Observations on the Psychology of Thinking and Writing

Ronald T. Kellogg

Theoretical claims about the process of writing and empirical findings from composition research have flourished for more than twenty years now. The journey from Janet Emig’s (1971) volume on the composing processes of high school students to the present has been intellectually vigorous and has appropriately attracted scholars from diverse disciplines in the humanities and social sciences. Inevitably perhaps, theorists have sought to contrast the perspective of their discipline with that taken by another. For example, we find cognitive models of writing pitted against social/cultural models, as if both views were not needed (Faigley, 1986). In a similar fashion, composition researchers shifted the traditional focus of literary scholars from the product of writing to the process itself (Hayes & Flower, 1983). Though process studies are clearly essential, we ought not lose sight that ultimately writing theory must show the linkage between how writers compose and how well they compose.

In this essay, I propose the integration of three perspectives on writing and frame the relation between factors that influence the writing process, on the one hand, and writing performance, on the other. My concern with the broader issues of a psychology of thinking leads me to the approach taken here.

The mental skills invoked by writing cover the waterfront of cognitive psychology, especially those areas concerned with thinking. Indeed, writing can be fruitfully viewed as the prototypical thinking task. The writer gathers information through reading and discussing ideas with others, creates original ideas and organizes their relations, solves content and rhetorical problems, generates language within the special constraints of written text, and evaluates and makes critical decisions regarding ideas, organization, sentences, textual coherence, and numerous other matters. One is hard pressed to define any aspect of thinking that does not find its way in some fashion into the study of writing. Certainly, the varieties of thinking that constitute Lipman’s (1991) encompassing categories of critical and creative thinking are woven throughout composition. The sheer breadth of the subject necessitates a broad theoretical approach.
Background and Overview

The novelist Walker Percy foreshadowed a theme of my observations in his remarks at the 18th Jefferson Lecture, sponsored by the National Endowment for the Humanities (Coughlin, 1989). Percy argued that “man’s unique behavior of language and symbol-mongering eventually must be confronted by science as a natural phenomenon that explains humanity.” Although it might be presumptuous to rename our species, Percy’s terminology of Homo symbolificus clearly suggests the fundamental importance of creating meaning in the mental life of human beings. We make meaning by creating and manipulating symbols in order to render our experience interpretable and coherent. These symbols include both the personal symbols of mental experience, such as images, thoughts, feelings, recollections, fantasies, and dreams, and the consensual symbols of public communication, such as oral and written discourse, music, painting and other art forms. Certainly, no account of human thinking can overlook the meaning making and symbol mongering that concerned Percy.

Csikszentmihalyi (1990) described two crucial senses in which people make meaning. First, there is the classic sense of reference. What is the meaning of chair? A consensual symbol, a word, refers to some object, event, or other form of complex experience. Similarly, personal symbols, such as a mental image of a chair, refer to what we know about the object. Through the construction of complex webs of reference, people order information in their world. Relationships and identity classes emerge through this form of meaning making. Second, there is the ultimate sense of purpose and significance in life. What is the meaning of life? People construct causal relationships among events such that they lead to some final purpose. Making sense of our experience entails both meaning as reference and as purpose. Meaning as reference provides a platform on which to build our theories and tales about the ultimate significance of human existence.

To suggest that meaning making defines our nature hardly makes news in psychology’s sister disciplines. This perspective has been thriving for several years now in cognitive anthropology, linguistics, literacy theory, and philosophy (Bruner, 1990). But in contemporary psychology the focus has been on information processing rather than meaning making. Jerome Bruner (1990) in his recent book Acts of Meaning recounted his efforts and those of his colleagues at the Center for Cognitive Studies at Harvard during the early days of the cognitive revolution in the 50’s and 60’s. He noted that “the originating impulse of the cognitive revolution . . . became fractionated and technicalized . . .” and that “very early on . . . emphasis began to shift from ‘meaning’ to ‘information,’ from the construction of meaning to processing of information.” (p. 4) This
troubled Bruner, who saw in the cognitive revolution a different agenda, as noted below.

It was, we thought, an all-out effort to establish meaning as the central concept of psychology—not stimuli and responses, not overtly observable behavior, not biological drives and their transformations, but meaning . . . It was an altogether more profound revolution than that. Its aim was to discover and to describe formally the meanings that human beings created out of their encounters with the world, and then propose hypotheses about what meaning-making processes were implicated. It focused on the symbolic activities that human beings employed in constructing and making sense not only of the world, but of themselves. (p. 2)

My observations here on the psychology of thinking and writing include five parts. First, I very briefly sketch a theoretical framework that integrates three distinct perspectives; they are the cognitive components of information processing and meaning making, the cycle of cognition, and the principle of constructive narration. Second, I consider in general terms how knowledge usage relates to writing performance and the factors that shape the writing process. The role of knowledge, personality, and method in shaping the process of writing text and in certain cases determining the level of skilled performance are discussed. Third, I present experimental evidence on how content knowledge and rhetorical knowledge affect the process and performance of writing. Fourth, I turn to two aspects of method—namely, the strategies used before and during composition and the writing tools employed by the writer—and address how these affect process and performance.

North (1987) characterized several paths in the field of composition. Those familiar with his classifications will recognize how the present essay attempts to conjoin several of those that he described. In the first section, the cognitive component perspective reflects work of the Formalists, who concern themselves with model building. The cycle of cognition is best identified with the Ethnographers, who concern themselves with the situated nature of thinking and writing in the context of culture; the principle of constructive narration draws from the Historians, who concern themselves with the narrative mode of thinking. The second and third sections reflect primarily the work of the Experimentalists, who aim to establish causal relations between an independent variable, such as choice of writing tool, and a dependent variable, such as text quality.
Three Perspectives on Writing

Cognitive Components

I show in Figure 1 (see p. 25) the cognitive components of writing skill. It includes the standard information processing components of attention, working memory, and long-term memory, and the task environment. But in addition it includes components unique to meaning-making activities. I will limit my remarks to these.

