

PREFACE

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Denis Alamargot and Lucile Chanquoy's book offers a vivid and original presentation of main trends in the research field devoted to writing. First, it provides both young and senior scientists with a comparative view of current theoretical models of composition, with different levels of reading made available: each element of these models is clearly situated in its historical context, and scrutinized in its further evolution. Second, this well documented theoretical analysis of writing mechanisms is checked against empirical data extracted from a lot of updated experimental studies; and lack of necessary data is thought to be underlined and defined when noted.

Following the usual description of writing phases initially proposed by Hayes and Flower, the first part of this book presents planning, translating and revision processes and compares them to other researchers' conceptions (from Bereiter and Scardamalia, to Kellogg or Galbraith). Such presentations of isolated models do exist in literature; but the present work really gives a good *comparative* analysis of components inside each of models, in a clear and cumulative way; a fine-grained observation of differences between similarly-looking models is also performed.

Such an overview allows us to note a strong evolution in conception and modelisation of writing activity: mainly descriptive and general at the beginning, models become more and more functional, often more local, and try to define exact sub-processes they comprise (for example, sub-processes of revising) and the relationships linking these elements. They also take more and more into account cognitive costs implied in managing such a complex activity, as well as individual differences and developmental or environmental aspects. New global theoretical conceptions are progressively invoked: connectionist or modularist views, for instance. Besides, more and more experimental works are led in this field, because of an higher precision of models. Strict psycholinguistic aspects nevertheless remain the poor relation in these approaches. All issues are questioned by authors caring of precision and rigor.

The second part is entirely devoted to the cognitive functioning of writing. Decisive issues are thus examined: are there sequential or parallel processes? How many cognitive resources do they consume? Does there exist a specific control structure managing different processes?

A particular chapter is devoted to a central component of most cognitive system described in literature, Working Memory, whose role is not usually analyzed in classical models of writing. A recent version of this approach, Kellogg's one, puts for-

ward the idea that the three classical writing processes are linked to the bringing to bear of the three components in Baddeley's model of Working Memory. The last chapter, very interesting, is about expertise. It allows us to differentiate developing capacity with age and acquisition (or learning) of writing with practice. Such a differentiation is performed by analyzing evolution of each sub-process and checking contributions from different developmental models (including neo-piagetian ones). And we cannot evade the final question: does really exist a developmental model of writing? Is it possible to get a model similar to those produced about spoken language, for which a social institutionalized learning does not exist? While different possible models are carefully examined, the authors are always keeping in mind the necessity of never forgetting functional aspects in change.

To conclude this fine presentation, in an interesting way, two prominent researchers in this field, John R. Hayes and Ronald T. Kellogg, have been invited to react to analyses developed in the book and to complete the presentation of their own model.

At last, this book is pleasant to read, useful to people working in teaching of writing or studying this specific human activity; it has to be included in students' lists of references.

GENERAL INTRODUCTION

A definition of writing and a presentation of the main models

1 WRITING A TEXT: A COMPLEX TASK

1.1 To elaborate a content, to write it, and to modify it

Writing a text is a complex task that needs a coordinated implementation of a large set of mental activities. Writers have to clearly delimitate the nature, the goal and the communicative function of the text. They also have to establish a precise representation about readers' characteristics and expectations, in order to anticipate systematically what must, or can, be written. Writers have equally to control the text topic so as to generate or to specify the most relevant ideas that will progressively constitute the text content. In addition, they must sometimes clarify the message, reorganise, modify and articulate ideas, while controlling the whole text coherence.

Surrounding, delimiting and adapting the text content constitute an important writing phase. In addition, it is also necessary to put ideas into words, that is to formulate them, throughout the writing process. This activity does not mean to simply copy out some words or an isolated sentence, but to clearly formulate a set of coherently articulated sentences, without any redundancy or, conversely, without too many thematic ruptures. To realise these operations, it is necessary, at least, (1) to choose the 'appropriate words' for each idea, (2) to use very strict syntactic, grammatical and orthographic rules, (3) to use correct punctuation and connection marks, in order to translate, in terms of linguistic relations, the semantic relationships linking these ideas.

These mental activities are still not sufficient to elaborate a text. A satisfactory text is only very rarely produced during the first trial. It is often the result of an important number of drafts, corrections, scratches, additions, and so on. These successive versions can certify both surface modifications, such as orthographic corrections, and deeper modifications, such as the reorganisation of the text organisation. To correct or to modify a text supposes that the writer can evaluate the quality and the pertinence of her/his own production. S/he has to read what has been written, during all the writing process, in order to be able to continue to write as well as to modify the previous text.

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1.2 To manage writing constraints

There is no optimal method to conceive the text content, to elaborate its linguistic form, to revise its content or its form and, consequently, to activate and to articulate these three activities throughout the writing process.

The writer must take into account a great number of clues that come from, for example, the writing context, imposed or posed goals, the state of writing, the text already produced, *etc.* This set of clues can represent as much constraints as the writer has to understand and to use in order to manage the necessary mental activities during writing and to control their efficiency. In other words, the writer has to elaborate an efficient writing strategy.

However, these clues do not constitute the unique constraints for the choice of a strategy. The writer's capacities to simultaneously operate a more or less important number of mental activities can equally play a central role. For example, the most or less important limitation of processing capacities can constrain the writer in the choice of appropriate mental activities, and perhaps in the activation of these activities. Thus, a writer not being able to think about the text continuation while writing, must frequently alternate phases of content research and phases of handwriting.

When we look at this great number of mental activities to be realised, managed and controlled, answerable to external as well as internal constraints, it is easy to understand that the writing expertise could only develop very slowly in children, and sometimes even to be very approximate in adults. To write good quality texts, both linguistically and semantically, requires from the writer a lot of practice, training and technique. Thus expertise certainly needs (1) the activation of writing strategies more complex than those generally used by novices, (2) the possibility to simultaneously manage a greatest number of constraints, and/or (3) a sufficient writing practice to automatise letter transcription or spelling rules.

1.3 Text production: a possible definition in the context of cognitive psychology

The diversity of mental activities of text writing implies that its study is both attractive and difficult. The text production activity can thus be very relevant and interesting for cognitive psychology because it supposes the activation of a great number of processes, that do not only concern verbal production, but equally reading and comprehension. In this view, the study of text production offers the possibility to analyse the functioning of numerous mental mechanisms that have often been defined and studied in isolation in other psychology areas. It is thus possible to study the conditions of process activation and interaction, processes ensuring, for example, (1) content retrieving and planning, (2) information encoding and maintaining in Working Memory, or (3) text reading and understanding, in very specific contexts.

