

Effects of Writing on Conceptual Coherence

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Abstract

Current cognitive models of writing attribute the discovery of new ideas through writing to explicit problem-solving processes, and treat text production as a passive process of translating ideas into text. This paper describes an alternative, dual-process model of writing, in which text production is assumed to be an active knowledge-constituting process. A key prediction of the model is that dispositionally guided text production will lead to the development of more conceptually coherent new ideas than writing directed towards extrinsic goals. An experiment designed to test this prediction is then described. The results confirm that dispositionally produced new ideas are relatively more conceptually coherent than new ideas produced to satisfy rhetorical goals.

Keywords: writing; coherence; dual process; text production.

Introduction

Writers commonly describe writing as an act of discovery, stressing that writing involves finding out what to say in the course of writing, rather than being simply a matter of translating preconceived ideas into text. In cognitive models of writing, this is typically characterized as involving active problem solving to satisfy rhetorical goals. Bereiter and Scardamalia (1987), for example, contrast the “knowledge-transforming” approach used by expert writers, which involves developing an elaborate set of goals for their text, and generating ideas in order to satisfy these goals, with the “knowledge telling” approach used by novice writers, which simply involves retrieving ideas prompted spontaneously by the topic and translating them directly into text. As Flower and Hayes (1980) 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.”

Despite its central role in cognitive models of writing, there have been relatively few attempts to examine the conditions under which writing leads to the development of thought, and in particular to test the claim that the extent to

which this occurs depends on the extent to which writing incorporates deliberate rhetorical problem solving. Our own research has attempted to do this by examining individual differences in the conditions under which writers develop new ideas through writing (Galbraith, 1992, 1999).

This research has used Snyder’s self-monitoring scale (Snyder and Gangestad, 1986) to distinguish between writers whose writing is presumed to be more or less directed towards rhetorical or dispositional goals. This self-report questionnaire distinguishes between *high self-monitors*, who are assumed to monitor and control their expressive behavior in order to achieve social goals, and *low self-monitors*, who are assumed to express their thoughts directly as a reflection of their current internal state.

Galbraith (1992) used this scale as a means of selecting writers whose writing he assumed would be either directed towards rhetorical goals (high self-monitors) or dispositional goals (low self-monitors). These groups were then asked either to make notes in preparation for an essay (global planning) or to write the text itself (text production), and the extent to which they developed new ideas as a function of writing in these different conditions was measured. According to problem-solving models of writing, one would expect the high self-monitors to develop more novel ideas (through “knowledge-transforming” adaptation of thought to satisfy rhetorical goals) than the low self-monitors (whose writing would be assumed to simply involve “knowledge-telling”). This difference should be most pronounced in the notes conditions where writers can focus on planning without having to produce detailed text, but should be in the same direction when writers have to produce full text. In fact, although the high self-monitors did indeed produce more new ideas after writing notes than the low self-monitors did, just as a knowledge-transforming model would predict, in the text condition, the difference was completely reversed, with the low self-monitors producing twice as many new ideas as the high self-monitors, contrary both to the assumption that knowledge transformation depends on adaptation of content to rhetorical goals and to the assumption that low self-monitors’ writing is a simple matter of “knowledge telling”.

Furthermore, while the number of new ideas generated by low self-monitors' text production were positively correlated with subjective ratings of increased knowledge, as would be expected if they had a clarifying effect on thought, the new ideas generated by high self-monitors' planned notes were unrelated to subjective changes in knowledge, suggesting that they did not necessarily develop the writer's understanding of the topic. More recent research has replicated this advantage for low self-monitors' text production (Galbraith, 1999).

In the light of these results, Galbraith (1999) suggested that problem solving models of writing only partially capture the way in which writers develop new ideas during writing, and proposed a dual-process model of writing.

