

Ecological Rationality and the Cognitive Process Theory of Writing

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The complexity of the written product or text, with its linear structure and sequential logical coherence, had once led rhetoricians to assume that the cognitive process that produced writing was equally complex and equally linear (Murray, 1978). More recent research has suggested that this is not the case. In their cognitive process model of writing, Flower and Hayes (1981) rejected the older, more linear model of writing and argued that the following processes are more descriptive of the cognitive practices that produce text:

1. Writing is best understood as a set of distinctive thinking processes, which writers orchestrate and organize during the act of composing;
2. The processes of writing are hierarchically organized, with component processes embedded within other components;
3. Writing is a goal-directed process. In the act of composing, writers create a hierarchical network of goals and these in turn guide the writing process;
4. Writers create their own goals in two key ways: by generating goals and supporting sub-goals which embody a purpose; and, at times, by changing or regenerating their own top-level goals in light of what they have learned by writing. (p. 366)

The process is dynamic and recursive, and is often characterized by false starts and dead ends. Writers do not follow a linear path in their composing process but instead are observed moving back and forth through planning, generating, and reviewing (revising and editing). Writers monitor their text production actively and, as new information is discovered, previous assumptions are challenged and textual adjustments are made. As Galbraith (1996) observed,

writing “[...] is a dynamic, recursive process in which the writer continually evaluates ideas and texts with respect to rhetorical goals, and in which goals are modified as text is produced” (p. 121).

It is important to remember, however, that the cognitive process model is an abstraction, which describes a dynamic process in static terms. The writer does not compose with the model in mind but instead works through a series of discrete problem-solving activities at particular junctures in the text. What may appear, retroactively, to be an exquisite process of textual construction is, in fact, the result of a series of localized decisions. Simon (1969) argued, in his parable of the ant, the appearance of complex cognitive processes may, in fact, be better understood as a specific adaptation to the environment.

Viewed as a geometric figure, the ant’s path is irregular, complex, hard to describe. But its complexity is really a complexity in the surface of the beach, not a complexity in the ant. On that same beach, another small creature, with a home at the same place as the ant, might well follow a very similar path.

(Simon, 1969, p. 24)

Just as the complexity of the ant’s behaviour over time cannot to be assumed to represent a correspondently complex cognitive process, neither should the finished essay or the retrospective accounts of writers be assumed to represent the thinking practice that leads to text production.

Though the Flower and Hayes’ (1981) model of writing has provided a useful representation of the writing process, it has also raised two important questions:

1. How, in the complex and ambiguous writing environment that Flower and Hayes (1981) describe, do writers make the kind of decisions they need to make?

2. If the writing process itself is not necessarily logical or linear, how does it happen that the textual product is?

I suspect that both questions can be addressed using Gigerenzer's (2007) model of ecological rationality. In answer to the first question, I will argue below that effective writers employ heuristics to make decisions on the basis of "useful patterns of available information" (Todd & Gigerenzer, 2007, p. 167). In answer to the second, I will propose two, complementary explanations: 1) that linearity is a characteristic of what Simon (1969) calls "the problem environment" (i.e., the outer environment or the writing space, p. 26); and, 2) effective writers adapt their thought processes to the problem environment using a heuristic that predisposes them to construe text production in spatial terms.

Embedding Artifice in Text

In observing that "man, viewed as a behaving system, is quite simple," Simon (1969) explained that "[t]he apparent complexity of his [man's] behaviour over time is largely a reflection of the complexity of the environment in which he finds himself" (p. 25). Using the analogy of an ant on a beach which must work through a series of obstacles to find its way home, Simon (1969) says:

[h]e has a general sense of where home lies, but he cannot foresee all the obstacles between. He must adapt his course repeatedly to the difficulties he encounters, and often detour uncrossable barriers. His horizons are very close, so that he deals with each obstacle as he comes to it; he probes for ways around or over it, without much thought of future obstacles. (p. 24)