From a cognitive viewpoint, we think that text production can be defined as a finalised and complex activity, because it supposes to process, by the implementation of several mental processes, and with a general goal – to write in order to communicate, for example – a great amount of knowledge. Thus, writing a text can be compared to a problem-solving situation whose resolution implies complex cogni-

tive activities and abilities. In such a problem-solving context, the resulting product – the written text – requires at least the uses of four types of knowledge: (1) Domain knowledge (the conceptual domain to be expressed in the text), (2) Linguistic knowledge (grammatical rules and lexical items that compose the text), (3) Pragmatic knowledge (that allows the writer to adapt for the addressee the conceptual content as well as the linguistic form of the text), and (4) Procedural knowledge (in order to use the three preceding types of knowledge and to strategically process them).

A general writing process fulfils the processing of each of these kinds of knowledge. This process ‘transforms’ the domain knowledge into a (necessarily) linear linguistic product, which must comply with a specific communicative goal. Due to the limited processing capacity of the cognitive system, the global transformation process is progressive and subdivided into a given number of sub-goals (*i.e.*, to elaborate, to write, to modify, *etc.*). Each sub-goal is realised by series of specific processes (*i.e.*, ordered sequences of mental operations) which are controlled by procedural knowledge (*i.e.*, knowledge for the application of processes).

1.4 *Some models to delimit and to define the necessary processes and knowledge*

It is easy to understand, while reading this possible definition of text writing activity, that researchers’ important difficulty is to be able to identify, to study and to integrate, in a complex system, these different mental mechanisms (*Cf.* Hayes, 1989). The complexity of this system is such that it is not possible to try this integration without using a *model* in order to delimit, to surround and to *a priori* define processes, knowledge and modes of processing necessary for the production of a text. The term of model is here considered as a blueprint, a simplification, or an outline. Text writing models allow researchers to focus on some dimensions of the writing task, without forgetting that these dimensions belong to a complex system. Mainly prospective, these models propose a relatively precise and analytic definition of the writing activity, both concerning the process architecture (in terms of arrangement of these processes in models as well as in terms of definitions of sub-processes or operations that compose the processes) and functioning (in terms of process management rules, control and activation in Working Memory). These models lead to a great number of experimental studies, but have still not reached a sufficient level of formalisation in order that a computer simulation, for example, could be possible.

1980, 1987, 1989 and 1996 represent four very important years for those cognitive psychologists who are interested in text production activity. It is in 1980 that Hayes and Flower published the first general model of text writing. After that, Bereiter and Scardamalia elaborated the first developmental writing model, in 1987. Two years later, in 1989, Levelt proposed a very precise modelisation of speaking activity that has greatly influenced models and works in the area of writing. Finally, 1996 is a prominent year. It corresponds to the modification, by Hayes, of the initial Hayes and Flower’s model, and to the publication, by Kellogg, of a model of text writing articulating processes and Working Memory, as conceived by Baddeley (1986).

2 THE MAIN MODELS OF VERBAL PRODUCTION

2.1 1980: Hayes and Flower's model

Hayes and Flower's model has been published in a collective book entitled '*Cognitive processes in writing*', edited by Gregg and Steinberg in 1980. It is probably one of the first books standing up for a cognitive approach to writing. The model elaborated by Hayes and Flower is presented in two successive chapters in this book. The first chapter, entitled 'Identifying the organisation of writing processes' proposed a description of writing processes and architecture while a second chapter, entitled 'The dynamic of composing: Making plans and juggling constraints', written by Flower and Hayes, rather focused on the functioning of the model, in terms of constraints linked to the activation of processes.

On an architectural viewpoint, the model of Hayes and Flower (1980) is composed of three main parts: the Task Environment, the writer's Long Term Memory, and the general writing process (Cf. Figure 1).

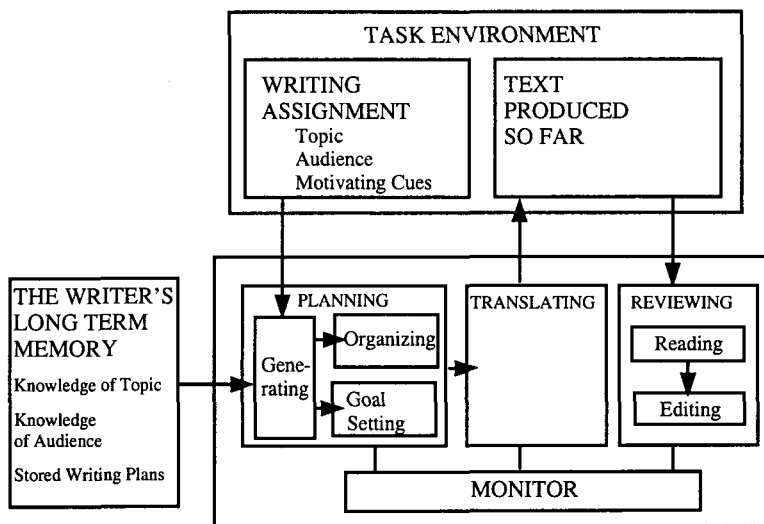


Figure 1: Hayes and Flower's model, adapted from Hayes and Flower (1980). Copyright © 1980 by Lawrence Erlbaum Associates. Adapted with permission.

The 'Task Environment' comprises all that is outside of the writer and can influence the performance. This environment is composed of:

- some writing instructions that determine (1) the general theme of the text to be written (Topic); its communicative goal (Audience), and (2) some motivational factors deriving from the writing situation (Motivating Cues),

- the text, gradually written (Text produced so far), that is going to be used as a reference for the writer, in order to progress as well as to revise the already written text.

The 'Writer's Long Term Memory' contains three knowledge areas concerning:

- the general text topic (domain knowledge – Knowledge of topic),
- the communicative act (pragmatic knowledge – Knowledge of Audience), and finally,
- linguistic knowledge about specific text plans, for example, story grammars (Stored Writing Plans).

The general writing process is composed of three processes that allows to transform domain knowledge in a linguistic product (with their sub-processes and/or associated operations) and a process of control. These processes are:

- the 'Planning' process with three sub-processes: 'Generating', 'Organising' and 'Goal-Setting',
- the 'Translating' process,
- the 'Reviewing' process, with the sub-processes of 'Reading' and 'Editing',
- the management and control process, called 'Monitoring' and that defines the order of activation of the three preceding processes.