The writer allocates attention to four basic writing operations to meet the demands of the writing task at hand. Collecting information, planning ideas, translating ideas into text, and reviewing ideas and text comprise the four basic operations and mirror those proposed by John Hayes and Linda Flower (1980). These occur recursively during each phase of product development. For example, new collecting and planning can occur even on a tenth draft of a document.

A full understanding of my use of these terms requires first understanding the difference between two types of symbols. The late Paul Kolers formulated an important distinction between the personal symbols of mental experience and the consensual symbols of public discourse (Kolers and Smythe, 1984). Drawing on the philosophical work of Susanne Langer and Nelson Goodman, Kolers defined consensual symbol systems as marks or inscriptions that are publicly available to all those trained in their use. Natural languages, pictures, diagrams, and the notations of logic, mathematics, and music are consensual in that anyone who has learned the system can scrutinize, comprehend, define, and manipulate the symbols.

Personal symbols, in contrast, are privately defined and used only by the person who experiences them. They are "phenomenal events that refer to other objects or events, such as mental images, mental associations, or dreams" (Kolers & Smythe, 1984; 294). Only the person experiencing the internal events has access to these symbols. Personal symbols exist as the product of mental activity and enable a person to model his or her environment symbolically. But they cannot be inspected by others. Communication among people succeeds only by mapping personal symbols, however imperfectly, onto the consensual symbols that provide us with a common basis of reference.

Turning now to the writing processes, collecting involves searching bibliographic indices, reading source materials, and experiencing events such as hearing a lecture. We gather and scrutinize consensual symbol systems and transform what we learn into personal symbols for subsequent use in thinking and writing. Planning involves creating and organizing ideas and setting goals to achieve during composition, such as choosing an appropriate tone for a given audience. Planning typically occurs in the mental domain of personal symbols. A writer might sit
staring blankly into space, looking almost catatonic, while personal symbols are created and organized. James Thurber when writing for the *New Yorker* shared in an interview once that his wife always caught him lost in planning ideas (Cowley, 1958):

Sometimes my wife comes up to me at a party and says, “Dammit, Thurber, stop writing”... Or my daughter will look up from the dinner table and ask “Is he sick?” “No,” my wife says, “He’s writing something.”

A writer might also draw a sketch, jot down key words, or produce a handwritten outline (Haas, 1990). In these cases planning involves consensual symbols in the form of externalized plans. Although these symbols may be scrutinized, they rarely make much sense to others (John-Steiner, 1985). The writer creates such plans for personal use and has no intention of communicating through such notes, lists, outlines, and doodles. Leonardo Da Vinci even went so far as to write his notes backwards in a secret short-hand notation to conceal his thoughts from others (Boorstin, 1985).

Translating ideas into text refers to the semantic, syntactic, and pragmatic operations involved in sentence construction. Although the distinction between planning and translating can at times be fuzzy (Nystrand, 1982; 1989; Witte, 1987), it remains a useful contrast in the framework proposed here. Translation involves mapping personal symbols onto the consensual symbols of written discourse with an intention to communicate. Communication occurs in the public world of culture through the efforts of translation. Whether communication succeeds or fails depends only in part on how well the writer translates his or her private world into the public world of text. It also depends on the work done by the reader in reconstructing the author’s intentions (Nystrand, 1982).

Finally, reviewing involves reading the evolving text, evaluating the text or plans for text, editing errors. Reviewing involves working with personal symbols, such as when the writer asks “Is this idea adequately developed?” It involves consensual symbols as well such as when the writer asks “Is this sentence on page 10 grammatical?” Finally, reviewing involves the mapping between personal and consensual symbols, such as when the writer asks “Does this sentence convey my intent?” In reviewing the writer tries to adopt the potential reader’s point of view and check whether the meaning that the reader will construct fits with the writer’s intentions.
The Cycle of Cognition

The term knowledge-transformation in this figure brings me to the second perspective on meaning making. Bereiter and Scardamalia (1987) documented how children progress from telling everything they retrieve from long-term memory to a more sophisticated knowledge-transformation process. As part of planning, the writer learns to set goals for the text, both in terms of content and rhetoric. The writer struggles with problems of belief and knowledge in what they called the content problem space and with problems of expression and persuasion in the rhetorical problem space. In a phrase, the writer learns to struggle with what to say and how to say it rather than simply telling everything that enters his mind at the moment. As a direct consequence of this struggle, the writer's knowledge transforms and grows.

Knowledge transformation in writing illustrates a more general feature, what I call the cycle of cognition following the cycle of perception described by Ulric Neisser (1976). Figure 2 (see p. 26) illustrates the cycle. Schemata construct anticipations about the physical, social, cultural, and task environment. These anticipations direct exploration of the environment, at all of its levels, in an effort to sample information. The extracted information may then modify, accommodate, or transform the schemata to the situation. Perceiving and thinking proceed through a cycle of interaction among mental schemata, exploratory behavior, and the environment.

When a writer produces an externalized plan or translates a plan into a first draft, the words and other consensual symbols become part of the physical and task environment. The writer then explores this new environment and samples information that may modify the schemata that produced the symbols in the first place. Thus, the act of writing transforms knowledge, at least for the skilled writer. This feature of composing has been expressed by several well-known writers. John Updike noted that “Writing and rewriting are a constant search for what one is saying.” E. M. Forster asked, “How do I know what I think until I see what I say?” (Both novelists cited by Murray, 1978.) The composer Ellen Zwilich (1985; p. 30) summed up how the cycle of cognition proposed here applies to meaning making activities in her comments on musical composition: “Inspiration engenders product, which in turn, engenders more inspiration. . . . All the written arts work this way. . . .”