Given the sparse information with which the ant is operating, Simon (1969) says, "[i]t is easy to trap him into deep detours" (p. 24). Nevertheless, if the ant is, in the end, successful in finding

his way home, the haphazard path he followed to get there suddenly appears reasonable, even sophisticated. Simon (1969) suggested the “embedding [of] artifice in nature” (p. 23) creates an illusion of meta-intentionality, retroactively ascribing discrete decisions with long-term purpose when they may, in fact, have been short-term problem-solving strategies. Both the ant on the beach and the “thinking human being [are] adaptive system[s]” with “goals [that] define the interface between [their] inner and outer environments” (Simon, 1969, p.25). From a distance, “[t]o the extent that [they are] effectively adaptive, [their] behaviour[s] will reflect characteristics largely of the outer environment (in the light of [their] goals) and will reveal only a few limiting properties of [their] inner environment[s] – of the physiological machinery that enables [them] to think” (Simon, 1969, p. 25-26).

Decision-making in the composing process may be very much the same. That is, though the finished writing product, if successful, is usually shaped by a linear connection between ideas that works toward a logical conclusion, the assumption that logic and linearity are active elements in thinking that produces texts may be no more accurate than the ascription of complex cognitive behaviours to Simon’s (1969) ant. As Flower and Hayes (1981) have reported, “a writer’s goals are [not] necessarily elaborate, logical, or conscious” (p. 379), but rather adaptations to the specific challenges at a particular juncture in the writing process. However, the tendency to assume complexity in the composing process is so pronounced that even the self-reports a writer provides about his or her own text-producing decisions are unreliable. Flower and Hayes (1981) found that “people’s after-the-fact, introspective analysis of what they did while writing [are] notoriously inaccurate and likely to be influenced by their notions of what they should have done” (p. 367). To uncover the process of thinking-in-time, Flower and Hayes (1981) used “thinking aloud protocols”, in which subjects were “asked to verbalize everything

that goes through their minds as they write, including stray notions, false starts, and incomplete or fragmentary thought [...avoiding] any kind of introspection or self-analysis while writing, but simply [thinking] out loud while working like a person talking to herself” (p. 367). What they found was that the process of composing, so far from being linear and logical, was tentative and recursive, addressing specific problems as they arose.

The Writing Environment

As Simon (1969) has argued, thinking behaviours are best understood using the metaphor of scissors: the world and the mind fit together “like the blades of a pair scissors – the two must be well matched for effective behaviour to be produced, and just looking at the cognitive blade will not explain how the scissors cut” (Todd & Gigerenzer, 2007, p. 167). One of the advantages of the cognitive process theory of writing is that it contextualizes composition as an interaction between the writer and the external environment.

As noted above, Flower and Hayes (1981) identified the writing process is a complex process, involving a number of discrete steps: planning and generating of knowledge, translation of the plan into speech, and editing or reviewing the plan. The writing environment is one in which the writer, regardless of the degree of expertise, operates in an ambiguous environment and with incomplete information. Flower and Hayes (1981) described the initial stage of writing in the following way:

At the beginning of composing, the most important element is obviously the rhetorical problem itself. A school assignment is a simplified version of such a problem, describing the writer's topic, audience, and (implicitly) her role as student to teacher. Insofar as writing is a rhetorical act, not a mere artifact, writers attempt to "solve" or respond to this rhetorical problem by writing

something. In theory, this problem is a very complex thing: it includes not only the rhetorical situation and audience which prompts one to write, it also includes the writer's own goals in writing. (p. 369)

In order to manage the demands of composition, “writers frequently reduce this large set of constraints to a radically simplified problem, such as ‘write another theme for English class’” (Flower & Hayes, 1981, p. 369). This simplification of a complex situation “is obviously an economical strategy as long as the new representation fits reality” (Flower & Hayes, 1981, p. 369). It is interesting to note that Todd and Gigerenzer (2007) used a similar explanation to argue for the rationality of heuristics, saying that it is reasonable in certain circumstances to use “a single reason to make decisions...restricting information as much as possible” (p. 168-169) (a fuller discussion of Todd and Gigerenzer, 2007, follows below).