In this model, the first – knowledge transforming – process is assumed to be much as described by Bereiter and Scardamalia, and involves the manipulation of ideas in working memory in order to create a mental model of the text which satisfies rhetorical goals. By itself, however, this process does not create ideas. Instead, it either selects and organizes existing ideas retrieved from episodic memory or, when such content is not available in episodic memory, activates input to the second process. This account of the knowledge-transforming process explains the greater number of new ideas generated by high self-monitors after planned notes and the fact that these are not associated with increases in subjective knowledge: the application of rhetorical goals during planning leads to the selection of different ideas from episodic memory compared to when ideas are freely retrieved before planning. (See Galbraith, Ford, Walker and Ford (2005) for evidence that new ideas generated to satisfy rhetorical goals during outline planning are associated with improved text quality, and that this is reduced by secondary tasks loading on central executive and spatial components of working memory).

The account of the second – knowledge-constituting – process assumes that, over and above the explicit representation of previously formulated ideas in episodic memory, the writer's knowledge is also represented by implicit relationships within semantic memory. These relationships correspond to the fixed connections between sub-propositional units in a constraint satisfaction network, and constitute the writer's disposition towards the topic. Two implications follow from this assumption. First, the writer's ideas are not retrieved directly from memory, but are instead synthesized by constraint satisfaction within the network in the course of text production. Second, the writer's disposition is represented by the set of utterances as a whole rather than by any individual proposition. Thus, it is assumed that each individual synthesis of content produces only a partial, best fit to the writer's disposition, and that feedback from this output prompts further syntheses designed to reduce mismatches between individual syntheses and the writer's disposition. In order, therefore, to capture their implicit disposition towards the topic, the writer has to formulate ideas dispositionally, free from external constraints. The crucial claim for present purposes

is that, when novel content is formulated by this process, it will, because it is generated as a dispositional response to preceding ideas, be conceptually coherent with those ideas. This account of the knowledge-constituting process explains why low self-monitors generate more new ideas during text production than high self-monitors (low self-monitors' text production is dispositionally guided, whereas high self-monitors' text production is constrained by rhetorical goals), and why the new ideas they generate were associated with increases in subjective knowledge.

These two processes are assumed to be complementary in their effects, and both are required for effective writing. Thus, the knowledge-constituting process is responsible for synthesizing conceptually coherent ideas, but needs the knowledge transforming process in order to ensure that content is presented in a rhetorically appropriate form. Similarly, while the knowledge-transforming process can create a rhetorically appropriate global structure for the text, it needs the knowledge-constituting process to ensure that this is articulated in a conceptually coherent way. The difficulty for writers is that the two processes operate best under opposing conditions, and hence interfere with one another: the unpredictable output of the knowledge-constituting process disrupts explicit planning; the constraints imposed by global planning prevent the dispositional spelling out of thought.

According to this model of writing, the fundamental difference between low and high self-monitors stems from the relative priority they give to planning and text production processes. Low self-monitors, whose fundamental goal is to articulate their implicit disposition towards the topic, prioritize spontaneous text production, and accordingly employ a relatively bottom-up strategy for writing. Thus, when trying to produce a single draft of well-formed text, although they may make explicit plans before writing, these will impose relatively less control on text production, and will be readily modified to accommodate dispositionally generated new ideas. The global structure of the final text will, therefore, reflect relatively more of the writer's implicit disposition towards the topic. By contrast, high self-monitors, whose fundamental goal is to satisfy external communicative constraints, prioritize explicit planning, and accordingly employ a relatively top-down strategy. Thus, when producing a single draft of well-formed text, they focus first on developing a global plan designed to satisfy rhetorical goals, and then use this to control subsequent text production. The global structure of the final text will, therefore, reflect relatively less of the writer's implicit disposition towards the topic, and will be structured relatively more in terms of their readers' anticipated response.

