Writing as a Knowledge-Constroituuing Process

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ABSTRACT

This chapter argues that current problem-solving models of writing fail to capture the role writing has in constituting thought. It sketches a model of language production as a knowledge-constituting process, in which content can be generated by constraint satisfaction within a distributed semantic memory, and in which sequences of ideas can be produced by inhibitory feedback from preceding output. The model is then used to clarify the distinctions between different forms of text production in writing, the relation between writing and discovery, and the interaction between explicit problem-solving processes and implicit knowledge-constituting processes during writing. It concludes by outlining the preliminary results of a study motivated by the model.

1 INTRODUCTION

If you were to ask a writing researcher and a well-known author to sum up the secret of writing in a single sentence, there’s a good chance that they would both say something to the effect that ‘writing is discovery’. For both, the point would be that writing involves finding out what to say in the course of writing, rather than being a matter of simply translating preconceived ideas into text. If you were to probe further, however, you would discover a peculiar paradox. Although cognitive models of writing often explicitly invoke expert testimony of this kind, when you look at what they each say in more detail, they appear to mean very different, if not completely opposite, things.

In the classic cognitive models of writing, discovery is attributed to active problem solving designed to satisfy rhetorical goals (Bereiter and Scardamalia, 1987; Flower and Hayes, 1980). The fundamental contrast between expert and novice writers, in this view, is that experts develop an elaborate set of goals for their text and generate ideas in order to satisfy these goals, whereas novices simply retrieve ideas prompted spontaneously by the topic and translate them directly into text. This difference pervades writing, applying to planning before and during writing (Flower and Hayes, 1980; Scardamalia, Bereiter, Burtis, and Tetroe, 1983) and to the evaluation and revision of text once it has been produced (Hayes, Flower, Schrivel, Stratman and Carey, 1987). As Flower and Hayes (1980, p. 28) put it: ‘At one end of the spectrum, writers are merely trying to express a network of ideas already formed and available in memory; at the other, writers are consciously attempting to probe for analogues and contradictions, to form new concepts, and perhaps even to restructure their knowledge of the subject.’

Bereiter and Scardamalia (1987) have summed up these differences between novices and experts as a contrast between a knowledge-telling and a knowledge-transforming model of writing. Knowledge telling is essentially a ‘think-say’ method of composition, in which ideas are retrieved directly from memory in response to topic and discourse cues, and are then translated directly into text. In consequence, the succession of ideas in the text is a direct reflection of the links
between ideas stored in memory. By contrast, in their model of knowledge transforming, the retrieval of ideas for translation is mediated by active problem solving, or ‘reflection’ as they call it. This involves a two-way interaction between a ‘content space’ - where content is worked out, and a ‘rhetorical space’ - where goals for the text are worked out. In consequence, writing is not just a matter of translating pre-existing content, but also involves working out new content when existing content does not satisfy goals, and hence to developments in the writer’s understanding of the topic. Furthermore, because content generation is guided by goals for the text, the text itself is not a direct reflection of existing content, but is structured so that the ideas it contains fit together in the service of the text as a whole. The overall result is both a deeper understanding of the topic on the part of the writer and a more rhetorically effective text.

These models appear, therefore, to explain why, to quote Scardamalia and Bereiter (1987, p. 143), ‘Discussions by expert writers are replete with testimonials to the effect that their understanding of what they are trying to say grows and changes in the course of writing’. Consider, however, the quotes from well-known writers shown in Table 1 (these are taken from a larger collection in Murray, 1978).

**Table 1** Descriptions of writing as discovery by expert writers (selected from Murray, 1978, pp. 101-102).

<table>
<thead>
<tr>
<th>Writer</th>
<th>Quote</th>
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<tbody>
<tr>
<td>W. H. Auden</td>
<td>Language is the mother, not the handmaiden, of thought; words will tell you things you never thought or felt before.</td>
</tr>
<tr>
<td>Robert Bolt</td>
<td>Writing a play is thinking, not thinking about thinking.</td>
</tr>
<tr>
<td>E. M. Forster</td>
<td>How do I know what I think until I see what I say?</td>
</tr>
<tr>
<td>Joanne Greenberg</td>
<td>Your writing is trying to tell you something. Just lend an ear.</td>
</tr>
<tr>
<td>Shirley Hazzard</td>
<td>I think that one is constantly startled by things that appear before you on the page when you’re writing.</td>
</tr>
<tr>
<td>Wright Morris</td>
<td>The language leads, and we continue to follow where it leads.</td>
</tr>
</tbody>
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The distinctive feature of these quotes is that they make no reference to the ‘thinking behind the text’; indeed, the quote from Robert Bolt could be taken as actively denying the importance of such thinking. Instead, they emphasise the role of writing (or, more generally, language) in constituting thought. For these writers, ‘writing is discovery’ means that what one thinks emerges in the text as it is produced, rather than being something which lies behind the text directing its production.

A similar assumption underlies the dual drafting strategies proposed by, among others, Wason (1980) and Elbow (1973). In these strategies, the writer is encouraged, not to plan their text before writing, but instead to articulate their thought spontaneously in text without worrying how well expressed or well organised the text is. Once the initial draft has been produced more explicit problem-solving operations are applied in order to turn the ‘exteriorised mass’, as Wason (1980) calls it, into a well-formed text. The crucial point here, for Elbow in particular, is that, although explicit problem solving plays a vital role in shaping the text into a rhetorically appropriate final form, it is the initial spontaneous draft which is responsible for the discovery of new ideas.
The conflict between the theoretical models and experiential accounts is not so much over whether text production does lead to the development of understanding, but rather over the mechanisms responsible for it. Thus, one of the main points which Kaufer, Hayes and Flower (1986) stress in their pioneering study of written sentence production is precisely that the production of text itself involves a considerable expansion of initial plans. Although this expansion is, in large part, due to further planning in the course of text production, it is also in part a consequence of the fact that ‘Writing sentences can lead to more than just a change in the writing plan. It can also provide the occasion for writers to change their understanding of the topic’ (Kaufer et al., 1986, p. 124). They then quote the following example of such an occasion (see Table 2 below):

Although there is less emphasis on this feature of writing in Kaufer et al.’s account than in the experts’ accounts - it is something which can happen, rather than

Table 2     Example of protocol segment cited by Kaufer et al. (1986, p. 124).