Greeno (1989), among many others, has described the manner in which cognition is situated in the context of an environment defined by task demands and physical, social, and cultural parameters. The social and cultural contexts that embed written discourse are especially formative (Nystrand, 1982; 1986; Rubin, 1988). All the products of thinking and writing—ideas, mental plans, notes, diagrams, outlines, early drafts, and
polished texts—are shaped only partly and crudely by the writing assignment, time constraints, secretarial and research assistance, and other elements of the task environment. Considerations of the audience in particular constrain on what may be said, what must be said, and how to go about saying it well. Social cognition is integral to the creation of meaning in texts, as Rubin, Piche, Michlin and Johnson (1984) explained in the following words:

Competent writers engage in social cognition, representing to themselves their audiences’ interests, values, prior knowledge, and experimental associations, as well as reader’s linguistic skill, and ongoing information-processing operations. Writers apply the conclusions of their social inferences to anticipate the effectiveness of persuasive strategies, the adequacy of informational content and the appropriateness of syntax and the aptness of organization cues and patterns (p. 297).

Through the cycle of cognition, schemata model the anticipated reader’s attitudes, beliefs, and knowledge of the topic and language. Schemata representing the writer’s rhetorical knowledge direct the exploration of the social environment and in turn are modified by the sampled information. Depending on how well a writer knows a particular audience and on how extensively she explores the environment, the rhetorical schemata may be simply fine tuned to meet the problems at hand or radically restructured. Some task environments call for collaboration with other writers, adding yet another social element to the process. Each collaborator’s mental representations offers another source of social information that may be explored by all others. Rubin (1988) notes that even the sole author has typically discussed a piece with others, received feedback from peer review, and benefited from the oversight of a succession of editors on the way to publication.

The cycle of cognition provides a second perspective on how people go about the work of creating meaning. But it in no sense competes with the perspective afforded by the componential view of thinking and writing. Both perspectives are necessary and neither is sufficient. Furthermore, the social and cultural dimensions of the writer’s environment play an absolutely central role in the products and process of meaning making, and I do not pretend to have done them full justice here in my brief remarks. But they cannot be viewed as the entire context in which the writer operates. The task environment, which I mentioned only in passing, and the physical environment, which I must forego altogether in this essay, complete the picture. In light of these points, it is counterproductive to maintain that cognitive and social theories of writing stand in opposition.
Constructive Narrator

The third perspective addresses how meaning is constructed in the stream of human consciousness. I begin with the claim that all conscious activity—recollection, perception, and imagination—entails the active construction of personal symbols. In psychology the constructivist approach to perception has long been controversial despite the general acceptance that recollection and imagination plainly invoke constructive mental operations (Neisser, 1976). With respect to the perception, comprehension, and recall of texts in particular, the reader is viewed as actively constructing meaning in the realm of mental representations or personal symbols (Spriro, 1980). The writer, too, constructs meaning both in personal symbols of the mind and in consensual symbols of written text. The writer actively selects relevant information from external sources of knowledge, connects the information with knowledge stored internally, and organizes the content into meaningful patterns (Spivey, 1990).

The construction of personal symbols in consciousness is governed by a narrative structure or schema. Sarbin (1986) refers to this basic notion as the narratory principle of psychology. We tell ourselves stories, moment by moment, about the events perceived, recalled, and imagined in our lives. The narrator of consciousness selects and organizes the events that are significant to the individual (Bruner, 1990; Leondar, 1977).

The first function of the narrator is to impose a sequential ordering of events in time. At any given moment parallel, simultaneous events occur in both the outer world of the environment and the inner world of the mind. In order to render this experience meaningful, the narrator forces a serial order on the events selected for conscious apprehension. Though complex plots may emerge in conscious content, with juxtapositions of imagined, recalled, and presently perceived events, a sequence unfolds nonetheless. The sequential nature of conscious content emerges early in cognitive development. Nelsol (1986), for example, concluded that young children appear predisposed to handle sequential information.

The evidence that two events never occur simultaneously in consciousness is compelling (Baars, 1988). Certainly parallel mechanisms can process multiple simultaneous sources of information and stimulation; but they do so automatically and unconsciously. Rapid attentional switching or time sharing enables a person to recognize and consciously process two channels of information presented aurally, visually, or in both auditory and visual modalities (Kahneman, 1973). Without time sharing, one of the channels registers in sensory memory levels and receives only unconscious automatic processing.

Two simultaneous sensory events are either merged as a single event, perceived sequentially, or selectively perceived by ignoring one of
them (Blumenthal, 1977). It appears that the psychological moment lasts roughly 100 milliseconds. Multiple events occurring within this integration interval of conscious attention must be fused into a single-compound event, delayed into a sequence of first one and then another event, or masked with one event blocking the conscious registration of another.

The second function of the narrator is to discover or establish causal relations among the events that comprise the sequential stream of consciousness. The narrator seeks to establish causal connections as a way of rendering experience meaningful. The narrator seeks to explain why events unfold as they do, providing a causal glue for holding perceptions, memories, and fantasies about the future together. The causes may or may not be veridical in the sense of bearing up to external scrutiny. What is important is that the narrator provides the individual with a story that makes sense. In the absence of a properly functioning narrator, perceptual, memorial, and imaginal events would seem random and experience meaningless.