As the composing process proceeds, however, it is further complicated by the dynamic relationship between the writer and the writing environment. New elements emerge in the text:

which [place] even more constraints upon what the writer can say. Just as a title constrains the content of a paper and a topic sentence shapes the options of a paragraph, each word in the growing text determines and limits the choices of what can come next. (Flower & Hayes, 1981, p. 371)

The degree to which the writing succeeds is a function of the writer’s ability to manage the dialectic between the inner and the outer environment. An incoherent text, for instance, suggests that “the text may have exerted too little influence; [and] the writer may have failed to consolidate new ideas with earlier statements” (Flower & Hayes, 1981, p. 371). The text of an inexperienced writer, on the other hand, is characterized by “a dogged concern with

extending the previous sentence and a reluctance to jump from local, text-bound planning to more global decisions, such as ‘what do I want to cover here?’” (Flower & Hayes, 1981, p. 371).

Against the influence of the emerging text, however, two other forces vie for control of the composing process: “the writer's knowledge stored in long-term memory and the writer's plans for dealing with the rhetorical problem” (Flower & Hayes, 1981, p. 371). This creates the potential for “a conflict between what [a writer knows] “about a topic and what [the writer] might actually want to say to a given reader”, demanding that “writers juggle and integrate the multiple constraints of their knowledge, their plans, and their text into the production of each new sentence” (Flower & Hayes, 1981, p. 371). Because the:

writer's long-term memory, which can exist in the mind as well as in outside resources such as books, is a storehouse of knowledge about the topic and audience, as well as knowledge of writing plans and problem representations. [...] a single cue in an assignment [...] can let a writer tap a stored representation of a problem and bring a whole raft of writing plans into play. (Flower & Hayes, 1981, p. 371)

However, the integration of this store of information with the emerging text adds to the difficulties for the writer, demanding that the writer circle back to ensure that the text remains coherent. Because the writing process is not linear but recursive, creating new rhetorical problems as it solves existing ones, it puts considerable strain on working memory. It is, after all, in “working memory that information (from the environment and from long-term memory) is stored during processing” (McCutchen, 1996, p. 300). With the working memory limited in capacity and duration, “trade-offs must exist between working memory’s storage

and processing functions” (McCutchen, 1996, p. 300), devoting fewer resources to storage of information as more are required for processing. Even if, as Flower and Hayes (1981) suggested, the cognitive workload can be reduced by off-loading memory work to the environment and thus freeing cognitive resources for processing, the difficulty of managing the myriad decisions is a challenge. As I will argue below, heuristics allow writers to manage the process by using “single best available cue[s]” (Todd & Gigerenzer, 2007, p. 169) for decision-making.

Heuristics

According to Todd and Gigerenzer (2007), “the modern study of decision-making began with the normative ideal that good decisions follow the mathematical prescriptions of Bayes’s rule or the maximization of expected utility” (p.168). The argument was that long term utility guided the active process of human decision-making. That seems not to be the case. Instead, “humans rely on multiple simple decision heuristics, not the one general purpose calculus of rationality” (Todd & Gigerenzer, 2007, p. 168). Initially, this process of decision-making was regarded as, at best, the least undesirable of the options available in information poor environments. As the use of heuristics was represented by Kahneman, Slovic, and Taversky (1982), individuals could “be led to use particular heuristics in inappropriate environments and consequently make errors” (as cited in Todd & Gigerenzer, 2007, p. 168). However, Todd and Gigerenzer (2007) rejected the assumption that heuristics were inherently flawed decision-making strategies, arguing instead that it was rational in certain circumstances to use “a single reason to make decisions...restricting information as much as possible” (p. 168-169). They further argued that:

brains on this planet have likely evolved longest to deal with patterns in the physical environment [...and that] many of these patterns can be characterized in terms of cue

validities (how often a cue indicates a correct decision), discrimination rates (how often a cue distinguishes between decision alternatives, regardless of its corrections), and redundancies (correlations between cue values across alternatives). (p. 170)

In short, depending on the circumstances and the environment single reason heuristics allow humans to make good decisions using the information that is available in the environment.