...The biggest mistake that beginning writers make is that they try to write as - let’s see - write the first thing that comes into their mind - write as soon as anything comes to their mind - try to write ... that they try to write ... write down whatever comes - but it’s not that they write down whatever comes into their minds - some of them do that - yeah - like un - but some of them are afraid to write anything down ...Okay so they write a sentence at a time ... The biggest mistake that beginning writers make is that they try to write without looking ahead - yeah I guess that’s better ... they try to write without looking ahead - they only - they only think one sentence at a time and don’t see where the next sentence is going to lead them ...

writing’s defining feature - they do clearly recognise this as one of the properties of writing. The conflict is not so much over the existence of this phenomenon, then, but over the mechanisms responsible for it. In the experts’ accounts, and in the dual drafting strategies, text production has an unbidden quality, in which a line of thought is followed as it unfolds in the emerging text. By contrast, Flower and Hayes (1984, p. 154, italics in the original) imply that discovery during sentence production is essentially a consequence of rhetorical problem solving writ small:

‘Abstract conceptual representations of knowledge are instantiated in prose not by a kind of automatic translation, but by an active rhetorical decision process ... Experienced writers often generate alternative instantiations all the way down the line - from their definition of the rhetorical problem, to framing, focus and word choice - and they test and compare these options. Children, on the other hand, have difficulty considering any material as optional (if you can think of it, it goes on paper).’

By itself, of course, there is no necessary contradiction here: the apparent differences could simply be a consequence of different levels of description. Furthermore, the scientific account would be superior in that it would be seen as revealing the hidden decision-making lying behind what seems like a spontaneous process. Ultimately, these are empirical questions. Is active rhetorical problem solving associated with the development of understanding? And is the same process responsible during both planning and translation?
In order to investigate these questions, I carried out an experiment (Galbraith, 1992; see also Galbraith, 1996) designed to explore the conditions under which writers develop their understanding of a topic. The experiment compared two types of writers, selected using Snyder’s self-monitoring scale (Snyder, 1986). High self-monitors are, in Snyder’s words, ‘particularly sensitive to the expression and self-presentation of relevant other in social situations and use these cues as guidelines for monitoring (that is regulating and controlling) their own verbal and non-verbal self-presentation’. I assumed that such writers would be more likely to direct their writing towards rhetorical goals. By contrast, low self-monitors’ ‘self-presentation and expressive behaviour . . . seems, in a functional sense, to be controlled from within by their affective states (they express it as they feel it) rather than moulded and tailored to fit the situation’. I assumed that such writers would be more likely to generate content as it came to mind. Each type of writer was asked either to write notes in preparation for an essay (planning) or to write an essay without pre-planning (text production). In addition, in order to measure the extent of discovery in the different conditions, the writers were asked, both before and, again, after writing, to list all the relevant ideas they could think of and to rate how much they felt they knew about the topic. This enabled me to measure the extent to which writers produced new ideas as a function of writing, and to test whether these new ideas were associated with changes in how much the writer felt they knew about the topic.

If discovery is a consequence of active rhetorical problem solving, then one would expect the high self-monitors (whose writing was assumed to be directed towards rhetorical goals) to produce more new ideas than the low self-monitors. Consistent with this assumption, I found that high self-monitors produced twice as many new ideas as low self-monitors when they made notes. However, contrary to the knowledge-transforming model’s claims, these new ideas were not associated with increases in how much the writer felt they knew about the topic. If anything, a greater amount of new ideas were associated with decreases in knowledge in this condition.

If the same process is responsible for the development of new ideas during both planning and text production, then one would expect high self-monitors to produce more new ideas than low self-monitors in the essay condition. Here, however, the results were precisely the opposite to the knowledge-transforming model’s predications: the low self-monitors produced twice as many new ideas as the high self-monitors, just as many, in fact, as the high self-monitors did when they wrote notes. Furthermore, in direct contrast to the new ideas produced by the high self-monitors’ notes, the new ideas produced by the low self-monitors’ essays were associated with increases in how much the writers felt they knew about the topic.

I concluded that there were two distinct processes involved in the production of new ideas during writing. One - rhetorical planning - did involve evaluating and modifying ideas to satisfy rhetorical goals, as claimed by problem-solving models, but was not associated with developments of the writer’s understanding. Instead, it involved the reorganisation of existing ideas. The other - which I called dispositional spelling out - involved spontaneously articulating thought, as it emerged during text production, and was associated with the development of the writer’s personal understanding of the topic. Furthermore, I suggested that this process - in which content generation was ‘controlled from within’ - corresponded more directly with the ‘unbidden quality’ present in the descriptions provided by
expert writers, and was compatible with the assumptions of dual drafting strategies. (See Galbraith, 1996, for evidence from a questionnaire study that low self-monitors are more likely to employ the kinds of dual drafting strategies described by Wason and Elbow, and that low self-monitors who employ such strategies tend to achieve better grades in undergraduate essays).

Although these results are suggestive, they don’t provide any direct evidence of the processes involved. At best, they suggest where we might look to find examples of ‘dispositional’ writing. Problem-solving models have one great advantage in this respect: they provide an explicit account of how, in principle, writing could lead to the development of new ideas. By contrast, the alternative account has some circumstantial evidence that discovery is instead a consequence of ‘dispositional’ writing, which is in some vague sense ‘controlled from within’ and involves ‘following where language leads’. What I want to do now, therefore, is sketch out a model of how translation could be the kind of knowledge-constituting process implied in expert writers’ accounts.