More precisely, the main function of the Planning process is to establish a writing plan from (1) domain knowledge retrieved from Long Term Memory, and (2) information extracted from the task environment. This plan guides text writing by defining the main goal and the sub-goals. As seen above, this plan can also be retrieved from Long Term Memory, if it has been stored among the writer's knowledge (Stored Writing Plans). Otherwise, it has to be built through three sub-processes: the retrieving (Generating) of the different pieces of knowledge stored in Long Term Memory; their organisation (Organising) in a writing plan, and the elaboration of criteria that will allow to judge the appropriateness between the written text and the intentions (Goal Setting).

The Translating process runs under the control of the writing plan and translates domain knowledge in language. According to Hayes and Flower (1980), the functions of this process are: (1) to retrieve, from Long Term Memory, complementary knowledge allowing (2) to develop each part of the writing plan before (3) translating the retrieved propositions in correct sentences (by means of lexical and grammatical processing).

Finally, the Reviewing process evaluates the appropriateness between the written text and the linguistic, semantic and pragmatic particularities of the writing goal. Two sub-processes carry out the revising activity: the analytical reading of the already written text (Reading) and its possible correction (Editing).

These three processes are managed by a control process – Monitoring – whose function is, among others, to regulate the recursion of their application.

The methodology adopted by the authors, to elaborate and validate this model, involved a verbal protocol analysis that was developed by Newell and Simon (1972) to study problem-solving processes. Although elaborated only on the basis of the protocol of one unique participant (speaking about his mental activities during ex-

CHAPTER 1

PLANNING PROCESS

1 INTRODUCTION: PLANNING IN WRITING

When they have to write a text, writers have generally to think, to anticipate, to foresee what they will write. This anticipation can involve the content (what has to be told) as well as the linguistic form (how to tell it) of the text. It is besides common to think that the longer and/or more intensive this reflection activity will be, the easier to write and the higher the quality of the text will be. Consequently, this text will not need any important modifications or corrections afterwards.

1.1 Planning: a general cognitive activity involved in text writing

‘Thinking before acting’ is not specific for text writing. Classically defined by Miller, Galanter and Pribram (1960) as ‘Planning’, this activity is a very general process that underlies every human task oriented by a goal, and which allows someone to differ in time every complex task, that cannot be simultaneously achieved because of human processing limited capacities. Planning can thus be considered as a high level cognitive skill or as a mental activity driven by memory (*Cf.* Akyürek, 1992: 103). Thus, planning does not simply consist of selecting plans or information stored in Long Term Memory but this activity can be more precisely defined as containing deliberate start up strategic procedures and practical goals. The planning process, conceived as ‘*the schematisation of a complex situation that has to be solved*’ (Hoc, 1987: 37, our translation), appears to be the most effective strategy to process different complex cognitive tasks and, in this way, it is involved in most cognitive activities.

In the case of verbal production, the Planning process is conceived as a ‘main determiner’ (Scardamalia and Bereiter, 1985). This process is costly in cognitive resources (Bock, 1982; Kellogg, 1996) and could take, in a specific situation, two thirds of the total production time (Gould, 1980). Within text writing activity, this type of processing can be found within each writing level, from the elaboration of a text plan to the elaboration of a graphic transcription plan. But more specifically, different kinds of planning can be distinguished (Barritt and Kroll, 1978; Hayes and Nash, 1996; Kaufer, Hayes and Flower, 1986). Hence, an important difference has to be made between planning of processes (that would consist of ordering the execution of different writing processes in a strategic way), and planning of contents (that would consist of delimiting, in organising and in adapting – according to the audience – the plan of the text – *Cf.* Piolat, 1987).

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1.2 Different planning activities in text writing

Flower and Hayes (1980, 1981b) have distinguished different kinds of planning activities by describing three types of processing that would underlie the elaboration of plans of different natures, dedicated to different activities (*Cf.* Figure 8). Thus, for the authors, there are three plans: a Plan To Do, a Plan To Say, and a Plan To Compose.

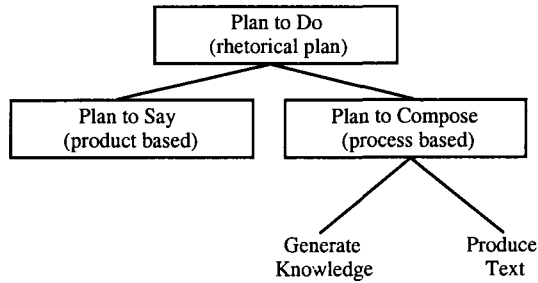


Figure 8: Different plans involved in writing activity, adapted from Flower and Hayes (1980). Copyright © 1980 by Lawrence Erlbaum Associates. Adapted with permission.

The Plan To Do, that could also be called 'Rhetorical Plan', permits the management of pragmatic constraints during the writing activity. It includes writer's and reader's characteristics, as well as the general topic of the text. The Plan To Say is a content plan (or a 'Declarative plan') that represents a summarised and simplified version, or an abstraction, of the whole set of information that will be translated in the text. The Plan To Say can be considered as the plan of the text. The Plan To Compose is not a content plan but rather a process plan (*Cf.* Espéret, 1989, for a discussion the differences between process and content plan). It determines the order in which the different writing processes and sub-processes will appear (as a 'Procedural plan'). This plan enables the transformation of domain knowledge (*i.e.*, for the authors, 'Generate Knowledge': generating and organising) as well as the linguistic translation of the semantic content ('Produce Text').

Inspired by Flower and Hayes' (1980) conception, Hayes and Nash (1996: 43-45) have recently improved such a categorisation of the different planning types involved in writing activity, by differentiating the nature of representations concerned by each kind of planning (for instance, content, non content or text representations). According to Hayes and Nash, planning in text writing could be decomposed into a hierarchical set, regrouping different types of 'sub-planning' activities (*Cf.* Figure 9). To describe planning in writing firstly requires distinguishing the planning of processing and writing main goals (Process Planning) from the textual and linguistic planning (Text Planning). While the first one is focused on the writer and the strategy to comprehend and execute the task, the second one is centred on what is being

written, that is to say the text content, its form and its awaiting impact upon the addressee.

Furthermore, according to Hayes and Nash (1996), the Text Planning is shared into an Abstract Planning and a Language Planning. The first one generates ideas, without specifying the language to be used. The second one is involved in the production of a grammatically and syntactically correct text. This last type of planning generally corresponds, in writing models, to the formulating stage (*Cf.* Hayes & Flower, 1980; Chapter 2). Finally, the Abstract Planning can be divided into two parts. The Planning allows solving rhetorical problems – the evaluation of the appropriateness between the text, the addressee and the writer’s goal. The Content Planning generates a simplified version of information to be expressed. These two kinds of Abstract Planning could respectively correspond to the ‘Planning to Do’ and the ‘Planning to Say’ sub-processes as defined by Flower and Hayes (1981b).