Again, using Simon's (1969) metaphor of the scissors, human rationality is best understood as a dialectic between the mind and the external world. If the heuristic allows the thinker to reason analogously, using the information available in the environment to predict a similar pattern in a new situation for which the reasoner has incomplete information, the heuristic may be, in fact, a reasonable strategy.

This process of reasoning by using "the single best available cue" (Todd & Gigerenzer, 2007, p. 169) may explain why effective writers, operating in the complex and ambiguous milieu of the writing environment, are able to make the kinds of decisions that are necessary to move the text forward. In many ways, the writing environment is one "with high variability, low predictability and little opportunity for learning, [where] good decisions may none the less be made more often by simple mechanisms than complex ones" (Todd & Gigerenzer, 2007, p. 169). However, as Flower and Hayes (1981) reported, "sometimes a single cue in an assignment [...] can let a writer tap a stored representation of a problem and bring a whole raft of writing plans into play" (p. 365-366). For instance, the heuristic that is used to make a decision in situations characterized by a J-shaped distribution (i.e., ones in which "the most influential cue is considerably more important than the second, which is considerably more important than the third") (p. 169) might allow effective writers to select new goals from the many possibilities that emerge in the writing process. By immediately discarding the goals that offer little promise, a

writer is able to concentrate on those with greater potential. Similarly, writers might use a foraging heuristic which allows them to identify the point at which brainstorming activities have begun to exhaust themselves by using “incremental or decremental rules which increase or decrease the tendency to stay in a patch with each resource item found, depending on whether patches have widely varying or roughly equal numbers of resources (Hutchinson & Gigerenzer, 2005).

Ecological Rationality and Spatial Representation in Written Language

Heuristics might also offer insight into a question that Flower and Hayes’ (1981) Cognitive Process Theory fails to address: if the linearity that characterizes the finished writing product is not typical of either human cognitive processes (Simon, 1969), or of the composing process (Flower & Hayes, 1981), then one how does it come to manifest itself in the text that is the product of those two processes? It may be useful to think of linearity as a desired destination (a “home” in Simon’s Parable of the Ant (1969)) or a goal (as cited in Flower & Hayes, 1981, Cognitive Process Theory). That is, because “[p]roducing a written text raises a critical issue—that of linearization ... [which requires that a writer translate] a multidimensional mental representation into a linguistic form that must be strictly sequential, hence unidimensional (Fayol, 1991, in Favart & Coirier, 2006), the characteristic linearity of the textual product may be a “[characteristic] of the outer environment” (Simon, 1969, p. 25) rather than a characteristic of the inner environment (i.e. the human thinking process). Similarly, logic, which, in many ways, is a *process* by which linearity is achieved, becomes a function of the text rather than a function of the inner environment that produces it. As Favart and Coirier (2006) explain:

In relation to the different writing processes, linearization could be “located”
at an intermediate position between the idea organization and translating.

Linearization concerns, on the one hand, conceptual choices which have to be made when ordering ideas (Levelt, 1981) and, on the other hand, the linguistic specification of the relationships between these ideas in the linguistic sequence (Bronckart, Bain, Schneuwly, Davaud, & Pasquier, 1985).

Linearization, therefore, deals with both conceptual and linguistic aspects of text composition. (Favart & Coirier, 2006, p. 306)

In other words, because written language requires logic and linearization, human thinking adapts to the writing environment to produce logic and linearization in the text.