2 TRANSLATION AS A KNOWLEDGE-CONSTITUTING PROCESS

There are, I think, two reasons why problem-solving models have difficulty accounting for the constitutive nature of language production. First, they assume that knowledge is stored as independent ideas linked together in a variety of relationships, as in a traditional semantic network (Anderson, 1983; Collins and Loftus, 1975). This assumption leads naturally to talk of ‘retrieving’ and ‘searching’ for ideas. Second, they assume that knowledge is stored in a uniform way, and hence that the same searching and retrieval operations as are assumed to apply during problem solving are also applied during text production. In consequence, text production is treated as a process of ‘problem solving plus translation’ in which translation does not generate content.

The fundamental assumption of the knowledge-constituting model is that the second of these assumptions is false; the knowledge encoded in text production is stored and processed differently to the knowledge to which problem-solving operations are applied. Specifically, it claims that the knowledge encoded in sentences is represented, implicitly, within a distributed network of conceptual relationships, and that ideas are synthesised by constraint satisfaction within this network, rather than being directly retrieved. In addition, although it accepts that problem solving is carried out in the way described in Bereiter and Scardamalia’s knowledge-transforming model, and hence that it does involve retrieving and manipulating independent ideas, it stresses that the representations involved are explicit, fixed propositions which have themselves been derived during previous episodes of sentence production. The main consequence of this for the knowledge-transforming model is that, by itself, it cannot lead to the formation of novel propositions, but is restricted to retrieving and reorganising existing propositions. Novel propositions are formed by the sentence production process which operates on the more basic sub-propositional level of representation.

Figure 1 shows a diagram of the main components of the model which I will refer to as I explain the model.
2.1 Planning and problem solving

The higher level of fixed, propositional representations assumed by problem-solving models is represented by the box labelled ‘TOPIC AND TASK SPECS’ (used very broadly). This is assumed to include the writer’s representation of the rhetorical problem, and to be the space within which problem-solving processes are carried out on explicit propositions. It also provides the input to, and can evaluate the output of, the sentence production process.

2.2 Synthesising ideas

The writer’s disposition

The more basic level of representation involved in sentence production is represented by the network of units above the box representing explicit planning and problem-solving processes (TOPIC AND TASK SPECS in the figure).

The first fundamental assumption of the model is that this consists of a distributed semantic memory in which, unlike in a traditional semantic network, individual units do not correspond to separate ideas. Instead, units correspond to sub-conceptual features, and different ideas emerge as different global patterns of activation over the same set of sub-conceptual units (Hinton, McClelland and Rumelhart, 1986). Figure 2 gives a simple example. It shows the same set of units, with the pattern of activation for the concept ‘cat’ in (a), and the pattern of activation for the concept ‘dog’ in (b).
This is, of course, only a toy example; the equivalent set of units in semantic memory is enormously larger, and the patterns of activation over these units do not represent individual concepts but complex potential ‘messages’ (see Van Gelder, 1991, for a review of the concept of distributed representations, and Van Gelder, 1992, for a more formal account of the concept).

What particular message is formed at any given moment depends on two sets of constraints: the input constraints (represented by TOPIC AND TASK SPECS in Figure 1) and the mutual constraints between the units within the network. These constraints within the network consist of weighted connections between each individual unit and all the other units; they may be positive or negative in direction, and vary in strength. In consequence, when one unit is activated, it will pass on activation to other units: how much activation a unit passes on to any other given unit will depend on the strength of the connection it has with that unit, and the effect on the unit will depend on whether the connection is excitatory (positive) or inhibitory (negative). When units within such a network are activated by some input, activation is passed back and forth between the units within the network until eventually a stable state of activation is reached in which each unit has ‘found’ a state of activation which is compatible with all the conflicting inputs it receives from other units. (For examples of such constraint satisfaction networks, see Rumelhart, Smolensky, McClelland and Hinton, 1986, where they are used to model schemas, and Thagard, 1992, where they are used to model scientific theories).

Ideas, then, in this model, are not stored explicitly but rather emerge in context as transient stable states of the network as a whole. Furthermore, ‘novel’ ideas emerge, automatically, whenever the network responds to a novel set of input constraints. Notice, however, that although ideas vary as function of context, the connections between the units are fixed. Thus, the fixed knowledge of the network lies in the connections between units - its weights - and the variety of ideas it produces in different contexts are a consequence of how the same set of weights transforms different patterns of input activation. One way of characterising this fixed set of weights is as the network’s theory of a domain (Churchland, 1989). In the present context, and in order to avoid the connotations of a theory as explicit knowledge, I will refer to them as the writer’s disposition towards the topic. This disposition is fixed (until further learning in the domain takes place), and unique to each individual, but cannot be accessed directly. Instead, it is displayed, partially, in the particular idea produced in the context prevailing at a given moment. This corresponds then to the ‘message’ the writer has to convey at a particular moment.

The language module

This message provides the input to a linguistic network (A in the figure) which is responsible for turning the pattern of activation into linguistic propositions (B in
the figure). The units within the linguistic network correspond to the lexical and syntactic representations making up the writer’s linguistic knowledge. These are also assumed to be represented in a distributed fashion, with many connections between lexical and syntactic units and units within the knowledge network. This network of linguistic units takes the global pattern of activation across the dispositional units as its input and, through further constraint satisfaction, produces an explicit verbal proposition. This can be written down, but may simply be mentally represented.

Note that this is a considerable simplification of the processes involved. Most current models assume that there are at least two general levels of representation involved here: an abstract functional level of representation and a positional level in which the surface form of the utterance is represented (e.g. Garrett, 1980). Furthermore, there is considerable debate about the extent to which these levels interact with each other (see for example, Dell and O’Searghda, 1991; Levelt, 1992). For present purposes what matters is the basic distinction between a message level of representation and a linguistic level of representation.