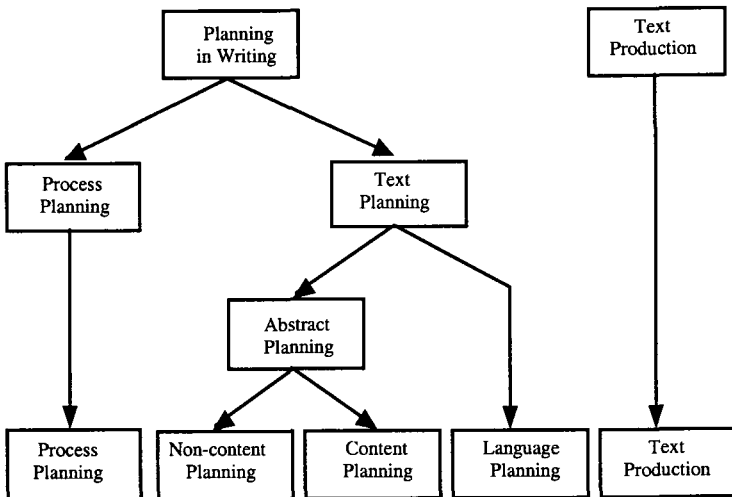


Figure 9: Taxonomy of different types of writing planning, adapted from Hayes and Nash (1996). Copyright © 1996 by Lawrence Erlbaum Associates. Adapted with permission.

These various kinds of planning can equally be characterised by the nature of the related mental operations. Hayes and Nash (1996) distinguish three kinds of processing involved in planning: ‘Planning by Abstraction’, ‘Planning by Analogy’ and ‘Planning by Modeling’. Planning by Abstraction, consisting of manipulating and ordering abstract concepts, would be more particularly involved in the case of Content Planning – drafting an abstract content of the future text, independently of the translation modalities of this content. Planning by Analogy allows generalising knowledge involved in a specific activity, resulting in a similar or a close activity. This kind of process would be used, in writing activity, each time that a text schema or a previous text plan can be adapted and used to write a new text. Hence, the ge-

neric application of a narrative schema, in the case of narrative text writing, can be a good example of Planning by Analogy, which is equally involved in content planning and economically replaces the Planning by Abstraction. Planning by Modelling can be distinguished from Planning by Abstraction in the sense that the first one does not focus on gists or abstract ideas – like plan text content – but takes into account the entire set of information needed to execute a given task. According to Hayes and Nash (1996), this mode of planning could occur during the linguistic formulation stage, when a sentence or a clause can be entirely and mentally planned before its graphomotoric execution.

1.3 Planning to elaborate the plan of the text

The various definitions presented above seem to be a good demonstration of the fact that planning, in writing activity, is a very complex notion and rests on various mental operations, bearing on various representations. However, in general writing models, the concept of planning is mainly used to account for a ‘preparatory thought’ (Hayes and Nash, 1996), allowing the elaboration of a text plan (Hayes and Flower 1980; Hayes and Flower, 1986; Hayes and Nash, 1996). The plan, elaborated during planning processing, globally depends on:

- both topic and objective of the production (*i.e.*, to write a text to distract, to inform, to explain...),
- the addressee (*i.e.*, to write a text for a known or unknown reader, for a friend, for a professor, *etc.*; *Cf.* Caccamise, 1987; Ransdell & Levy, 1994; Rubin & Piché, 1979),
- the text type (*i.e.*, to write a text in order to explain, to describe, to argue, *etc.*; *Cf.* Cooper & Matsuhashi, 1983; Martlew, 1983) and,
- knowledge available in Long Term Memory, as a function of the expertise level concerning the domain knowledge of the text (*Cf.* Kellogg, 1987a; Martlew, 1983; Voss, Vesonder, & Spilich, 1980).

In the initial model of Hayes and Flower (1980), this process, simply labelled ‘Planning’ is introduced as one of the three main processes in writing activity (with Translating and Reviewing processes). According to Hayes and Nash’s (1996) taxonomy, this planning process, dedicated to the content, could be ensured by a mode of Planning by Abstraction. Planning process, as described by Hayes and Flower (1980), is central in the organising of text content and in the processing of content coherence. More precisely, according to the authors, the main role of Planning process is to establish a writing plan by using (1) domain knowledge retrieved from Long Term Memory and (2) information available in the Task Environment. If this writing plan has not been previously stored in the writer’s memory (Stored Writing Plans and, for Hayes, 1996, Planning by Analogy), it must be entirely produced by means of three sub-processes: (1) Generating knowledge from Long Term Memory, (2) Organising this knowledge into a writing plan, and (3) Goal Setting – establishing criteria to test the appropriateness between the written text and the communicative goals.

The functioning of such a Content Planning process has been differently conceived and formalised in the main models of verbal production. Here, the description of content planning is globally guided by the organisation of the Planning process as defined in Hayes and Flower's (1980) model. Thus, we will first detail the functioning of Generating and Organising sub-processes, before considering, through Goal Setting sub-process, the nature and the role of pragmatic processes during planning.

2 THE GENERATING SUB-PROCESS

2.1 *Definition of the Generating sub-process*

The sub-process labelled 'Generating' by Hayes and Flower (1980), consists of retrieving domain knowledge units from Long Term Memory and organising them into a writing plan (*Cf.* General Introduction). A memory probe (according to the classical definition of Raaijmakers & Shiffrin, 1981), initially elaborated on the basis of a writing instruction (defining the topic, the type of text and the audience), would retrieve a first knowledge unit, serving in turn as a probe to retrieve the following unit, and so on. The initial probe would trigger off a 'chain reaction', ending in a final product comparable to an associative chain of units (*Cf.* Figure 10).

During this sub-process of domain knowledge retrieving, a processing operation, called 'Evaluate Retrieved Element', may interrupt this associative chain if contents retrieved are not suitable regarding, for example, the theme of text. In this case, if the writer's objective is to generate contents, some new memory probes are elaborated instead of the inappropriate probes. Finally, it is interesting to notice that the Generating sub-process is not only dedicated to the mental content recovery but also involves an operation named 'Consider Notes' that evaluates the possibility to linguistically translate the knowledge unit *via* an operation labelled 'Write Note'.

