

## CHAPTER 4

### NATURE AND CONTROL OF PROCESSING

#### 1 INTRODUCTION: FROM THE NATURE OF PROCESSING TO THE NATURE OF CONTROL

In the first part of this book, we have discussed the architecture of writing processes (Planning, Translating and Revising), such as it can be described through different models. Nevertheless, the structural description of processes implied in the activity of text writing is not sufficient to account for the progress of this activity. The writing activity is indeed based on dynamism of processes. Thus, when composing a text, writers have to continually shift between planning the main ideas, content translating and text revising. This continuous shifting gives the writing activity its cyclic nature and depends on a strategic and recursive ordering of different sub-processes.

According to Breetvelt, van den Bergh and Rijlaarsdam (1994), such a temporal management of writing process plays a central role in writing activity. For example, if a given process is set up too late, or too early, this can affect the final product quality, concerning both content organisation (planning process) and grammatical aspects (linguistic formulation). These authors have carried out an analysis of the temporal unfolding of processes underlying forty texts, accomplished by twenty participants (15-years-old). Largely inspired by the architecture of Hayes and Flower's (1980) model, Breetvelt *et al.* (1994), like Caccamise (1987), have divided each subject's total writing time in three periods. They have identified, within each period, the verbal protocol nature collected throughout the writing activity. The protocols have been classified in eleven categories, defined according to criteria determined by Flower and Hayes (1983) or Swarts, Flower and Hayes (1984), and susceptible to reflect the totality of writing sub-processes (Goal Setting, Generating, Organising, *etc.*). The analyses of the distribution of the different verbal protocol categories, considering the three periods, show that the first third of the writing time would be devoted to the comprehension of the instructions and to the evaluation of the task goal. The second period would be characterised by the realisation of Goal Setting, Generating and Organising sub-processes, while the last period would be mainly devoted to the handwriting (Execution) and to the reading (Reviewing) of the text. These results confirm processing sequencing (from Macroplanning to Execution and Revision). They especially show that the quality of the final text would strongly depend on adequately triggering the different processes, within a sequence of processing. It seems, according to authors, that releasing a given process too early or too late could lead to a negative effect on the quality of the final text.

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This experiment clearly shows that the management and the co-ordination of the different processes constitute a crucial problem for the writer (Fayol, 1994). In the same perspective, Bruce, Collins, Rubin and Genter (1979) emphasize that the necessity of co-ordination represents one of the major difficulties of the writing activity. In Hayes and Flower's (1980) model, such a co-ordination is carried out by a control process called Monitoring (*Cf.* General Introduction). This entity would determine the processes organisation and ordering, and would allow reiterating some processes if the text characteristics do not respect the previous writing objectives (*Cf.*, about the notions of management and control: Bracewell, 1983; Espéret & Piolat, 1991; Graham & Harris, 1994). Although minimum, this definition of Monitoring is interesting because it supposes that the control of processes relies on two activities. The first one is strategic: the writer needs to determine an optimal processing organisation. However, this optimisation of processing itself depends on a second activity, which involves evaluating the appropriateness between the processed and the fixed objective.

The writer has then to control not only the activation of processes but also the pertinence of the processed text, for a given stage in the progress of the writing activity. Nevertheless, from one model of writing to another, and from speaking to writing models, the conception and the definition of this control entity, managing these two activities, can considerably vary. For example, while Hayes and Flower (1980) give to the Monitor the function of processing control of Planning, Translating and Reviewing processes, Kellogg (1996) considers that this kind of control would be performed by a component relatively close to the Reviewing process, as defined by Hayes and Flower (1980). In the same way, Hayes (1996), in his new model, seems to have renounced to a Monitoring entity and has replaced it with the notion of processing control through Task Schemas. This heterogeneity about control ideas is all the more apparent when the oral production models are also considered. In Levelt's (1989) model, for example, two modes of control co-occur. A first type of processing control would be intrinsically carried out. Each process component (here the Formulator and the Articulator; *Cf.* General Introduction) would start only if the products previously processed are in accordance with the processes ensured by the component situated just after. A second mode of control would be executed by a comprehension loop on the final verbal product. This comprehension system would be able to engage the reiteration of processes if the message does not respect communicative goals, or comprises lexical or grammatical errors. It is clear that definitions and formalisations to account for the principles of a control entity in oral production models are very diversified. Nevertheless, if this fact certifies, to a certain point, that this control entity is still relatively unknown, such diversity is finally only apparent.

In fact, it seems that the different ideas about control, within the models, are much linked to the more general theoretical foundations, adopted by authors, to account for the nature of processes that they formalise. The important point is here that the nature and modalities of processing would strongly determine the mode of con-

trol of these processes. Indeed, while local models of sentence production adopt sequential modes of formalisation (for example: Garrett, 1980), as well as parallel (Cf. Dell, 1986, and Chapter 2), global models of verbal production can also be distinguished as a function of theoretical foundations adopted to account for the nature of processes that they formalise. For example, Levelt's (1989) model is issued of modularist ideas while the writing model developed by de Beaugrande (1984) relies on interactive processes, most functioning in parallel. Thus, a modularist formalisation of processes often supposes the adoption of a control entity relying on a comprehension system, because processes would be impenetrable (*i.e.*, they are considered as encapsulated; Cf. Fodor, 1983 and Cf. further). In a perspective close to connectionist theories, the control of processes, here able to appear in parallel, would rather be intrinsic, relying on activation and inhibition potentials that propagate in a network.

Through these different examples, it clearly appears that an analysis of the nature of the processing control within verbal production models cannot be dissociated from an analysis of the nature of controlled processing. Before describing and discussing the control entities in different production models, the different conceptions about processing will be analysed. Thus, the double question about (1) the nature of writing processing and (2) the control nature of processes will be developed and discussed through different models, issued from cognitive psychology, speaking and of course writing research.