Overall, then, these three sources of constraints, in combination, result in the output represented by the two boxes labelled B in Figure 1. Before concluding this section I want to stress two features of this process. First, although the utterance which is ultimately produced reflects the influence of all the units in the network, this utterance is only a partial, ‘best fit’ to what the writer has to say about the topic. Of all the content activated initially in response to the topic some has ‘lost out’ during conflict resolution within the writer’s disposition, and of all the content remaining as the ‘message’ to be formulated some has lost out in the competition to produce a single utterance. Second, although I have described this as if it were a sequential process of (i) activating content, (ii) resolving content into a message, and (iii) resolving a message into a single sentence, I suspect there is considerable overlap between these processes. In particular, there may not be a clearly identifiable stage at which there is a stable message, separate from its linguistic formulation.

2.3 Feedback from output

Once an initial utterance has been produced, it is added to the store of explicit propositions in episodic memory, and is therefore available for evaluation by explicit planning and problem-solving processes. And, just as in standard models of translation, one of the ways in which a further utterance can then be produced is by using the planning process to provide new input to sentence production. This new input may simply be the result of direct retrieval from episodic memory (as in knowledgetelling), or it may be the result of more extensive rhetorical planning (as in knowledgetransforming).

But, in addition, and this is the feature I will focus on here, the model provides a further source of input in the form of feedback from the utterance to the writer’s disposition (represented by C in the diagram). There are two important features of this feedback as it is conceived in the model.

First, feedback only occurs once activation has been passed from the disposition to the linguistic units. Until the message has been represented in this different form it is unable to represent itself to itself. According to the model, this is one of the main functions of language in thinking; it provides a means of representing content separate from the content itself. Furthermore, this enables the disposition, through feed-
back from the output, to influence itself. The feedback adds a new source of input to the network which will alter the pattern of activation produced by constraint satisfaction, and hence lead to the production of a different idea. The crucial feature of this is that it enables the network to produce different ideas on successive cycles (D, E and F in the figure) without requiring a change in the input from TOPIC AND TASK SPECS. It provides the machinery required to make thought self-moving, and enables a succession of ideas to be produced while the input from planning is held constant.

Second, these feedback connections are assumed to be inhibitory in form: they reduce the activation of units within the network which were associated with the previous output. (See Houghton (1994) for a proposal that such inhibitory mechanisms have a central role in sequential behaviour at all levels of information processing.)

This has two important consequences. First, it provides a way for the network to overcome the fact that any particular synthesis of content is only a partial representation of the network's response to its input. The particular utterance produced by a single cycle of constraint satisfaction only represents the units which came to dominate the network during constraint satisfaction. When inhibitory feedback is sent back from the linguistic units, it will reduce the activation of these units, and hence allow previously suppressed units to assume a more dominant role during the next cycle of constraint satisfaction. The next synthesis will, in effect, be guided by the remaining, previously suppressed, content. Assuming that this synthesis is itself only a partial reflection of the remaining content, then, it in turn will prompt a further cycle . . . and so on. The process will continue, therefore, until all the units activated by the input have been expressed, and then inhibited. Overall, then, the disposition’s response to its input will be constituted over a series of cycles, and will be represented by the set of interdependent utterances as a whole, rather than by one particular utterance.

The second consequence derives from the fact that two distinct kinds of constraint satisfaction are responsible for the overall synthesis of an idea. There is the constraint satisfaction within the disposition which is responsible for the formation of the message, and there is the constraint satisfaction within the linguistic network which is responsible for the articulation of the message in words. In principle, both of these will only produce partial representations of their respective inputs on a single cycle, hence we can distinguish two levels at which such cycles should occur.

The first, local set of cycles will be a consequence of the failure of an individual utterance to capture all the content present in the message. Feedback from this utterance would be expected therefore to reduce the activation of corresponding dispositional units by a relatively small amount, and hence essentially the same message would be reconstituted on the next cycle. As a result, the content synthesised on the next cycle will correspond to the remainder of the message. This will continue until the message has been output in a series of utterances.

But inhibitory feedback does not just enable a single message to be articulated as a sequence of sentences without external planning. As progressively more utterances are produced, so the corresponding units within the disposition will be progressively reduced in activation, until, eventually, the disposition will settle into a different stable state, and an alternative message will be produced. In other words, inhibitory feedback also enables a sequence of messages to be produced.
Overall, the output will be produced as a series of local cycles in which a stable message is articulated, embedded within a series of global cycles in which different messages are produced. Furthermore, because later messages consist of previously suppressed material, they may represent conflicting views on the topic. The sequence of ideas will, in effect, consist of reflective thought about the topic, produced in the text, without the need for an external evaluatory process.

3 IMPLICATIONS OF THE MODEL

The knowledge-constituting model replaces the single process problem-solving models with a dual process model. The problem-solving component involves explicit processing, and is assumed to operate in the ways described by the models of Hayes and Flower, and Bereiter and Scardamalia, with the major qualification that, because problem solving operates on ideas once they have been formed, it can only lead to the reorganisation of existing content, but cannot, by itself, lead to developments in understanding. The text production component involves implicit processing (constraint satisfaction and inhibitory feedback) and introduces an extra source of content generation which is capable of forming novel ideas, and hence is, in principle, capable of leading to developments of understanding.

In the knowledge-constituting model, then, content can be produced in two ways: it can be retrieved from episodic memory or it can be synthesised in the course of translation. The second source of content involves what I will call a dispositional dialectic in which content is produced as a consequence of a dialectic between the writer’s implicit disposition and the emerging text. This represents a fundamental change in perspective because it allows variation in writing strategies to be viewed not just as variations in problem-solving activity but also as variations in the extent to which the dispositional dialectic occurs.

In this section I want first to compare different forms of translation in terms of the extent to which they involve a dispositional dialectic. In particular I want to use the knowledge-constituting model to provide an explicit specification of the conditions under which the dispositional dialectic will be at a maximum. I will then discuss how this process relates to discovery and why it is necessary for effective writing, as implied by expert accounts and proponents of dual drafting strategies. Finally, I will consider what this implies for the role of problem solving in writing and for the relation between explicit problem-solving processes and implicit knowledge-constituting processes.