If we now consider this last point, the functioning of the Generating sub-process, as conceived by Hayes and Flower (1980), is relatively similar to that described by Bereiter and Scardamalia (1987), in the framework of the Knowledge Telling Strategy generally adopted by younger and/or less skilled writers (*Cf.* General Introduction, page 7).

According to Bereiter and Scardamalia (1987), the content generation process within the Knowledge Telling strategy is ensured by an iterative set (like a routine) composed by three operations (*Cf.* Figure 2, page 7) called 'Construct Memory Probe', 'Retrieve content from memory using probes' and 'Run test of Appropriateness'. Globally, these operations, under the control of the text theme and genre, respectively underlie: (1) the elaboration of memory probes, (2) the effective retrieving of domain knowledge units, before (3) the relevant evaluation of these units.

As in Hayes and Flower's (1980) model, a first knowledge unit would be initially retrieved, *via* a memory probe, elaborated on the basis of minimal cues constituted by the text theme and genre. This first retrieved unit would contribute to the elaboration of new memory probes allowing the retrieving of another unit, strongly connected to the previous one. This chained retrieval, more precisely defined than in Hayes and Flower's (1980) model, would obey, according to Bereiter and Scar-

CHAPTER 2

TRANSLATING PROCESS

1 INTRODUCTION: FROM CONTENT ELABORATION TO GRAPHIC EXECUTION

According to Hayes and Flower's (1980) model, the writer would have built, as an output of the Planning process (Cf. Chapter 1), a content plan. This plan, following communicative and eventually rhetorical intentions, lists an organised structure of the main themes or main ideas of the to-be-written text. However this content plan is just a general plan. It can only permit to plan the general text content and to keep the global coherence. It does not provide any detail about this content and, furthermore, any information about the future 'linguistic and physic aspects' of the text, on paper or on a computer screen. In other words, if the Planning process organises and plans, it does not enable the effective composition and realisation of the text. Indeed, after the Planning process, the writer has to (1) elaborate the text content by developing each part of the plan that needs to be developed, and (2) translate this developed content into a linguistic form. It is in this way that Hayes and Flower (1980: 15) consider that *'the function of the translating process is to take material from long term memory under the guidance of the writing plan and to transform it into acceptable written English sentences'*. The general definition of the Translating process they propose is underlined by the fact that these authors consider that the domain knowledge is not linguistic nor linear: *'We assume that material in memory is stored as a proposition but not necessarily as language. By a proposition we understand a structure [...] where concepts, relations and attributes are memory structure, perhaps complex networks or images, for which the writer may or may not have names (p. 15)'*. This claim highlights that the writer, during Translating, needs to bridge the gap between hierarchically organised conceptual thoughts (networks, for instance) and a linearly organised linguistic structure.

1.1 *Translating process in Hayes and Flower's (1980) model*

In Hayes and Flower's model (1980), the change from a conceptual structure to a linguistic structure is carried out by six Translating operations, respectively labelled: 'Get next part of writing plan'; 'Plan next sentence: Retrieve propositions'; 'Express next proposition part'; 'Repeat first part of sentence'; 'Express proposition part' and 'Interrogative' (Cf. Figure 14).

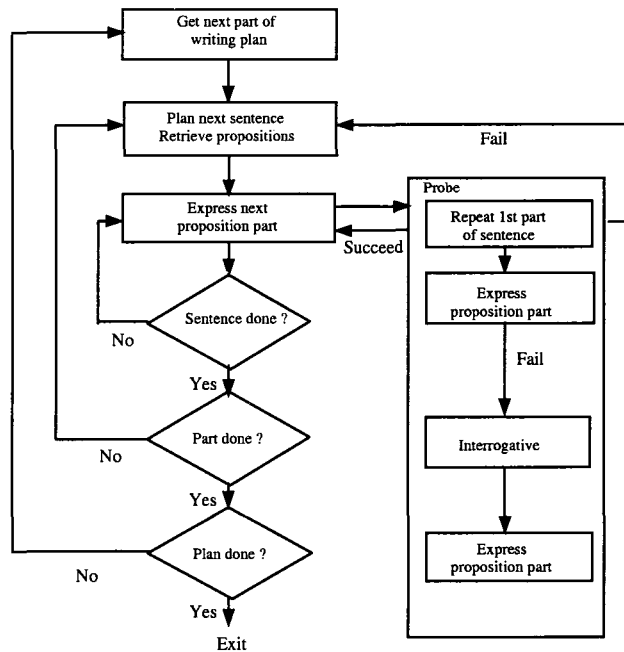


Figure 14: Architecture of Translating process, adapted from Hayes and Flower (1980).
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According to the authors' description (pp. 15-16), the 'Get next part of writing plan' operation would allow the writer to retrieve (and certainly to maintain in Short Term or Working Memory) a new piece of the text plan. The elaboration of a sentence, controlled by this activated piece of plan, would be carried out by the 'Plan next sentence: Retrieve propositions' operation. This operation would have a double function: it would allow (1) to retrieve, from Long Term Memory, some propositions, which can be considered as semantic structures (for example: 'Concept: Horse'; 'Action: To gallop'; 'Attribute: Fearful'), and then (2) to relate these propositions into a sentence plan ('Horse = To gallop' [because] 'Horse = Fear'). This plan, which can be considered as 'syntactico-semantic', would then be next linguistically translated, part by part, by the 'Express next proposition part' operation.

The linguistic translation could be controlled in order to verify and to optimise the local coherence or the sentences syntactic structure. To do so, the 'Repeat first part of sentence' operation would allow to maintain in Short Term Memory the previously translated part of the sentence (*i.e.*, 'The fear...') so as to retrieve the linguistic form to better express the proposition that is semantically linked through the 'Plan next sentence: retrieve proposition' operation. During this research, the 'Interrogative' operation would select more and more suitable linguistic forms (*i.e.*, '...').

the fear, which causes the horse to gallop...'; 'the horse is galloping because he is afraid...'; etc.) while the 'Express proposition part' operation would mentally test these forms before their effective transcription, *via* the 'Express next part of proposition' operation ('The fear makes the horse gallop').

1.2 *Qualities and limits of Hayes and Flower's (1980) model*

1.2.1 *Six Translating operations defined*

The description Hayes and Flower (1980) have made concerning the nature and the functioning of Translating operations shows that, conversely to Berninger and Swanson's (1994) objection, the Translating box is not so 'desperately empty', as it is observed in the schema of the model. Thus, if Hayes and Flower do not develop the Translating process as precisely as for the Planning process, they define six processing operations. These operations carry out the transformation of a hierarchically organised structure of the domain knowledge into a linear linguistic structure. In addition, it seems important to notice that the description of the nature of these six operations shows that Translating processing does not only carry out the linguistic (*i.e.*, grammatical and lexical) translation, but also conceptual (*i.e.*, non linguistic) processing. This last process elaborates the content of the future text, under the control of the text plan, and transforms this content into a preverbal message that will be linguistically translated. In other words, the different kinds of Translating processing would concern conceptual representations (*i.e.*, retrieving domain knowledge, syntactico-semantic planning) as well as linguistic representations (*i.e.*, grammatical and lexical translating of planned propositions).