Conceivably, the anomic of existentialist philosophers, and, more tragically, of those suffering from clinical depression, may stem from the failure of the narrator to construct a sensible story from the events of life experience. Clinical psychologists have analyzed the importance of the stories that individuals tell themselves about their experiences (Howard, 1991) and the idiosyncratic causal links that they establish (Beck, 1991). The studies of social psychologists, too, have documented the richness and complexity of a person assigning causal credit and blame for life events (Myers, 1987). Attribution theory deals in essence with the functioning of the narrator in the realm of social relations. Finally, developmental psychologists have suggested that narratives are central to the moral life and growth of children (Bettleheim, 1976; Vitz, 1991).

The work of the narrator in imposing sequence and a network of causal relations often results in a linguistic running commentary on experience. Jaynes (1976) characterized this commentary well in the following:

Seated where I am, I am writing a book and this fact is imbedded more or less in the center of the story of my life, time being spatialized into a journey of my days and years. New situations are selectively perceived as part of this ongoing story, perceptions that do not fit into it being unnoticed or at least not remembered. More important, situations are chosen which are congruent to this ongoing story, until the picture I have of myself in my life story determines how I am to act and choose in novel situations as they arise. (pp. 63-64)
Jaynes (1976) suggested that we see ourselves as the central character in the stories of our lives and build a coherent account of the causes of perceived events and reasons for our behavior. While agreeing with Jaynes' view of narratization, I have serious reservations about limiting narration to linguistic commentary alone as well as some of Jaynes' other proposals. The personal symbols of conscious experience certainly are often linguistic in nature, particularly in reflective thought when the mind comments to itself about various internal or external phenomena. But conscious contents include perceptual, memorial, and imaginal experiences that are coded in visual, auditory, tactile and other nonlinguistic personal symbols. These sequences of symbols can tell a story, in the same way that a silent film can convey a plot without language. To take a simple example, we can see causal relations between moving visual elements as one launches, drags, or deflects another (Michotte, 1963). Even reflective thought can proceed in a highly visual, nonlinguistic manner (Arnheim, 1986; John-Steiner, 1985).

Process and Performance

I turn now to some functional relationships that are central to the psychology of writing and meaning-making. My theoretical framework addresses the relations among key characteristics of the writer and the shape that the writing process takes, on the one hand, and the performance level that writing skill attains, on the other. Conceptual knowledge, method, and personality variables comprise the key characteristics or resources of the writer. Theoretically, these variables influence both how writers compose and how well they compose.

The Writer's Resources

Conceptual knowledge includes both content and discourse knowledge as shown in Figure 3 (Alexander, Schallert, & Hare, 1991) (see p. 27). In a nutshell content knowledge refers to what the writer knows about a given topic whereas discourse knowledge refers to what the writer knows about language. Word or lexical knowledge represents a mixture of these in that concepts and words map onto each other. Much of what a writer knows about a topic is specific to a domain, whereas word knowledge and rhetorical knowledge are general and applicable to many topics or domains of expertise.

Method includes the strategies, tools, work environment, schedules, and rituals employed by writers in the act of using their knowledge. The role of strategies in problem solving, reasoning, decision making, and memory is well-established, and strategies are certainly important in writing as well. But the writing task uniquely highlights attention on the four other aspects of method, and we know relatively little about them. I
will present some data on tools in my discussion of writing with a word processor.

Personality includes individual differences in componential intelligence (Sternberg, 1985), motivation (Amabile, 1982; McClelland, 1961), cognitive style (Baron, 1985; Jensen & DiTiberio, 1989; Sternberg, 1988), and anxiety (Nickerson, 1988-89; Rose, 1985). These four dimensions of personality have been studied in several thinking tasks, including, to a limited extent, the writing task. Theoretically, they influence both how writers compose and how well they compose. Here I illustrate the theoretical approach advocated with studies from my laboratory on selected aspects of knowledge and method. This limitation should not be construed to mean that personality and other factors overlooked here are less important.

**Process and Performance**

I distinguish between structuring and restructuring the process from amplifying the performance of writing. The process of writing—how one composes—assumes virtually an unlimited number of shapes depending on the writer’s knowledge, method, and personality. How well one composes refers to the quality of text produced, the fluency of language generation, and productivity in completing documents. These performance measures also depend on knowledge, method, and personality, but in a much more circumscribed way.

In contrast to my expectations about process, I assume that only variables that directly influence the use of knowledge have any effect on writing performance. Knowledge usage entails that relevant knowledge be available, that it be retrieved when it is needed during composition, and that it be inventively applied to the content and rhetorical problems posed by the writing task.

Having knowledge available is necessary but not sufficient for skilled performance. I presume that well-understood principles of episodic memory can be extended to the retrieval and application of all forms of relevant knowledge in writing tasks. These are concentration, organization, and encoding specificity. Concentration refers to focusing attention on one or two writing operations rather than attempting to juggle several multiple operations. Focused attention supports better retrieval than divided attention. Organization also supports retrieval, as documented in many studies. Finally, the principle of encoding specificity shows that knowledge retrieval operates best when the cues originally used to store the knowledge are reinstated.

To summarize, I assume that knowledge, method, and personality all shape the process of composing. Some aspects of these affect performance in that they mediate the availability, accessibility, and application
of knowledge. The retrieval and application of available knowledge presumably occurs in writing tasks in ways consistent with what we have learned from the memory laboratory. Not all method and personality variables have an impact on how well available knowledge is retrieved and applied. Further, even the variables that can affect knowledge usage may have only a limited impact on performance without the writer being motivated to devote maximal effort to using knowledge in the task at hand.