3.1 Conditions for the dispositional dialectic

Kaufer et al.’s (1986) model of written sentence production treats variations in translation as variations in the extent to which rhetorical problem solving is applied (Flower and Hayes, 1984). By contrast, the knowledge constituting model treats these variations as variations in the extent to which the dispositional dialectic occurs during translation. It enables us to analyse and compare different kinds of translation in terms of the relative length of the dispositional dialectic involved. One can distinguish two groups of factors which influence this.

The first group of factors relate to differences in writers’ knowledge, and are fixed so far as a specific episode of writing is concerned. The dispositional dialectic is essentially a consequence of the tension between the amount of potential content
within the writer’s disposition and the amount which can be expressed in a single utterance. In terms of the knowledge-constituting model, one can distinguish three different fixed factors which will affect this:

(i) The conceptual complexity of the writer’s disposition. This corresponds to the complexity of the connections between the units within the writer’s disposition - the structure of semantic memory. The more complex these interrelationships are, the more cycles will be required before all the units within the disposition have been deactivated, and the dispositional response to the topic has been articulated. For example, one would expect children to have a less complex set of relationships between the units within their disposition, and hence to be less capable of sustaining an extended dialectic than adults. Notice, incidentally, that this would explain the less reflective nature of children’s writing compared to adults in terms of differences in the form of their knowledge, rather than, necessarily, in terms of differences in their rhetorical problem-solving capacities (as suggested in Bereiter and Scardamalia’s knowledge-telling model).

(ii) The range of units activated within the writer’s disposition. In addition to depending on the complexity of the connections within the network, the length of the dialectic will also depend on how many units within the disposition are strongly activated by the input. The dialectic will be shorter when few units are activated than when many are. An example of this factor is differences in the complexity of the conceptual representations of different topics. A more complex concept - ‘terrorism’, say - would be expected to be represented by strong activation across a wider range of units than a simpler concept - ‘cats’, say. In consequence, one would expect the dispositional dialectic to last for longer when writing about more conceptually complex topics. One would also expect this to vary within individuals, with different topics varying in the range of units which are strongly activated.

(iii) Linguistic knowledge. The other side of the tension which drives the dialectic is the amount of potential content which can be expressed in a single utterance. One would expect that this would be affected by the writer’s linguistic skill. Specifically, one would expect writers with greater linguistic skill to have a more differentiated set of linguistic structure for expressing content. The consequences of this for the dialectic are, however, unclear. Such writers should be able to express more content in a single utterance (Kaufer et al., 1986), and hence one might expect a shorter dialectic. However, at the same time, they may express content more precisely, and this may impose more selectivity on the content which is expressed, leading to a longer dialectic.

The second group of factors relate to the writer’s strategy for translation. While the fixed factors I have just discussed determine the potential length of the dispositional dialectic, the actual length depends on the specific strategy the writer employs. One can distinguish three factors here, each corresponding to a different component of the knowledge-constituting model.

(i) Type of planning. This relates to the range of units which are activated within the writer’s disposition: the more such units which are strongly activated, the greater the conflict between units within the disposition, and hence the longer the dialectic required to articulate the disposition. In addition to the fixed differences in the writer’s knowledge of specific topics, this will also be affected by the writer’s strategic decisions about how to partition up the task. At one extreme, which I will call synthetic planning, the writer may try to articulate their
dispositional response to the topic as a whole, without pre-planning. In other words, they will allow the topic to activate the full range of units corresponding to it, and accordingly one would expect the dialectic to be of maximum length. At an intermediate level, the writer may engage in pre-planning, and use their existing knowledge in episodic memory to break the topic down into sub-topics. This form of outline planning would be expected to reduce the length of the dispositional dialectic, breaking it down into a series of cycles over a narrower range of units. Finally, at the opposite extreme to synthetic planning, the writer may simply retrieve individual ideas in episodic memory, and translate them directly into text, as in knowledge telling. This would be expected to reduce the dialectic to a minimum - the length of the dialectic would depend on the conceptual complexity of the dispositional representations corresponding to individual objects in episodic memory.

(ii) Form of output. This is analogous to the fixed linguistic knowledge variable I discussed earlier. The extent of the dialectic should depend on how content is expressed in language. There are a range of potential effects here, including possible effects of linguistic style. For present purposes, though, I will focus on the most extreme contrast: that between prose, in which each state of the disposition is articulated as an individual utterance, and notes, in which each state is labelled, typically in a nominal phrase. At the prose end of the continuum, one would expect the length of the dialectic to be longer, because the formulation of content in individual utterances should impose greater selectivity on the disposition, and hence leave more content to be expressed in later cycles. By contrast, when states of the disposition are labelled in note-form, one would expect the dialectic to be substantially reduced, even removed completely, because such notes would, in effect, label whole patterns of activation, so that on feedback all the units would be deactivated. At this extreme, then, movement from one idea to the next would depend on explicit planning and memory retrieval.

(iii) The writer’s goals. The final factor is the most straightforward. It is a defining feature of the dialectic that each successive utterance is a synthesis of the new state of the disposition as it responds to inhibitory feedback from the preceding utterance. For the dialectic to occur at all, therefore, writing must be directed towards dispositional goals, towards articulating the state of the disposition as it unfolds. By contrast, when writing is directed towards external rhetorical goals, the dispositional dialectic will be interrupted as each idea is evaluated and as new input constraints are formed to specify the utterance required to satisfy the writer’s goal. Overall, then, the knowledge-constituting model enables us to describe different kinds of translation in terms of the extent to which they involve the dispositional dialectic, and to specify that the conditions under which the dispositional dialectic will be at a maximum correspond to the synthetically planned, dispositionally-driven articulation of thought in continuous prose.