1.2.2 *The necessity to explain the nature and the functioning of the Translating process*

Whether Hayes and Flower's (1980) proposals on Translating operations seem interesting and judicious, the description they made is nevertheless relatively superficial and general. Many points must thus be clarified, concerning both 1) a precised definition and 2) the strategic and recursive functioning of these Translating operations.

To complete the definition of Translating operations: towards four processing stages. The definition of Translating operations by Hayes and Flower (1980) raises a certain number of questions or discussion points:

- The fact that they consider that some memory contents are retrieved, from Long Term Memory (under the control of the text plan), supposes the presence of a retrieving sub-process (or operation) which would function solely during Translating. However, Hayes and Flower (1980) do not explain this retrieving mechanism. Can it be considered as the Generating sub-process, that the authors define as belonging to the Planning process?

- In addition, it is not obvious to consider that the propositions, even if they are retrieved under the control of the text plan, can be directly used to constitute the future sentences. Despite this observation, no semantic elaboration or re-elaboration mechanism of retrieved propositions is found.
- The model is also relatively imprecise regarding principles of proposition insertion into a sentence plan. This processing would be carried out only by one operation, that being labelled 'Plan next sentence: retrieve proposition'. It is nevertheless not so obvious that the proposition retrieval and the sentence semantico-syntactic planning use the same kinds of processing. Another processing distribution, sharing more clearly content retrieving and content planning, could be discussed.
- Beyond the processing distribution, it is important to make it clear that linguistic processes, which are actually the heart of the Translating process, are simply identified through operations such as 'Express next proposition part' or 'Express proposition part' (Cf. Figure 14), with no details, once again, about the nature of the underlying lexical and grammatical processes. It seems nevertheless very important to explain how the matching between a conceptual structure (some semantic propositions) and a linguistic structure (grammatical and lexical) can take place and with what kinds of criteria.
- Finally, Hayes and Flower (1980), opposed to Kellogg (1996, Cf. General Introduction) do not describe handwriting or typewriting operations that carry out the physical output of linguistic processes, that is the transformation of the linguistic mental product into a written trace.

These critical points concerning Hayes and Flower's (1980) model show the necessity to specify the definition of processing led by the Translating process. Some responses can be found in other models (as well global as local) of verbal (oral or written) production. To describe and analyse the nature of Translating operations through these different models, we propose to take into account our previous critics, to distinguish four processing stages. They can be differentiated by the nature of processing operations that compose them, or by the nature of representations that they process. We label these stages 'Elaboration', 'Linearisation', 'Formulation' and 'Execution'.

- The Elaboration stage consists of retrieving and elaborating the text content from a piece or the totality of the text plan. Within Hayes and Flower's (1980) model, this step mainly concerns processing carried out by the 'Get next part of the plan' operation and by a part of processing ensured by the 'Plan next sentence: retrieve propositions' operation, which here focuses on the content retrieval.
- The Linearisation stage enables a first transformation of these contents in a linear semantico-syntactic structure. This transformation would correspond to the other part of processing ensured by the operation 'Plan next sentence: retrieve proposition', which is here the planning of the next sentence.

- The Formulation stage, mainly linguistic, puts into words and into a grammatically correct form the previously planned semantico-syntactic structure. It concerns a linguistic stage of sentence elaboration.
- The fourth stage, called Execution, carries out planning and graphic execution of the linguistic product; it thus concerns handwriting as well as typewriting.

Surrounding the dynamics of the Translating process. Beyond imprecision concerning the definition of Translating operations, few indications are provided of the activation, the progress or the temporal sequencing of these operations. The processing recursion nevertheless appears as a fundamental necessity. The transformation of ideas into text does not obviously operate during one unique process activity, but more likely during recursive processing cycles. Throughout the writing activity, some portions of plans are activated, developed, then expressed in linguistic terms. This is probably realised on small units. The question is then to identify the nature of these units. Hayes and Flower (1980) consider that a sentence is produced part by part. This cycle of processing is however only postulated. Are there experimental results to validate this notion of processing units? The observation of on-line parameters (such as pause duration, Cf. Chapter 1) can represent an interesting investigation means to appreciate the temporal progress of processing cycles during content elaboration and linguistic formulation.

In the following parts of this chapter, the nature of the Translating process is analysed by describing, through different models, each of the four processing stages, which characterise the Translating process (Section 2). Then, the principles of dynamics and recursion of the Translating process are developed (Section 3).

2 THE NATURE OF TRANSLATING OPERATIONS: FOUR PROCESSING STAGES

2.1 *Stage one: elaboration of text content from the writing plan*

During Translating, the writer has to retrieve all the sets of ideas about a topic or a sub-topic, which is defined by a part of the text plan. According to Hayes and Flower (1980: 15), domain knowledge units or structures, which are retrieved from Long Term Memory, are formatted into a propositional structure, labelled 'Argument-Predicate', and built, for example, such as: <(Concept A) (Relation B) (Concept C)> or <(Concept D) (Attributes E)>. This retrieval can be executed by using, as memory probe, the main idea from a part of the text plan. The content, retrieved under the control of the text plan, can thus be considered as an elaboration and a specification of main ideas. This possible definition of the elaboration of the text content raises two central questions as for the definition and principles of content generation. The first question focuses on the possible specificity of the content generation during Translating as compared to the content generation during Planning. The second focuses on the nature of operations that could evaluate and modify the

CHAPTER 3

REVISING PROCESS

1 INTRODUCTION: REVISING PROCESS IN WRITING

Fitzgerald (1987: 484) wrote:

'revision means making any changes at any point in the writing process. It involves identifying discrepancies between intended and instantiated text, deciding what could or should be changed in the text and how to make desired changes and operating, that is, making the desired changes. Changes may or may not affect meaning of the text and they may be major or minor.'

The key elements of this definition concern the fact that revising involves making some changes, whatever they are, not only in the text but also during the whole writing process. For the author, revision necessitates three main operations: identifying a problem, deciding about any change and operating it. It also involves two objects (the intended text and the instantiated text), two types of rules (conventions: what should be changed, and rhetorical rules: what could be changed), and strategies (how to implement the desired changes).