Thus, I assume that process effects and performance effects may or may not be linked, depending on whether a variable effectively influences knowledge usage. Evidence on this point follows in the next section. Its significance lies in that much of the research on writing done over the past decade has focused exclusively on the process of writing while paying insufficient attention to the variables that actually impact writing skill.

Process structuring can be quantitative or qualitative. I will present data showing how the pattern of allocating attention to writing operations varies across time depending on the strategy or tool used by the writer. This illustrates quantitative structuring. The qualitative nature of the planning or reviewing process might also change depending on whether the writer composes in longhand or on a word processor.

Amplification refers to gains in skilled performance, measured for example by judgments of document quality or by a text analysis measure. I will present data showing how performance amplifies depending on the degree of knowledge available to the writer or on the prewriting strategy employed to retrieve and apply available knowledge. Amplification represents one type of performance change. I assume that writers often "satisfice" or economize effort rather than amplify performance. Writing normally demands exceptionally high levels of effort. Relative automation means that writers economize effort as much as possible by settling for a satisfactory level of performance and devoting less than maximal processing time and cognitive effort. In the absence of adequate intrinsic or extrinsic motivation, writers "satisfice" performance and economize effort.

The high degree of effort demanded by composing can be seen in Figure 4 (see p. 28). Here I have plotted a standard measure of cognitive effort, interference in secondary task RT, for several primary tasks. Specifically, the time it takes in milliseconds to detect a randomly occurring auditory signal increases when an individual engages attention in a primary task. The magnitude of this increase reflects the momentary cognitive effort demanded by the primary task (Kahneman, 1973). The writing and learning data come from my laboratory and the reading and chess playing data come from studies by Bruce Britton and his colleagues (see Kellogg, 1986 for details). The writing operations of planning ideas,
translating ideas into text, and reviewing ideas and text consume markedly more cognitive effort than operations invoked by incidental learning, intentional learning, reading syntactically simple text, or reading complex text. The engagement of novices and experts evaluating moves in the middle stages of a chess game is substantial. But remarkably the levels of effort measured in fairly simple laboratory writing tasks with undergraduates are matched only by those seen among expert chess players engrossed in move selection. Given the high effort demands of writing, I assume that writers generally seek to economize effort when possible.

Figure 5 (see p. 29) illustrates the ideas of amplification versus automatization. Panel A shows the relative automatization that may occur with increases in available knowledge. The quality of text produced increases to a degree as knowledge increases, but reaches an asymptotic level of mediocrity. The effort expended also decreases as the writer automatizes, relatively speaking, the collecting, planning, translating, and reviewing operations. Full automaticity in writing theoretically never occurs because of the demanding nature of the making of meaning. Panel B shows amplification. Effort expenditure remains uniformly high as knowledge increases. The writer, therefore, uses all available knowledge in an effective manner and achieves increasingly higher skill and document quality.

Looking forward to the next section, I shall first present data that illustrate amplification and automatization of performance with increases in available knowledge. These changes take place without affecting the quantitative structure of the writing process. Second, I will describe experiments on prewriting strategies that affect both the process and performance of writing. Finally, I will compare composing on a word processor with writing longhand and show that the tool affects the process but not the performance of composing. I aim then to illustrate the functional relations that I have described here and to drive home the point that process and performance need not be linked.

Amplification and Automatization

The experiments I will present follow a common methodology. College students compose essays, letters, and other relatively short documents—typically about 400 to 700 words—in a single laboratory session. The documents concern a variety of topics, but generally require analytic and informative writing. I manipulate how much knowledge they have available by assigning participants to conditions on the basis of test scores, by selecting topics that are more or less familiar to college students, or by providing groups with varying amounts of knowledge relevant to the writing topic. I manipulate the strategies they use through
instructions and the tools they use by giving some a pen and others a word processor. The participants first receive appropriate training in strategy and tool use in several experiments.

In most of the studies I track the writing process by measuring the processing time and cognitive effort devoted to planning, translating, and reviewing. I ignore collecting because the participants write from memory without source materials. First, I train the students to identify their thoughts as examples of planning, translating, reviewing, or other, extraneous processes. They find this classification easy to do, and a validity study I conducted early on in my work suggests the procedure yields useful classifications (Kellogg, 1987). On hearing a computer generated tone while writing, they say "Stop" into a microphone as quickly as possible and their reaction time is recorded. Then they retrospect about whether their thoughts at the moment they heard the tone reflected planning, translating, reviewing, or other and record their answer with a button push. The percentage of times that they report a writing operation provides an estimate of the processing time given. The increase in RT to detecting the tone while writing compared to baseline RTs obtained when not writing provides a measure of the cognitive effort given to the reported operation.

The chief performance measure is document quality. I assess this by asking two trained judges to rate the document on a scale from poor to excellent. They usually rate the documents in terms of content quality, which reflects idea development, organization, and effectiveness of communication. They also rate style quality, which reflects primarily spelling, word choice, punctuation, grammar, tone, and other indicators of skill in language usage. I separate these two to provide a more sensitive measure to certain variables than holistic quality, though in some studies I simply add the ratings to gauge holistic quality. The two judges reliably agree, though agreement never is perfect because of the complexities of the judgment process and because of the value-laden nature of the term "quality" (Huot, 1990; Freedman & Calfee, 1983). In some studies I also analyze the text directly to measure the use of coherence ties between adjacent clauses. Following Haliday & Hasen's (1976) model, a text achieves cohesiveness—a strong indicator of quality—when writers employ many coherence ties among clauses. These include referential ties, such as pronominal anaphora, lexical ties, such paraphrasing, and inferential ties that link sentences on the basis of real-world knowledge.

Amplification through Availability and Access

The first study documents that the quality of expository essays increases with gains in verbal knowledge as measured from the English
subtest of the ACT. Also, it shows that quality may be further amplified by using a prewriting strategy of outlining.