3.2 The necessity of discursively constituting thought

The first claim I want to make here is that it is this pure form of the dispositional dialectic - in which text production is synthetically planned and dispositionally driven - which experts are trying to capture when they described writing as a process of discovery and which corresponds to the initial draft of the dual drafting
strategies proposed by Wason and Elbow. Thus, the dispositional dialectic exemplifies E. M. Forster’s, ‘How can I know what I think until I see what I say’ in that ideas do not exist prior to their verbal expression. Furthermore, insofar as successive ideas in the dialectic are a consequence of feedback from the preceding utterance to the writer’s disposition, the process is precisely one in which, as Wright Morris says, ‘language leads and we continue to follow where it leads’.

In addition, the model clarifies the sense in which the dispositional dialectic is a necessary form of text production. In particular, it suggest two reasons why this is so.

The first reason stems from the implicit nature of the writer’s understanding. The writer’s conceptual knowledge is embodied in the connections between the units within their disposition, and cannot be directly accessed. Instead, in order to make their understanding explicit, the writer has to articulate their dispositional response to the topic. But, this is not necessarily something which can be captured in a single utterance, so in order to capture their understanding as a whole, the writer must continue to synthesise the disposition’s response as it unfolds. In order to grasp their implicit knowledge, therefore, the writer must constitute their thought, discursively, and unpredictably, over a series of cycles.

This is essentially a negative claim: it implies that the writer may fail to grasp their understanding of a topic if they fail to fully constitute their thought. In particular, it implies that evaluation with respect to rhetorical goals, if it is applied before the dispositional dialectic is complete, may lead to a decrease in the writer’s understanding of the topic. Although this is one of the rationales for dual drafting strategies - one should avoid evaluation of what one is writing and focus on getting what one thinks down on paper - by itself, this is a relatively weak claim which is compatible with writing strategies other than the dispositional dialectic. Knowledge telling, for example, in which content is retrieved from memory and translated into text, would comply with this constraint, so long as each piece of content was fully constituted before the next item of content was retrieved.

The second, stronger claim for the dispositional dialectic stems from the fact that it is the form of writing in which the widest range of units within the writer’s disposition are activated at the same time. This has two advantages over other forms of writing.

First, it means that the ideas in the text are produced in relation to one another; each successive idea is, because of inhibitory feedback, a consequence of the preceding idea. By contrast, when a narrower range of units are active simultaneously, and successive ideas are retrieved from memory, as in knowledge telling or outline planned writing, then the ideas are only related, externally, by their common relation to the topic. The knowledge-constituting model claims, then, that when ideas are produced in the course of the dispositional dialectic, they will have a greater ‘organic unity’ than ideas which are retrieved separately from memory. In consequence, not only will the writer have a better understanding of the relations between their ideas, but the reader will be better able to follow their reasoning. Of course, this is not to say that the dispositional dialectic will lead to perfect text on the first draft; indeed, given the potential of the dialectic to produce conflicting trains of thought, one might expect the initial draft to be disorganised and hard to follow. Rather, the claim is that such text will provide better raw material for revision and for subsequent drafts, and that, in consequence it will lead, ultimately, to more coherent text.
The second advantage arising from the simultaneous activation of a wider range of units is that it is precisely this which enables the writer to go beyond their existing ideas. It provides the potential for novel syntheses to be produced. By contrast, when a narrower range of units is activated at the same time then there is less potential for novel syntheses to be produced. At the extreme, in knowledge telling for example, where only the units corresponding to existing material in episodic memory are simultaneously active, then there will be little possibility of novel syntheses. In addition, because in the dispositional dialectic, ideas are produced in relation to the disposition as a whole, when new ideas are produced they will contribute to the writer’s overall understanding of the topic. By contrast, novel ideas produced within the briefer dialectics prompted by activation across a narrower range of units will make more local contributions to the development of the writer’s understanding.

The knowledge-constituting model claims then that the dispositional dialectic will lead to the production of more novel ideas than other forms of writing in which a narrower range of units is simultaneously active, and that these will make a relatively greater contribution to the development of the writer’s understanding. Note, however, that this is a relative difference: the absolute number of new ideas which will be produced will depend on how explicit the writer’s existing understanding of the topic is. One can imagine cases - where the writer has recently formulated their thoughts on the same topic, for example - in which, even though the text is produced dispositionally, as if for the first time, the writer will nevertheless end up reproducing a set of ideas which are similar to those already in episodic memory.

3.3 The role of explicit problem solving

The knowledge-constituting model claims that in order to capture and develop understanding the writer must articulate thought in a dispositional dialectic without pre-planning and without rhetorical evaluation. It favours, in other words, the kinds of dual drafting strategies described by Wason (1980) and Elbow (1973). This has two implications for the role of problem-solving processes in writing: (i) it shifts them to the revision stage of writing, and to the interface between successive drafts; (ii) it focuses attention on the interaction between problem-solving and thought as it is constituted externally in the text, rather than on the interaction between different mental spaces. Thus, although it assumes that the effectiveness of problem solving does depend, as Bereiter and Scardamalia’s knowledge-transforming model suggests, on the extent to which it is directed towards rhetorical goals, it also stresses the strategic nature of the processes involved in turning text into ideas for manipulation, and the processes involved in turning the results of problem-solving back into text.