Despite the apparent simplicity of this definition, numerous other definitions of revision are found in the literature and can be very different. This fact underlines the ambiguity of the term 'revision', that designates both the realisation of a correction and the different procedures (or processes) used to revise (Freedman, 1986).

It therefore appears important, in this chapter, (1) to clearly define the term of revision, (2) to expose, through several models, how the activity of revision operates, and (3) to try to surround problems that prove to be important to solve when proposing a procedural and functional model of revision.

1.1 Definition of the revising process

In Hayes and Flower's (1980) model, the revising process, called 'Reviewing', is conceived as being recurrently distributed throughout the writing activity. This process is composed of two sub-processes, respectively labelled by the authors 'Reading' and 'Editing' (Cf. General Introduction). The Reading sub-process allows the writer to detect errors and to evaluate the appropriateness of the written text in relation with the communicative goals established during the Planning process. The Editing sub-process appears as a system of production rules to solve problems.

While rereading the text, the writer can perceive dissonance between intention and production (Scardamalia and Bereiter, 1983), which asks for or necessitates a D. Alamargot & L. Chanquoy (2001). Revising process. In G. Rijlaarsdam (Series Ed.) & D. Alamargot & L. Chanquoy, *Studies in Writing: vol 9. Through the Models of Writing*, 97 – 121. © 2001 Kluwer Academic Publishers. Printed in the Netherlands.

correction stage. This procedure of correction can, according to Bartlett (1982), be outlined in three main sub-processes: Detection, Identification and Modification of the text portion considered as erroneous by the writer. However, the already written text is not the unique object of revision. Revision is also a process of rethinking thoughts, of evaluating and clarifying them (Chanquoy, 1997, 2001; McCutchen, Francis and Kerr, 1997; McCutchen, Hull and Smith, 1987). In fact, the revision activity can be considered as an activity of text reading or thought evaluation, followed, in the case of dissonance(s), by some corrections. In this way, the revision can then be defined as a set of processes, that consist, as previously defined by Fitzgerald (1987), of identifying a problem, deciding whether to change or not the part of the text in which the problem has been found, and selecting a strategy and operating it. In addition, writers carry out revisions in order to verify and improve their texts (Faigley and Witte, 1981; Hayes and Flower, 1986; Hayes, Flower, Schriver, Stratman and Carey, 1987), but also to verify and eventually improve the mental representation(s) elaborated during the writing activity. The revision can thus be considered as a complex process that would heavily weigh on writer's limited attentional capacities (Beal, 1996; McCutchen, 1996).

1.2 Taxonomy of revisions

Another approach to define the revising process is to classify the different kinds of revision that appear in texts. Some authors have tempted to categorise revisions, according to certain types of criteria. For example, Sommers (1980) has specified four revising operations: the 'Deletion', the 'Substitution', the 'Shifting' and the 'Reorganisation', that can be carried out in four different linguistic levels: the word, the phrase, the sentence, or the idea. Monahan (1984) has added or modified dimensions to Sommers' categorisation. The author proposed four dimensions: (1) the moment during which the revision occurs (for example, on the draft or on the final copy), (2) the linguistic level of the revision (to revise a word, a phrase, a clause, a sentence, a paragraph, or the whole text), (3) the type of correction (addition, deletion, rearrangement, embedding) and finally, (4) the objective of the revision (visual presentation of the text, spelling, style, emphasis of transitions, supplementary information, *etc.*). The important point in this classification is that Monahan extended the definition of revision, with a goal-related and a functional perspective. In a more general way, two great types of modifications, or again two categories of revising activities are taken into account by Chanquoy (1997): (1) the changes she labelled 'Surface Revisions', which comprise modifications of punctuation (addition of a capital letter or a punctuation mark), the re-writing of a word or a text segment considered as hardly legible, spelling corrections, grammatical spelling (subject-verb agreements, verb tenses, *etc.*), and (2) the 'Deep' or 'Semantic Revisions', that modify the sense of the text and comprise additions, deletions, shifting, substitutions and transformations of words, phrases, clauses, sentences or longer text segments. Furthermore, for each of these categories, the modifications can be considered as cor-

rect, erroneous or neutral (*i.e.*, neutral corrections do not improve the quality of the text, but do not decrease it; *Cf.* also Scardamalia & Bereiter, 1983).

Although there currently exists a relatively great variety of revision classifications, the taxonomy elaborated by Faigley and Witte (1981, 1984), even if it is now outdated, is nevertheless still the only one that takes into account both syntactic and semantic aspects of revision. Indeed, six types of operations and six linguistic levels are distinguished. This classification considers, as the preceding proposal, the level of text considered: revisions can be superficial (*i.e.*, surface changes), or change the meaning of the text (*i.e.*, text-based – semantic – changes). In addition, this classification proposes a certain number of revising subcategories. Thus, surface changes can be formal (formal changes: spelling, punctuation, *etc.*), or can preserve the text meaning (meaning-preserving changes: additions, deletions, *etc.*). Similarly, text-based changes can be micro- (additions, deletions, *etc.*) or macro-structural (*Cf.* Table 2).

Table 2: Taxonomy of revision, adapted from Faigley and Witte (1981)

Surface revisions	
Formal Changes (conventional editing revisions)	Meaning preserving changes (paraphrases)
Spelling	Addition
Tense	Deletion
Number and modality	Substitution
Abbreviation	Permutation
Punctuation	Distribution
Format	Consolidation
Semantic revisions	
Microstructural changes (minor revisions)	Macrostructural changes (major revisions)
Addition	Addition
Deletion	Deletion
Substitution	Substitution
Permutation	Permutation
Distribution	Distribution
Consolidation	Consolidation

According to this table, in surface changes that keep the meaning and in micro- and macrostructural revisions that modify the meaning, the operations are the same, only their depth level in the text can change.

Whatever the chosen taxonomy to classify revisions, it is always difficult to distinguish between a surface or a mechanical error and a meaning error (*Cf.* Chanquoy, 1998). The addition of an adjective can, for example, be considered as a surface modification, because it does not modify the meaning of the text, or as a deeper

change, changing the meaning of the sentence. For example, if the sentence '*the boat was sailing on the sea*' is revised as '*the boat was sailing on the blue sea*', the modification is only a superficial one, and does not change the global meaning of the sentence. Conversely, if this sentence is modified to '*the boat was sailing on the furious sea*', the meaning is radically changed.