Plotted in Figure 6 (see p. 30) are mean overall quality judgments for students who scored above the 70th percentile on the ACT English subtest and those who scored below it (Kellogg, 1989). I have consistently found that verbal knowledge affects style quality more dramatically than content quality, whereas the reverse pattern holds for knowledge about the writing topic. To allow comparisons of results across manipulations of verbal and topic knowledge, I sum the style and content ratings to yield overall quality. The large and significant difference favoring high verbal writers over low verbal writers fits my expectation that the availability of knowledge determines in part how well a writer composes.

The outline condition spent time before composition in generating a written hierarchical plan for their document. The cluster condition generated an unorganized network of ideas during their prewriting time. The control condition began to compose without the benefit of prewriting time. For reasons that I will clarify later, I predicted that outlining, but not clustering, would help the writer to retrieve and apply knowledge, and the results support this. Thus, this study documents that performance may be amplified by increasing available knowledge or by increasing access and application of knowledge.

You will recall that amplification of performance entails both an increase in quality but also a uniformly high level of investment in cognitive effort. The next study included four levels of verbal knowledge (n = 14-16). My assistants tested the students individually, allowing the measurement of cognitive effort to writing operations. Both expository and narrative writing tasks were studied and the results I present here are collapsed over both types. Figure 7 (see p. 31) contains the outcome for overall quality and for cognitive effort, indexed in terms of the interference found in RT while writing relative to baseline RT (Kellogg, 1992). The relation between available verbal knowledge and performance as measured by text quality is strongly and reliably linear. Cognitive effort, in contrast, unreliably fluctuated slightly across these groups. These data clearly document both aspects of the phenomenon I refer to as performance amplification.

**Relative Automatization**

The two studies examined thus far manipulated verbal knowledge, which primarily assesses word or lexical knowledge and syntactic knowledge. These aspects of discourse knowledge can be applied usefully when a writer composes on most any topic. Such knowledge tends to be domain free or generally useful. In contrast, knowledge of the topic tends to be specific to a particular domain or discipline. Knowing much about
ally any writing task. Knowing much about baseball does not help much when the topic shifts to something other than baseball.

One possibility is that automatization occurs more readily with domain-specific topic knowledge than with verbal knowledge. The results of two of my studies taken together could be interpreted in this manner. We have already seen the amplification pattern for when verbal knowledge was varied (Kellogg, 1990). I show in Figure 8 (see p. 32) the results of a study that varied domain-specific topic knowledge and measured the overall quality of persuasive essays, using subjective ratings, and cognitive effort, using secondary task reaction times (Kellogg, 1987; Experiment 1). The decrease in cognitive effort was statistically reliable, whereas the slight increase in text quality was not, a pattern consistent with relative automatization. The high-knowledge writers achieved a satisfactory level of performance while reducing dramatically the effort required.

The results suggest relative automatization rather than amplification. Quality, both on scales of content and style, showed only a slight and nonsignificant increase, whereas cognitive effort decreased reliably as topic knowledge increased from low to high. The high-knowledge writers settled for satisfactory performance and economized effort.

I questioned whether it would be possible to observe automatization in the case of verbal knowledge. The type of text composed may be a critical factor in the relationships observed. I suspected that in narrative writing tasks in particular a pattern of automatization could readily develop with growing expertise in topic knowledge and may even be observable with variation in verbal knowledge.

Bruner (1986) has distinguished between a narrative mode of thinking, such as that seen in writing a narrative text, and a paradigmatic or logico-deductive mode, such as that seen in writing a persuasive text. The principle of constructive narration suggests that the narrative task ought to be more compatible with the mode of thinking that people habitually use on daily basis. Kellogg, Krueger, and Blair (1991) found that students compose narratives more fluently, more coherently, and with less cognitive effort relative to persuasive texts. The fact that we found that the effort expenditure was less for narratives compared to both persuasive and descriptive assignments is telling. This clearly implies that the narratives are comparatively less demanding rather than the persuasives being exceptionally challenging.

A recent study provides tentative evidence that automatization is observable with increases in verbal knowledge in the case of narrative writing (Kellogg, 1992). Shown in Figure 9 (see p. 33) are overall quality scores for students who differed in terms of the availability of verbal knowledge (based on ACT English scores). The students were tested in
knowledge (based on ACT English scores). The students were tested in small groups precluding the collection of cognitive effort reaction times, which must be measured laboriously for one participant at a time. The analysis revealed a plain difference between the narrative and persuasive tasks. The pattern for narrative writing follows that expected for automation whereas that for persuasive writing shows the linear relationship of amplification. I am presently attempting to replicate these findings and extend them by assessing cognitive effort. I anticipate that cognitive effort should decrease as verbal knowledge increases for the narrative writing task and remain uniformly high for the persuasive writing task, as indicated in Panels A and B of Figure 4 (see page 28).

The studies described thus far show clear changes in performance as the level of available knowledge increases. None of these studies showed a different structure in the pattern of allocating cognitive effort or processing time to planning, translating, or reviewing. To illustrate, consider the processing time results from Experiment 2 of the Memory & Cognition paper just discussed (see Figure 10, p. 34).

As the writer moved from the early phase of composing to the final phase, the time devoted to planning decreased and the time devoted to reviewing increased. Translating time remained uniform across all phases. The key point here is that this pattern held for both low- and high-knowledge writers. The knowledge variable failed to interact reliably with process or phase variables. Thus, knowledge represents a case that has no impact on the quantitative structuring of the writing process but has a major impact on writing performance. Now let us turn to a variable that both restructures the writing process and amplifies performance.