In Elbow’s (1973) version of the dual-drafting strategy, the first step after the initial draft involves summing up the main ideas contained in the external text. It involves, in other words, turning discursively constituted thought into the kind of fixed, independent ideas required by explicit problem solving processes. Evaluating content with respect to rhetorical goals, therefore, is not just a matter of transferring material from content space for evaluation in rhetorical space. It involves a deliberate strategy for defining the ideas contained in the text, and for turning these into a form suitable for explicit manipulation in working memory.
Once the text has been converted into this form, then problem-solving processes can be applied to create a coherent global structure for the ideas, and this can be evaluated with respect to rhetorical goals. Notice, incidentally, that this is the same process as is presumably involved in creating an outline of the text during outline planning. The difference is that when it is applied during planning it is applied to existing ideas stored in episodic memory, whereas when it is applied during revision of a dispositionally produced draft it is applied to ideas corresponding to the writer’s understanding as it has been constituted in the text. In both cases, the result is a reorganisation of existing ideas. And, so far, I have been describing this as ‘only’ the reorganisation of ideas in order to stress that it does not lead to developments of the writer’s understanding. Here, I want to stress that it is nevertheless an important transformation of thought in its own right. It involves taking a disparate set of ideas and creating an integrated global structure of ideas, readily available in memory. My point is that this is different to the development of understanding during text production, not that it is a less important transformation.

Furthermore, when problem solving involves not only creating a global structure but also evaluating this structure with respect to rhetorical goals, it provides the preconditions for development of the writer’s understanding. Evaluating the global structure enables the writer to identify gaps within their understanding, and hence offers the potential - through filling these gaps - to develop one’s understanding. This much is common to both Bereiter and Scardamalia’s knowledge-transforming model and the knowledge-constituting model. The difference lies in how the gaps are filled. In the knowledge-transforming model, this involves a search through content space for relevant material. According to the knowledge-constituting model, however, although this may occur, it is not sufficient to develop the writer’s understanding, because it cannot lead to the formation of novel ideas, but can only lead to the retrieval of different, but pre-existing content. In order to lead to developments of understanding these cues have to be used to activate units within the writer’s disposition, and the writer’s understanding of how to fill the gap has to be discovered in the course of articulating thought in text. In other words, in this form of dual-drafting strategy (as it is interpreted in terms of the knowledge-constituting model), the content required to satisfy rhetorical goals is discovered by formulating text, rather than by searching through content space.

For the knowledge-constituting model, then, the two-way interaction (to use Bereiter and Scardamalia’s term) responsible for the transformation of thought in writing is between explicit problem-solving processes and implicit knowledge-constituting processes, rather than between two mental spaces, and involves two different kinds of transformation of thought rather than a single one. It predicts, therefore, that when each of these processes is carried out on their own, one will be able to distinguish between their different effects: a pure dispositional dialectic should be associated with the development of understanding but not of organisation; pure rhetorical planning (e.g. in note-form when text is not being constituted) should be associated with the development of organisation but not of understanding. But, in addition, it predicts that when the two processes are carried out in combination, because of the conflicting nature of the processes involved, there should be a trade off between the two processes, with one or the other being given more priority by different writers and in different conditions.
Armed with this more explicit model of the processes involved in ‘dispositional spelling out’ (Galbraith, 1992) and how they interact with explicit planning processes, I want to conclude with a brief illustration of how the model can be applied empirically, using some data from a recently completed experiment. I should caution you here that these data are still under analysis, and that I will only give a summary of selected aspects.

The knowledge-constituting model highlights two problems with the experiment summarised in the introduction to this chapter and described in detail elsewhere (Galbraith, 1992). First, this experiment did not include a measure of changes in subjective organisation so different kinds of transformation of thought could not be explicitly identified.

Second, it did not manipulate the kind of planning employed. In consequence, although the general pattern of results were compatible with the model’s predictions, it is not clear how directly the conditions specified by the model were satisfied in the experiment. Accordingly, in this more recent experiment I tried to test the predictions of the model more precisely by explicitly manipulating the type of planning employed, and by including a rating of how much writers experienced a change in the organisation of thought, as well as ratings of how much the writers felt they knew about the topic.

Specifically, low and high self-monitors (whose writing is assumed to be directed towards dispositional and rhetorical goals respectively) were asked to produce texts under three different planning conditions: (i) unplanned, in which writers were simply asked to write out their thoughts as they came to mind without worrying about how well organised the text was; (ii) synthetically planned, in which writers were given 5 minutes (after generating the initial list of ideas used as part of the measure of idea change, but before writing the text) in which to write down a single sentence summing up their response to the topic; (iii) outline planned, in which writers were again given five minutes to plan before writing, but were asked to construct an outline of the text to be written. In addition, in both the planning conditions, writers were asked to try to produce a well-organised text but not to worry about how well the text was expressed. The same measures were used as in the previous experiment.

The first important finding was that, as in the earlier experiment, there was a clear, highly significant difference in the number of new ideas produced by low and high self-monitors $[F(1,84)=8.05, p<.006]$. Furthermore, although there was no significant interaction, the difference was most pronounced within the synthetic planning condition. The mean number of new ideas produced in each condition (measured as a proportion of the number of ideas initially produced) are shown in Figure 3.

Consistent with the model’s claim that low self-monitor’s synthetically planned prose is the only condition where the dispositional dialectic is the sole process responsible for constituting ideas, there was a significant positive correlation between the number of new ideas produced and increased knowledge in this condition ($r=.62$, $n=15$, $p<.02$), but not in any of the other conditions.

In addition, I was also able to investigate when changes in organisation were experienced and how these were related to new ideas in the different conditions. These data produced some particularly interesting findings. First, summing across the different conditions, more high self-monitors (91%) than low self-monitors...
(71%) experienced a change of organisation ($c^2=7.91$, df=2, p<.05). This is consistent with the claim that writing directed towards rhetorical goals has greater effects on the organisation of thought than writing directed towards dispositional goals. Second, although I was unable to examine relations between new ideas and change in organisation for the high self-monitors because of the restricted range of the data, I was able to examine this within the low self-monitors. This showed that the new ideas produced in the outline planned condition (where one would expect planning to be most dominant) were associated with changes in organisation ($R=.67$, n =15, p<.05), but that the new ideas produced in either unplanned or synthetically planned writing (where one would expect there to be less explicit planning) were not.