This analysis predicts that: (i) When writing a rough draft free from external constraints, the knowledge-constituting process will predominate, and hence new ideas produced in the course of writing will be conceptually coherent. Furthermore, because low self-monitors prioritize this process, they will generate more new ideas than high self

monitors. (ii) When external constraints are imposed and global planning is applied, fewer new ideas will be produced by low self-monitors than when they write rough drafts, but because ideas are generated from the bottom-up these will still be conceptually coherent. By contrast, because high self-monitors prioritize the knowledge-transforming process they will generate more new ideas than when they write rough drafts, but because they generate their ideas from the top-down, the knowledge-constituting process will be reduced and these new ideas will not be conceptually coherent. To test these predictions we used a measure of conceptual coherence derived from constraint satisfaction models (harmony), and investigated the effect of low and high self-monitors writing either rough drafts or outline planned texts.

Method

Participants

96 undergraduate students at Staffordshire University, the majority of whom (76%) were women, volunteered to participate in the experiment in return for credits in the Psychology department's research participation scheme. Their average age was 21.5 years (s.d. 6.04).

Participants were pre-selected using Snyder's 18 item self-monitoring scale (Snyder and Gangestad, 1986). They were classified as *low self-monitors* (n = 48) if they scored between 0 and 8 on the scale, and as *high self-monitors* (n = 48) if they scored between 10 and 18 on the scale.

Design

Participants were randomly allocated to one of three groups in the design summarized in table 1. In the two experimental groups, they were asked to write an essay discussing whether "the use of violence to achieve political aims can ever be justified". They were reminded to consider arguments for and against the proposition, with a view to arriving at a conclusion about the issue. In the control group, they were asked to write about a different topic – "describe a recent social event that you have attended" - but instructions and procedure were otherwise identical, and all the dependent variables were about the same topic as for the experimental groups. This was designed to control for effects of generic features of writing (cognitive effort, mode of processing) on the dependent variables.

Table 1. Summary of experimental design.

	Writing condition		
	Control	Rough draft	Planned essay
Low SM			
High SM			

The two experimental groups were asked to write about the topic in two different ways. In the *rough draft* condition, participants were given 5 minutes to think about the topic

prior to writing, and asked to write down a single sentence summing up their view of the topic. They were then given half an hour to write the draft. This involved writing down their thoughts as they occurred to them, in continuous prose, but without worrying about how well organized or well-expressed their text was. In the *outline planned* condition, participants were given 5 minutes to make an outline of their essay prior to writing. They were then given half an hour to write a well-structured essay about the topic. This involved trying to communicate their ideas as clearly as possible to their readers, but without worrying too much about mechanical features of the text. In the *control* condition, participants were alternately asked to write either a rough draft or an outline planned essay. Initial analysis found no differences on any of the dependent variables between these two groups within the control group, so analyses comparing performance with the experimental groups were conducted using the control group as a whole.

Procedure

All participants carried out the task individually in a sound-proofed laboratory cubicle, and wrote their essays using a computer keyboard and simple text-editing software. The procedure for measuring relationships between ideas before and after writing and for identifying new ideas after writing is summarized in table 2 below.

Table 2. Summary of procedure.

- 1 Generate list of ideas about the topic (list 1) (10 minutes).
- 2 These ideas were then randomly presented in pairs on the computer monitor, and participants indicated by mouse click the degree of relationship between each pair of ideas on a 7 point scale. The rating scale extended between -4 (for very incompatible or opposed ideas), through 0 (for unrelated ideas), up to +4 (for very compatible or closely related ideas). This continued until all possible pairs had been presented.
- 3 Write texts according to instructions specified in the different conditions (30 minutes).
- 4 Generate new list of ideas about topic (list 2) (10 minutes).
- 5 Rate relationships between ideas within list 2, using the same procedure as before writing.
- 6 Compare lists 1 and 2, rating the extent to which ideas in list 2 corresponded to ideas in list 1. The rating scale extended between 1 = identical point and 6 = no corresponding idea in list 1.

Measures

For this paper, two measures will be analyzed.