**Prewriting Strategies**

The prewriting strategy of outlining has been in and out of favor with composition instructors over the decades. I turned to it early in my research on writing because a clear psychological case could be framed that outlining should restructure the process of writing and amplify writing performance. Outlining before starting a first draft should allow the writer to spend less time planning during the earlier phases of drafting and concentrate more on translating ideas into text. Outlining should help the writer to retrieve and apply content knowledge for two reasons. The restructuring of processing time should alleviate the attentional overload of juggling too many processes at once. By concentrating on translation the writer should bring knowledge to bear on the task more effectively. Further, the hierarchical plan of an outline organizes the content knowledge that must be included in the text. Organization as well as concentration ought to improve access and application of relevant content knowledge.
My 1988 paper in the *Journal of Experimental Psychology: Learning, Memory, and Cognition* tested the view that outlining restructures processing time and that it improves document quality (Kellogg, 1988). I show in Figure 11 (see p. 35) processing time for students who outlined first and for those who began drafting without any prewriting time. Notice in the first phase of drafting, the outlining group devoted significantly less time to planning relative to the control group. The control writers juggled planning, translating, and reviewing across all three phases of composition whereas the outliners concentrated on translating throughout composition.

The restructuring in this case allowed those who outlined to concentrate on fewer operations, and I expected this would improve their performance. Figure 12 (see p. 36) plots overall document quality, and you can see the significant amplification of performance brought about with outlining. This effect is robust in that it occurs for both writers who attempt to polish their first draft and those who initially create a rough version. The generality of the outline effect is also supported by a survey of productivity in publishing technical documents among science, social science, and engineering faculty (Kellogg, 1986). Use of an outline during prewriting was associated with a higher level of productivity both for writers who habitually polish their first draft and for those who dash off a rough first draft.

As noted before, I suspected the concentration effect explained part of the performance improvement, with the remainder coming from the organizational aid provided by outlining. To tease these apart, I designed a study that varied the degree of organization provided by prewriting strategies. Based on an earlier experiment (Kellogg, 1990), I knew that in single-session, laboratory writing tasks the use of a clustering strategy during prewriting led to an essay judged no better in quality than one produced without the benefit of prewriting at all. Clustering involves the development of a network of ideas and relations. Each idea is circled; relations among ideas, which can be labeled explicitly, are shown by a line linking two circles. The clustering strategy has been advocated as a brain storming technique (Rico, 1983) and it may well be useful for writers in the very early stages of prewriting on a lengthy, complex assignment. But in the laboratory setting the writer must focus attention on not only generating ideas and relations but also on ordering those ideas into a coherent document plan. The clustering strategy fails to provide either a linear or a hierarchical organizational scheme.

I designed a study with a no prewriting control, a cluster, a list, and an outline condition; an expository writing assignment was used. Writers in the list condition generated a list of ideas in the order they planned to include them in the text; thus, it possessed linear organization. Writers
in the outline condition generated a plan that possessed both linear and hierarchical organization, presumably the most useful form for a writer trying to retrieve and apply what he or she knows about the content of a writing assignment.

Figure 13 (see p. 37) includes the overall quality means for each of the four conditions in the experiment. As expected from past work, the outline condition supported significantly better text quality than either the control or the cluster conditions. The key outcome here is that the list condition fell between the cluster and outline conditions. I interpret these results as supporting the notion that part of the benefit that stems from outlining lies in the superior organization it provides. Writers who listed ideas during prewriting presumably could focus attention on translating during composition much like those who first developed an outline. But only the outline writers had the extra organizational benefit of a hierarchical plan as well as the freedom to concentrate on translating ideas into sentences.

To summarize these studies on prewriting strategies, the findings consistently show that outlining amplifies performance and that it restructures the writing process. I interpret the amplification effect in terms of the prewriting strategy helping writers to retrieve and apply what they know about a topic to the rhetorical and content problems that challenge them. The means by which this occurs appears to be partly due to the memorial consequences of superior concentration, on the one hand, and superior organization, on the other.

Word Processors

I turn now in this final set of experiments to a comparison of writing tools. Naturally there is much interest in how word processors influence both the process and performance of writing relative to composing in longhand. Previous findings in the literature suggested that using a word processor restructures the process in a couple ways. First, writers focus more on local editing—fixing spelling, punctuation, grammar, and diction as they compose—when using a word processor relative to longhand (Card, Robert, & Keenan, 1984). At the same time, global editing of content and organization appear to be more difficult because of problems in scrolling and reading text on the small screens of most personal computers (Haas & Hayes, 1986). Second, writers alter the nature of their planning when using a word processor in that they are less likely to jot down notes, outlines, lists, networks, sketches, doodles, and other externalized plans (Bridwell-Bowles, Johnson, & Brehe, 1987). Thus, I anticipated that writing on a computer would probably qualitatively and quantitatively restructure the writing process.
But does use of a word processor improve the quality of the resulting document, leave it unchanged, or perhaps even hamper it? The existing literature suggests all these possibilities. The quality of the studies comprising this literature also varies widely, ranging from carefully controlled experiments to anecdotal reports from enthusiastic and discouraged users. From my own theoretical framework, the tool used by a writer to translate personal symbols into consensual symbols should have no bearing on how well writers use their knowledge. Hence, I predicted no difference between word processor and longhand in performance, despite the important differences expected in process.

I present in Figure 14 (see p. 38) the cognitive effort results of writers composing a persuasive essay on a word processor versus in longhand (Kellogg & Mueller, in press). Consistent with expectations and others' findings, the tool restructured the pattern of allocating cognitive effort. Writers devoted significantly greater cognitive effort to planning and reviewing relative to translating only when they used a word processor. The writers are more engaged in planning and reviewing on a word processor, possibly because they find planning harder with paper in front of them and because they are focused on local editing of mistakes.

