (b) clears them up in the process of writing. The second alternative is clearly the most interesting. Many writers have had the experience of crystallizing ideas only once they begin to write them down, and the role that language generation itself plays in this process is a most intriguing question.

Also interesting is the development of the ability to view language as separate from the content it expresses. How and when does the writer, or the language user in general, begin to represent language as opaque, as something that can be crafted to better express given semantic concepts rather than just a transparent window on those concepts? For the novice language user, the emphasis is usually on the message, but the writer must focus on the linguistic expression of that message as well. Understanding how "what is said" differs from "what is meant" is a critical part of writing.

Thus, focusing on writing both as a text-driven linguistic task and as a planning task, writing researchers may begin to get a more comprehensive understanding of the writing process.

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