## 2 THE NATURE AND MODALITIES OF PROCESSING

It seems that the components formalisation of verbal production models is currently very diversified in the choice of more general cognitive models from which they are inspired. They are different modes of representations and processes in the verbal production models, and these different ideas about processing modalities can be described according to two axes. The first axis concerns the nature of processes and it globally opposes an interactionist idea to a modularist idea of processes. The second axis, partly linked to the first, concerns modalities of processing implementation. It opposes a sequential mode of processing to a semi-parallel or parallel mode of processing.

### 2.1 *Processing in interactionist models of verbal production*

The interactionist approach is currently the most classical in production models. Interactionist models can be classified into two categories: (1) computational symbolic models, supposing globally that symbolic representations are transformed by processes ordering a continuation of operations; (2) connectionist models, characterising by an absence of processes and symbolic representations and by the presence of implicit processing, linked to modifications of activation potentials (state change) in a sub-symbolic (or a-symbolic) network.

Although these two models (symbolic and connectionist) strongly differ, both concerning the idea and the formalisation of processes, they nevertheless rely on the same general interactionist principle. This principle supposes that the processes realised for a given representation level (symbolic or sub-symbolic) can modify processes realised at a superior or inferior representational level. Processes are therefore considered as interactive.

### 2.1.1 *Computational symbolic models*

*Nature of processing.* In the case of the symbolic computational approach, the interactionist nature of processing relies on the following six postulations and principles:

- The processing is managed by interactive and recursive processes. These processes are composed by an organised set of operations, each playing a role in the transformation of one symbolic representation into another.
- The process constitutive operations, as components of a more general cognitive system, do not strictly depend on a given activity.
- The relatively generic character of an operation, and maybe of a process (as, for example, the Planning process performed in most complex activities; *Cf.* Miller, Galanter, & Pribram, 1960 and *Cf.* Chapter 1) allows to process different kinds of representation, according to the nature of the activity for which this operation or this process is solicited (*i.e.*, visual, spatial or propositional representations).
- The implementation of a given operation, and, in a stronger way, of a given process, necessitates, most of the time, an aware, conscious and attentional control, supposing the allocation of a pool of limited cognitive resources.
- The attentional control of the implementation of operations and processes implies that processes can be interrupted at any given time and/or that the functioning of an operation can be influenced by processing realised by another operation. This permeability of processes, both top-down and bottom-up, mainly underlies the interactionist principle (in other words, the interaction of processes).
- The permeable and generic characters of processing operations, and the necessity to allocate them with cognitive resources propitious to their implementation, often suppose the existence of a superordinate control entity, managing the temporal sequencing of these operations, as well as the allocation of cognitive resources.

Applied on writing activity, these processing principles are the basis of the initial model built by Hayes and Flower (1980) and Flower and Hayes (1980), in order that the activity of a process can be released or interrupted according to the activity of another process. Similarly, van Dijk and Kintsch (1983) have developed, in their model, a particular mode of processing based on the top-down influence of levels of symbolic representations, through the notion of embedded strategies (*Cf.* Chapter 1). Finally, in Bereiter and Scardamalia's (1987) Knowledge Transforming Strategy, the formulating process can be interrupted to give place to rhetorical and organisa-

tional processes allowing to adjust contents to be formulated as well as the 'linguistic appearance' of this formulation.

Concerning the non specificity of processes, Hayes (1996: 13) postulates that the cognitive processes implied in writing are not exclusive to writing activity, but can be used in other types of activities, such as reading (in the case of Text Interpretation process, for example), problem-solving (in the case of Reflection process), or during conversations or drawing execution (in the case of Text production process). Finally, the idea of an allocation of cognitive resources to the different processes is equally adopted by Hayes (1996) who considers that Working Memory and Long Term Memory resources can be freely shared between writing processes.

*Modes of processing: some mainly sequential processing.* In computational symbolic models, the necessity to allocate cognitive resources (furthermore limited) to processes leads to the consideration that their respective implementation is sequential or serial. Such are equally the modalities of processes adopted by the most classical writing models, as Hayes and Flower's (1980) or Bereiter and Scardamalia's (1987) ones. These authors globally consider that writing processes, because of their respective cost, could only be applied separately. Nevertheless, a lesser necessity of attentional control and allocation of resources can be reached if the functioning of operations or processes is sufficiently automatised, as in the case of an important expertise in a given activity (Anderson, 1983a). In this case, it is possible to envisage a parallel functioning of several processes.

More precisely, it could be considered that low level processes (as graphic planning or lexical access) could function at the same time as a high level process (planning one written segment during the graphic execution of another segment; Cf. Chanquoy, Foulin, & Fayol, 1990, 1996; Power, 1986). But this parallel processing mode is considered (as it will be developed in Chapter 6, devoted to the development of expertise) only when low-level processes no longer require cognitive resources. Unfortunately, non much experimental works exist concerning the validity of such parallel processes during writing.

### 2.1.2 *Connectionist models*

*Nature of processing.* In the particular case of connectionist models, the interactivity does not concern the process activity (that are non-existent to the extent that the sub-symbolic system modifies itself by the game of activations and inhibitions propagated between the nodes that compose it), but concerns different levels of sub-symbolic representations in a hierarchical network (*i.e.*, comprising several strata of a-symbolic representations). The activation of a node in a given level propagates to the related node(s) of similar, and low or high levels. By this game of propagation of activations (and inhibitions), all modifications of one representation level (a stratum in the network) leads to modifications within another level. In this system of processing and opposed to the symbolic computational approach, modifications of the

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