Just as it would be a mistake to assume that the thinking the writer uses to produce a linear text is itself linear, it would also be a mistake to assume from the observations of the writer's recursive and sometimes disjointed writing process that the writing has no specific goal. In Simon's (1969) parable, the ant's path, though it seems irregular and convoluted, is guided by a purpose that is found in the environment: the ant's goal is to find its way home. Similarly, the writer has a goal that is embedded in the writing environment. Written texts require that the "multidimensional mental representation[s]" that are characteristic of active human thinking must be translated "into a linguistic form that must be strictly sequential, hence unidimensional" (Fayol, 1991, as cited in Favart & Coirier, 2006). The logic of written language demands that each text will have a beginning and an end, and the path between the two will be, to some degree, sequential and unidimensional. The linearity that characterizes writing, therefore, is a condition of the textual environment rather than being a characteristic of the thinking process that produces writing.

The Analogy of Problem-Solving in Geometry

The effectiveness of the use of heuristics to govern the ambiguous writing space might be inferred by examining the efficacy of similar strategies of problem-solving in mathematics. Like the process of writing, “[m]athematical proving is a complex activity combining processes of concise logical argumentation and the heuristic processes of producing a conjecture and looking for plausible supporting arguments” (Hilbert, Renkl, Kessler, & Reiss, 2008, p. 55). In addition, again as is the case in the writing process, “[t]he outcome of this activity (i.e., the final proof) reflects only part of the proving process [...and] the proving process [itself] remains opaque for a majority of students” (Hilbert et al., 2008, p. 55). In order to foreground the process of problem-solving in mathematics, Pólya (1973, as cited in Hilbert et al., 2008) identified four steps that students might follow: “(a) understand the task, (b) make a plan, (c) execute the plan, and (d) reflect on their work and if necessary improve it” (p. 55). Pólya (1973) also identified a set of heuristic strategies, such as working backwards from the goal to the beginning that could be helpful in the process of mathematical problem-solving (as cited in Hilbert et al., 2008, p. 55). Hilbert et al. (2008) later used Pólya’s (1973) preliminary work to develop a more sequential, four-stage model of mathematical problem-solving that included a strategy for teaching students to recognize patterns in their investigation process:

- (1) Production of a conjecture. This phase includes the exploration of the problem situation as well as the identification of arguments to support the evidence. For example, students check whether the observation to be proved (e.g., “Connecting the centres of the sides of a rectangle leads to a lozenge”) holds in different examples (i.e., different rectangles) and they find possible reasons for it.

(2) Formulation of the statement. This phase aims at providing a precisely formulated conjecture according to shared textual conventions that will then be the basis for all further activities. Students should formulate an exact “rule” such as “If the centres of the sides of any rectangle are connected then the resulting figure will be a lozenge.”

(3) Exploration of the conjecture. In this phase, appropriate arguments for the validation of the conjecture are identified. For example, the students collect related geometrical knowledge about rectangles, congruency mappings and triangles.

(4) Selection and combination of coherent arguments in a deductive chain. In this phase, conclusions are drawn from the collected arguments and those that are useful for the final proof are put together in an informal proof according to classroom standards. For example, students can use their knowledge on congruency mappings to show that the right-angled triangles that developed from connecting the centres of the sides of a rectangle are congruent and therefore the resulting quadrangle inside the rectangle needs to be a lozenge.

(Hilbert et al., 2008, p. 55)

If it is true, as suggested above, that the writing environment can be understood spatially, then it seems likely that a similar process of problem-solving through heuristics might be effective in the writing process. By explicitly teaching writers to recognize patterns of organization in the text, it may facilitate their understanding of the relationship between textual components. Once the components are identified as discrete elements writers can use a four-step process of problem-solving similar to the one suggested by Hilbert et al. (2008). It is the explicit

identification of elements of the text as analogous to quantitative values, and the identification of the writing environment as a linear space, that allows writers to recognize logical argumentation in written language.

Conclusion

The Flower and Hayes (1981) Cognitive Process Theory of Writing has contributed significantly to the understanding of writing as a process rather than a product. By identifying the “distinctive thinking processes which writers orchestrate and organize during the act of composing” (p. 366), and by explaining how these processes are hierarchically organized, with component processes embedded within other components, Flower and Hayes (1981) mapped the complex relationship of ideas with which writers contend. In addition, by identifying the dynamic relationship between the goals and sub-goals that guide the text and the text that changes those goals, Flower and Hayes (1981) effectively began to establish that the locus of textual control was not in the exclusive domain of the writer but rather at a point somewhere between the writer and the writing environment.