New Ideas

Following the practice used in previous research (Galbraith 1992, 1999), ideas in the second list were classified as new if participants either did not identify a corresponding idea in the initial list or if a corresponding idea was identified but was rated as only having low correspondence (4 or above on the 6 point scale). In order to control for variations in the number of ideas generated in list 1, new ideas were expressed as a proportion of the ideas occurring in list 1.

Mean Harmony

To measure the mutual consistency of the relationships between writers' ideas, we used a measure of harmony used in constraint satisfaction networks (Britton & Sorrells, 1998; Thagard & Verbeugt, 1998). In these networks, the harmony of a set of relationships is represented by $\sum_i \sum_j w_{ij} a_i(t) a_j(t)$, where w = strength of link between units i and j , a = degree of activation of the units, and t = time step of activation update. Harmony is maximized when two highly activated units are linked by a high positive weight, and when two conflicting units are linked by a negative weight. It is calculated by updating an initially random set of activations according to the weights linking them until a stable state occurs. When the power algorithm is used to update the network, the final state is equivalent to the first principal component of a principal components analysis, with the factor loadings corresponding to unit activations and the eigenvalue corresponding to the harmony of the network.

To calculate the harmony of the ideas produced before and after writing, we therefore carried out a principal components analysis on the participants' ratings of the relationship between ideas within lists, and used the eigenvalue of the first principal component as a measure of total harmony. In order to control for variations in network size (number of ideas) we then converted these total harmony scores to a measure of mean harmony by dividing the first eigenvalue of the principal components analysis by the number of relationships in the network.

Results

New Ideas

Preliminary analysis of the data revealed that 4 participants had made errors in the correspondence rating task. They were removed from this analysis. A square root transformation was then carried out on the remaining data to normalize the positively skewed distribution of scores. Two remaining outliers were then excluded from the data set.

A two-way (3 * 2) between subjects ANOVA revealed a significant interaction between writing condition and self-monitoring ($F(2, 84) = 4.59, MSE = 0.06, p = 0.01$). As can be seen in table 3, the low self-monitors produced more new ideas after writing a rough draft than in the control group

(planned comparison, $p = 0.03$) and marginally more after writing an outline planned essay than the control group (planned comparison, $p = 0.07$). By contrast, the high self-monitors produced marginally fewer new ideas after writing a rough draft than they did in the control group (planned comparison, $p = 0.06$) and no more new ideas after writing the outline planned essay than in the control group (planned comparison, $p = 0.37$).

Two other features of the data should be noted. First, although the number of new ideas produced by the high self-monitors in the control group was not significantly greater than the number produced by the low self-monitors ($t(30) = 1.7, p < 0.1$), it was relatively high compared to all the other conditions. This suggests that high self-monitors have a propensity to change the ideas they consider relevant to a topic even when they have not written about the topic, and raises a question about whether the high number of new ideas produced by high self-monitors after writing a planned essay are a consequence of writing about the topic or simply of this general propensity. Second, the number of novel ideas produced by the high self-monitors after writing a rough draft was significantly lower than the number they produced after writing the outline planned essay ($t(27) = 2.81, p < 0.01$) and than the number produced by the low self-monitors writing a rough draft ($t(29) = 2.07, p < 0.05$).

Table 3. Mean number (and s.d.s) of new ideas (square root as a proportion of the initial list of ideas) produced in each condition by low and high self-monitors.

	Writing condition		
	Control	Rough draft	Planned essay
Low SM	0.47 (0.28)	0.64 (0.22)	0.62 (0.13)
High SM	0.62 (0.26)	0.44 (0.30)	0.71 (0.22)

Overall, then, these data replicate Galbraith's (1999) finding that low self-monitors change their ideas more than high self-monitors when they write a rough draft, and demonstrate further that this is greater than when they write about an unrelated topic. Low self-monitors appear to change their ideas to a similar extent after writing an outline planned essay, suggesting that the number of new ideas is relatively unaffected by the form of pre-planning (explicit planning). High self-monitors, by contrast, appear to change their ideas after planned writing, suggesting that idea change for them depends on explicit planning processes.