One might wonder whether the restructuring of attention reflects merely inexperience with the use of word processors. All the participants had at least a fair amount of experience, but I designed Experiment 2 to separate those with extensive experience versus only moderate experience. I also included expository and narrative writing assignments. The results held up; both groups of users showed the restructuring effect of devoting more cognitive effort to planning and reviewing.

Processing time also revealed a quantitative restructuring effect in that the time spent reviewing remained relatively constant across phases of writing for those using a word processor. The typical pattern I have shown you earlier for longhand writers was an increase in reviewing time from the early to late phase of composing. This quantitative restructuring effect was actually most pronounced for the highly experienced users studied in Experiment 2 of Kellogg and Mueller (in press).

I looked also for evidence of qualitative restructuring and found that writers using the word processor reported attending significantly more to editing local mechanics compared to longhand writers. Once again, the highly experienced users reported this most convincingly. Use of the word processor decreased the likelihood that writers would jot down notes and the likelihood that they would draw plans of various sorts. The magnitude of this qualitative restructuring was equivalent for both levels of experience.

Turning now to document quality, those writing on a word processor performed slightly though nonsignificantly worse than those writing in longhand in Experiment 1. In the follow-up experiment, I found that
the slight decrement came solely from writers with only moderate experience on word processors. Certainly the degree of experience with a tool makes a difference. Writers for whom a word processor is as second nature as a pen in hand wrote reliably better than less experienced users of word processors. The key point, however, was that the high-experience and longhand groups of writers failed to differ. The word processor failed to amplify document quality, as one would expect from the position that knowledge-usage alone is what determines the quality of writing. Both the style and the content ratings supported this conclusion.

The point is not that the tools writers use never make a difference in terms of performance. It may well be that knowledge-based tools for writers will prove to be powerful amplifiers of writing performance. Such idea processors differ from word processors in that they attempt to make available to writers additional knowledge or they attempt to aid the writer in retrieving what they already know (Hartley, 1992; Kellogg, 1989). Outlining programs and automated editing systems are only two examples of such knowledge-based idea processors. The former illustrates what Hartley (1992) called a level 3 computer tool and the latter a level 2 tool; a word processor is a level 1 tool. Whereas the word processor aims to solve the typing problems involved in composition, higher level idea processors go after the collecting, planning, translating, and reviewing problems. Zellermeyer, Saloman, Globerson, and Givon (1991) reported that a level 3 computer-based system can indeed amplify performance, but additional work in this area must be undertaken to learn which specific tools are effective for whom and why.

Rather, the point of this section is that word processors illustrate a factor that restructures in several ways the process of writing but has no reliable impact on writing performance. Thus, it brings us full circle. In the experimentation section of this essay I began with studies on knowledge availability that strongly affected performance but not process. We then turned to studies on prewriting strategies and saw that outlines both restructured the process and improved writing performance. It did so by improving a writer's ability to use available knowledge. The word processing studies show that a tool can dramatically alter the qualitative nature of writing operations and restructure the pattern of allocating attention to these operations. Yet, because the restructuring effects have no link with improving access to what the writer knows (unlike the case with outlining), no corresponding gain in writing performance occurs.

Conclusion

The components of information processing and meaning making, the cycle of cognition, and the principle of narrative construction are necessary concepts in an adequate theory of human thinking. I doubt that
they are sufficient but hold no reservations in claiming that all three perspectives must find their way into accounts of written composition, a prototype of human thinking. Past accounts of written composition have at times attempted to pit one perspective against another instead of seeking integration. I view the present integration as a platform for building more detailed theoretical structures.

Similarly, the intense interest we have seen in the process of writing at times neglected the quality of the product and other measures of writing performance. Both process and performance must find their way into writing theory, and they must be explicitly linked. Here the principle of knowledge usage offers one possibility. Some empirical support can be marshalled for the idea that knowledge and method variables affect performance only when they affect the use of relevant knowledge in the task at hand. I view the knowledge-usage principle as a guide for understanding previous composition research and for designing future experiments and case studies.

University of Missouri—Rolla
Rolla, Missouri

Author's Note

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Figure 1. The cognitive components of information processing and meaning making.
Figure 2: The cycle of cognition (adapted from Neisser, 1976).
Figure 3. The structure of content and discourse knowledge (from Alexander, Schallert, & Hare, 1991).
Figure 4. Cognitive effort for writing and other cognitive operations as indexed by interference with secondary task reaction time (msec).
Figure 5. Automation (Panel A) and amplification (Panel B) with increases in available knowledge.
Figure 6. Overall quality ratings for low and high verbal writers as a function of prewriting strategy.
Figure 7. Overall quality ratings as a function of available verbal knowledge.
Figure 8. Overall quality ratings and cognitive effort measurements as a function of available topic knowledge.
Figure 9. Overall quality ratings for persuasive and narrative texts as a function of available verbal knowledge.

VERBAL KNOWLEDGE

COGNITIVE EFFORT

OVERALL QUALITY

Effort

Quality
Figure 10. Estimates of processing time devoted to planning, translating, and reviewing across each third of total writing time (Phase 1, 2, and 3).
Writers who first outlined versus those who did not.

Figure 21: Estimates of processing time across phases for process PR and phase (1, 2, 3).

PERCENT OF LETTER TIME

= OUTLINE

= NO OUTLINE
Figure 12. Overall quality ratings as a function of prewriting and first draft strategies.
Figure 12. Overall quality ratings as a function of prewriting strategies.
Figure 14. Cognitive effort measurements for planning, translating, and reviewing as a function of writing tool.
References