The analysis within the low self-monitors, then, has supported the model’s claim that new ideas produced by the dispositional dialectic (assumed to be active in low self-monitors’ synthetically planned text) should be associated with increased knowledge (assumed to correspond to understanding in the model), but not with changes in organisation. It also supports the claim that new ideas produced by explicit planning (as in the low self-monitors’ outline planned texts) should be associated with changes in organisation, but not with increases in knowledge.

In fact, one would expect the situation to be more complex than this implies because new ideas are presumably a product of both kinds of process in the two conditions (albeit in different proportions). Furthermore, according to the model,
these processes should conflict with each other. In order to test this I examined the interrelationship between changes in knowledge, changes in organisation and the amount of new ideas produced. For reasons of space, I will just show you the results for the outline planning condition.

Figure 4 shows the relationship between changes in organisation and changes in knowledge in the low self-monitors’ outline planned condition. For illustrative purposes, I have plotted the mean change in knowledge at different levels of change in organisation, and have annotated the graph with the number of new ideas produced at the different levels of change in organisation. Note also, that changes in knowledge are represented on a 5-point scale, with unchanged knowledge corresponding to the mid-point (represented by the dotted line), and increases in knowledge represented by points above this mid-point, decreases in knowledge by points below this line. As you can see, there is a strong curvilinear relationship between changes in organisation and changes in knowledge (R=.69, n=15, p<.05).

The knowledge-constituting model explains this pattern of data in the following way.

First, it assumes that, when writing is outline-planned, the writer tries to construct a coherent, rhetorically appropriate global structure for the text using the ideas available in memory. Evaluation of these leads to the rejection of some ideas,

**Figure 4**  Graph to show relationship between changes in organisation and knowledge in the low self-monitors’ outline planned texts; annotated with the mean proportions of new ideas produced and the number of participants contributing to each point.
and prompts a search for other ideas to fill the ‘empty slots’ in the model for the text. This would be expected to take place largely during pre-planning but may also extend into text production.

The variations in the data can then be explained as a consequence of differences in the results of this search for further content. The first case occurs when the search for content in memory is successful: the writer slots the alternative ideas into the model, and then translates these into text. The result is the production of different ideas in the list produced after writing (0.51 ‘new’ ideas) and an increase in organisation of thought, because disparate ideas have been combined into a coherent global structure. However, there will not be any increases in knowledge, because the ‘new’ ideas are not novel propositions but rather different pre-existing ideas. This corresponds to the point on the right-hand side of the figure where organisation has increased, but where the mean knowledge rating is only just above the dotted line corresponding to unchanged knowledge (one of the eight writers did experience an increase in knowledge here).

The other two cases - represented by the points corresponding to unchanged organisation and decreased organisation - occur when the search for existing content is unsuccessful and the writer has to create new ideas. In the particular circumstances of this form of writing, the majority of the writers appear to be unable to do this (five out of the remaining seven writers), hence few new ideas are produced (0.11 new ideas). In consequence, although organisation remains the same, the writer’s subjective knowledge decreases: they are unable to create the content required to fill out the existing organisation - rhetorical planning has exposed their lack of a full understanding of the topic. This corresponds to the point in the centre of the figure where organisation remains the same.

Finally, there is a minority of writers (two) who are able to create new ideas (0.37) and hence experience an increase in knowledge. The interesting feature here is that, just as the dual process model predicts, the process of creating these new ideas appears to conflict with the maintenance of a coherent model for the text in memory, and so a decrease in organisation is experienced.

One intriguing possibility is that this difference between writers who were able to create new ideas and those who weren’t is a consequence of a difference in writing strategy. Specifically, the writers who succeeded may have constituted their ideas in the text, as advocated in the knowledge-constituting model’s analysis of dual-drafting strategies, whereas those who failed may have persisted in a fruitless search of ‘content space’. (There is a similar difference present in the other conditions which I haven’t discussed here, so it is not just an aberrant feature of the two subjects shown in this example. It is worth noting, also, that both Dansac and Alamargot, and Van den Bergh and Rijlaarsdam, in their contributions to this volume, report variations in writing strategy which are consistent with such a difference).

This is only a sample of work in progress, designed to illustrate how the model can be tested. Nevertheless, the results of the analysis so far do support the model’s predictions, and demonstrate the fruitfulness of distinguishing between different kinds of effects of writing on thought. Given that the conditions do produce the kinds of effects predicted by the model, I am currently planning a further study using verbal protocols, with the aim of obtaining more direct evidence about the nature of the processes involved.
5 CONCLUSION

Models are metaphors, and metaphors are tools for thought. They help us organise phenomena under a coherent set of explanatory principles, and enable us to predict new phenomena. But they never work perfectly, like all abstractions they fit some phenomena better than other. Indeed, one of their virtues is that, in highlighting what they can explain, they also define and clarify what they can’t explain. The problem-solving metaphor has been a useful way of thinking about the mental phenomena associated with writing. However, as I have argued in this chapter, and as others have argued in the past (e.g., Nystrand, 1989), it has difficulties accounting for the constitutive nature of writing.

My aim in this chapter, therefore, has been to try to formulate a model to capture the knowledge-constituting features of writing. Clearly, this is an abstract characterisation of the processes involved - more of a sketch than a model - which would need to be specified much more fully before it could be implemented as a working simulation, and before it could account for many basic features of text production. Nevertheless, even in this abstract form, I think it is a useful heuristic for thinking about knowledge-constituting processes in writing. It enables us to capture the varied ways in which ‘translation’ can be carried out; it clarifies the nature of discovery in writing; it provides a theoretical rational for different drafting strategies; and it helps guide the design of empirical research.

More generally, even if it turns out to be substantially wrong, it will serve a useful purpose if it stimulates the development of alternative models of how knowledge is constituted in writing. I imagine, for example, that one could develop an alternative, non-connectionist and more symbolic account of the processes involved. However, I think this would still involve the fundamental distinction between implicit knowledge-constituting processes and explicit problem-solving processes. In order to develop better theories of writing, we need to understand much more about how these two kinds of process interact within and across drafts during writing.

AUTHOR NOTE

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