Mean Harmony of Ideas

In total, 8 participants produced data that was unusable in this analysis. Deleted participants were drawn equally from all conditions. A log transformation was then carried out on the remaining data to normalize the positively skewed distribution of scores.

A three-way (3*2*2) repeated measures ANOVA revealed a significant interaction between writing condition, self-monitoring and mean harmony before and after writing ($F(2, 82) = 3.94, MSE = 0.102, p = 0.02$). As can be seen in

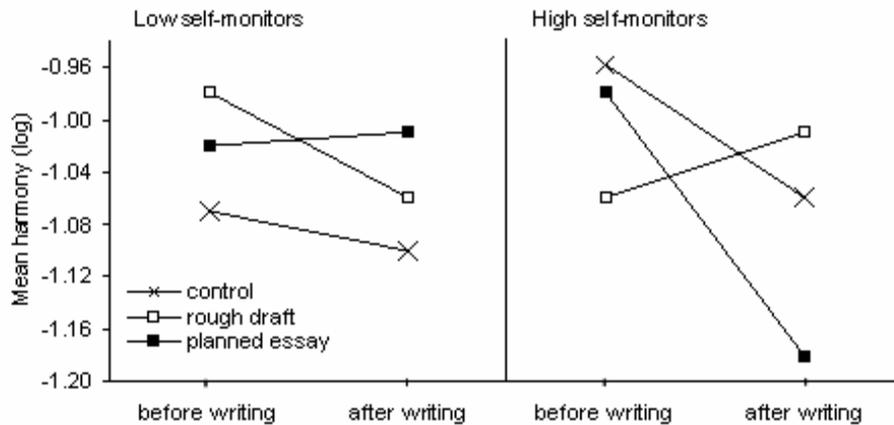


Figure 1. Mean harmony (log) before and after writing as a function of self-monitoring and writing condition.

figure 1, this interaction reflects the contrasting effects of rough drafting and planned writing on harmony for the low and high self-monitors. The harmony of the high self-monitors' ideas was significantly reduced after planned writing ($t(14) = 3.58, p = 0.003$) but not after rough drafting, where there was no significant change as a function of writing ($p = 0.48$). There was also a marginally significant reduction in harmony in the control condition for high self-monitors ($t(14) = 2.15, p = 0.06$). By contrast, although the changes were in the opposite direction for low self-monitors, with harmony increasing slightly after planned writing, and decreasing after rough drafting, none of these changes, including within the control condition, were statistically significant ($p > 0.3$ in all cases). The key finding here is that although low and high self-monitors produced a similarly high number of novel ideas after planned writing, this was associated with a reduction in harmony for the high self-monitors but not for the low self-monitors.

New Ideas and Changes in Harmony

If new ideas are directly generated in order to create a more coherent mental model of the text, as some forms of Bereiter and Scardamalia's knowledge-transforming model would imply, then one would expect new ideas to be positively associated with increases in harmony. Alternatively, if new ideas are produced by another process, be it spontaneous text production or deliberate adaptation to the anticipated needs of the reader, then new ideas could in principle have any direction of relationship with increases in harmony, depending on the effect of new ideas on conceptual coherence. As can be seen in table 4, the correlations were in fact negative or absent, implying that new ideas were not directly generated in order to increase the coherence of the writers' mental model of the text.

The most important result here is that, in the conditions where a relatively high number of new ideas were produced, there were strong negative relationships between new ideas and increased harmony. This implies that, regardless of

whether new ideas are produced by dispositional text production or rhetorical planning, they have a negative effect on the conceptual coherence of thought. A possible explanation for this is that the production of novel ideas per se makes it harder to form a coherent mental model of the text in a limited capacity working memory.