However, Flower and Hayes (1981) do not fully explain how writers manage the cognitive demands that arise from this ongoing dialogue between the emerging text and the writer’s goals. In this paper, I have argued that the complex writing environment that Flower and Hayes (1981) describe is one in which writers might benefit from the insights that derive from Simon’s (1969) understanding of cognitive complexity and artifice as elements that are embedded in the environment and from Todd and Gigerenzer’s (2007) construct of ecological rationality.

I have used Simon’s parable of the ant to explain the apparent disjunction between a recursive writing process that executes short-term problem-solving strategies serially and the

textual product that is characterized by linearity and over-all coherence. I have also argued that logic and linearity are functions of what Simon (1969) calls “the problem environment” (i.e., the outer environment or the writing space, p. 26), rather than being active participants in the cognitive process. Effective writers adapt their thought processes to this problem environment using a heuristic that predisposes them to construe text production in spatial terms.

Similarly, I have used Todd and Gigerenzer’s (2007) construct of ecological rationality to explain how effective writers manage the complex interplay of their changing goals, on one hand, and the demands of an emerging text on the other. I suggest that, rather than attempting to orchestrate the entire writing process simultaneously, writers use a series of single cue decision-making processes, or heuristics, to attend to localized challenges in the problem environment. In most cases, these cues derive from an understanding of textual organization in physical or geometrical terms. The use of these cues, or heuristics, which facilitate effective decision-making, may explain why effective writers are able to “orchestrate and organize” (Flower and Hayes, 1981, p. 366) their composing processes more easily than other writers.

I did not fully explore the variety of heuristics that might be used in the composing process. However, I suspect that the similarity between the dynamics of problem-solving in the textual environment and the dynamics of problem-solving in geometry may provide a fruitful ground for investigation. In particular, Hilbert, Renkl, Kessler, and Reiss’s (2008) examination of the heuristics students use to solve problems in geometry seems to hold promise for adaption to problem-solving heuristics in composition.

References

- Favart, M., & Coirier, P. (2006). Acquisition of the linearization process in text composition in third to ninth graders: Effects of textual superstructure and macrostructural organization. *Journal of Psycholinguistic Research, 35*, 305-328.
- Flower, L. & Hayes, J. (1981). A cognitive process theory of writing. *College Composition and Communications, 32*, 365-387.
- Galbraith, D. (1996). Self-monitoring, discovery through writing and individual differences in drafting strategy. In G. Rijlaarsdam, H. van den Bergh, & M. Couzin (Eds.). *Theories, models and methodology in writing research*. Amsterdam: Amsterdam University Press.
- Gigerenzer, G. (2007). *Gut feelings: The intelligence of the unconscious*. New York, NY: Viking Press.
- Hilbert, T., Renkl, A., Kessler, S., & Reiss, K. (2008). Learning to prove in geometry: Learning from heuristic examples and how it can be supported. *Learning and Instruction, 18*, 54-65.
- Hutchinson, J., & Gigerenzer, G. (2005). Simple heuristics and rules of thumb: Where psychologists and biologists might meet. *Behavioural Processes, 69*, 97-124.
- McCutchen, D. (1996). A capacity theory of writing: Working memory in composition. *Educational Psychology Review, 8*, 299- 325.
- Murray, D. M. (1978). Write before writing. *College Composition and Communication, 29*, 375-381.
- Simon, H. (1969). The psychology of thinking: Embedding artifice in nature. In *Sciences of the Artificial 23-26*. Cumberland, RI: MIT Press.

Todd, P., & Gigerenzer, G. (2007). Environments that make us smart: Ecological rationality. *Current Directions in Psychological Science, 16*, 167-171.