Table 4. Correlations between increases in harmony and number of new ideas

Condition	Self-monitoring (SM)	
	Low SM	High SM
Control	0.1	- 0.49
Rough draft	- 0.82***	- 0.19
Planned	- 0.81**	- 0.64*

It is important to note here, however, that although the low and high self-monitors produced a similarly high number of new ideas after writing the planned essays, and show a similarly strong negative relationship between new ideas and changes in harmony, there was nevertheless a pronounced difference in the extent to which harmony was reduced in the two conditions. The fact that, overall, there was a slight increase in harmony after the low self-monitors wrote planned essays but a marked decrease in harmony after the high self-monitors wrote planned essays implies that the new ideas produced by the low self-monitors were relatively more compatible with the global organization of their ideas.

Finally, it is worth noting that in the high self-monitors' control condition, although the relationship is non-significant, it is moderate in strength and in the same negative direction as in the planned essay condition.

Conclusion

The general pattern of results supports the claims of the dual process model. Thus, the number of new ideas

produced in the rough drafting condition was higher for the low self-monitors than for the high self-monitors, implying that dispositionally guided text production is not simply a matter of knowledge telling, but is an active knowledge-constituting process in its own right, which is inhibited by the application of rhetorical goals. Furthermore, in the planned essay conditions, where writers have to take external rhetorical constraints into account, the high self-monitors did produce a high number of new ideas, as would be expected if high self-monitors generate new ideas through rhetorical planning.

The one unexpected finding here was that low self-monitors produced a similar number of new ideas in the planned essay condition and that this was no lower than in the low self-monitors' rough draft condition. One possible explanation for this is that it is a consequence of the extended period of time the participants spent considering content during the rating of relationships between ideas. This general activation of content prior to writing may have led to a more 'planned' mode of writing in all conditions, which may have reduced the extent to which rough drafting was dispositionally driven, while at the same time activating more potential content to be manipulated by explicit planning during the planned essay. Alternatively, it may be that low self-monitors tend to ignore rhetorical constraints even when they are present.

Whatever the explanation for this, the key issue for the dual process model is not so much the relative number of new ideas produced under different conditions (which it would expect to vary depending on a range of factors, including the balance of implicit and explicit knowledge about specific topics) but rather the relative conceptual coherence of these ideas. The fundamental prediction of the model here was that low self-monitors' new ideas - because they are dispositionally produced - would be more conceptually coherent than high self-monitors' new ideas. This was strongly confirmed by the fact that, although they produced a similar number of new ideas, low self-monitors maintained the harmony of their ideas after writing both rough drafts and planned essays, whereas high self-monitors showed a marked decrease when they produced new ideas after planned writing.

At first sight, the presence of strong negative correlations between the number of new ideas produced and increases in harmony appears to contradict this conclusion. As we suggested earlier, however, we think this reflects the fact that two different factors are at work here: (i) the conceptual coherence of the ideas in themselves and (ii), the ability of the writer to identify this coherence when a high number of new ideas are present in working memory. The present results imply that, although novel content generally reduces the writer's ability to create a coherent mental model of the text in working memory, dispositionally produced new ideas are relatively more coherent than those produced by rhetorical planning.

Furthermore, this may, in part, also be a consequence of the fact that writing in this experiment was restricted to a

single draft, where the writer has to create a global organization for their ideas at the same time as formulating them in text. Writers may find it difficult, immediately after an intense period of text production, to step back and form a clear picture of the overall structure of their text. If this is correct, then it implies the problem may be alleviated when the writer is allowed to write more than a single draft. We would predict that low self-monitors would show greater increases in conceptual coherence if they were to employ revision strategies involving the identification and organization of ideas in their previously written text (see Galbraith and Torrance, 2004, for fuller details of these strategies).

Finally, we should point out that the pattern of results for high self-monitors' planned essays were similar to the control condition where they wrote about an unrelated topic. This casts further doubt on the claim that the new ideas produced in these conditions reflect genuine discovery, and provides support for the idea that their new ideas are a consequence of directly manipulating a mental model of the text, rather than a consequence of text production. In the control condition, the requirement to write an essay, even about an unrelated topic, may be sufficient to activate general rhetorical goals which cause high self-monitors to modify their ideas after writing.

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