Besides classifications exclusively concerning revisions of the already produced text, some authors distinguish two modes of revision (revision here in the sense of the activity of correction): an updating activity, automatically released and an activity of revision, controlled and intentional. The controlled revision activity would intervene during precise moments of the writing process (Matsuhashi, 1987) and would then be opposed to the editing activity (Editing sub-process of Hayes and Flower, 1980), automatised and mechanical, able to intervene at any given time during writing, and even to interrupt the other processes (Cf. Bridwell, 1980; Faigley & Witte, 1981, 1984; Graves, 1975; Hayes & Flower, 1980; Kaufer, Hayes, & Flower, 1986; Perl, 1979).

The term of revision therefore designates both the complex process of changes carried out during writing and the changes effectively realised by the writer. Up till now, the authors have generally distinguished between effective revision on paper and mental revision (Cf. *supra*). The first category has been classified, as previously mentioned. Conversely, the second type, due to its mental aspect, is more difficult to approach and categorise, except when researchers use, for example, verbal protocol analyses. Thus, this definition of revision can be proposed: something (*i.e.*, a word) is done (*i.e.*, added, deleted, *etc.*) to reach a certain goal (improving style, content), at a certain text level and on a certain text (pretext, already written text), at a certain moment (*i.e.*, draft, final copy), with a certain effect (*i.e.*, improvement, neutral, decreasing effect) and with a certain cognitive cost.

Even if, through the previous theoretical presentation of revision, it is possible to roughly define the revising process, it is still quite difficult to explain how revision works. It is therefore by means of models, presented hereafter, that the process of revision will be described. The revising processes (or sub-processes), and external or internal modifications to which they lead, are presented, through an analysis of the evolution of revision models. This presentation would, in addition, allow specifying the different sub-processes and operations in the progress of revision.

2 EVOLUTION OF REVISION MODELS: FROM REVIEWING PROCESS TO SPECIFIC AND PROCEDURAL MODELS OF REVISION

2.1 *Hayes and Flower's first proposals (1980, 1983; Flower and Hayes, 1981c)*

In the initial Hayes and Flower (1980) model, revision is viewed as an autonomous process, called Reviewing, and composed of two sub-processes: Reading and Editing, that simply involve checking and correcting the text, already written or simply mentally planned (Cf. Piolat & Roussey, 1991-1992 or Temple, Nathan, Temple, & Burris, 1993 for a description of the revision activity). The Editing activity is considered as recursive, possibly appearing at any time during the writing process (Cf.

also: Collins & Gentner, 1980; Faigley, Cherry, Jolliffe, & Skinner, 1985; Fitzgerald, 1987; Piolat, 1988, 1990; van den Bergh, Rijlaarsdam & Breetvelt, 1993) and, consequently, may also interrupt the progress of the other activities. It can also appear after the text has been entirely written (Faigley & Witte, 1981, 1984). The Reading sub-process is voluntarily released, so as to evaluate the text produced-so-far. The Editing sub-process comprises production rules concerning possible corrections (*i.e.*, to correct semantic imprecision, to evaluate the precision for the reader, *etc.*). This sub-process allows both automatic and controlled corrections (*i.e.*, it can interrupt any other writing process).

Thus, according to Hayes and Flower (1980), as soon as a discrepancy between intended text and external text has been detected, the Editing sub-process would function in an irrepressible and automatic manner. This puts nevertheless the problem of the correction of this error. According to these authors, once the error has been detected, the writer would immediately (or almost immediately) have means (or production rules) to solve it; it is thus possible to wonder why an error is committed...

The framework of Reviewing, such as proposed by Hayes and Flower (1980) in their general writing model, enables distinguishing two sub-processes and specifying that the revision has to be approached both as an internal (evaluation) and external phenomenon (effective corrections). However, this formalisation is insufficient. This is all the more paradoxical because the activity of revision is thereafter studied in a particularly intensive manner, by these authors and other researchers, and has led to increasingly complex architectures, resulting in formalisations sometimes more complex than the general text production process itself. Besides, a year after the 1980 model, Flower and Hayes (1981c) have slightly modified the theoretical position they had previously defended. Then, still two sub-processes are distinguished in the Revising activity, the 'Evaluation' sub-process (that globally corresponds to the Reading sub-process in the 1980 model; *i.e.*, to read and to compare the already produced text with the intended text) and the 'Revision' sub-process (also similar to the Editing sub-process, that roughly involves correcting the errors that can be found in the text). However, opposed to the 1980 model, Revision is in this instance considered to be deliberate. Consequently, contrary to their preceding proposal, the Reviewing process and its two sub-processes are considered as controlled. More precisely, Revision sub-process is no longer limited to an automatic correction activity that functions according to production rules.

In their publication of 1983, Hayes and Flower distinguish the activity of 'Reviewing' from the activity of 'Revising'. This distinction relies on the 'external' or 'internal' characteristics of revisions that are carried out by the writer. Reviewing is necessary to evaluate what is written or what has been planned, and it can lead to the detection of discrepancies between the intended and the written or to be written text. Thus, Reviewing is considered by the authors as a mental (or internal) activity whereas Revising is an external activity, allocating the text and leading to physical modifications, which can be traced in the text surface (external revisions; *Cf.* also,

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

CHAPTER 5

WORKING MEMORY IN WRITING

1 INTRODUCTION

1.1 Importance of Working Memory in text writing activity

Writing processes are multiple and focus on different kinds of knowledge and representation (domain, linguistic and pragmatic). This multiplicity needs, as seen in Chapter 4, the implementation of management, control and regulation of processing. Defined as a complex activity, the text writing assumes that the writer could manage a great number of constraints (Flower and Hayes, 1980; Scardamalia, 1981). In addition, the choice of a given strategy (added to the simultaneous consideration of this set of constraints) supposes the management of various processing levels (Graham and Harris, 1996). Thus, one of the fundamental problems of language production consists in the capacity to manage simultaneously and/or serially different types of processing, while taking into account Working Memory limited capacity (Bereiter and Scardamalia, 1984; Glynn, Britton, Muth and Dogan, 1982).

One of the main factors in the determination of writing strategies seems to be linked to Working Memory span. The Short Term Memory (or the temporary storing capacity of Working Memory) has been considered very early on as one of the central factors in writing activity, as well as in Flower and Hayes's (1980), Bereiter and Scardamalia's (1987), or van Dijk and Kintsch's (1983) models. More precisely, the role of Short Term Memory has been mainly considered through processing constraints, imposed by the memory span limitations. While these constraints are often only briefly noticed by Flower and Hayes (1980), or Bereiter and Scardamalia (1987), van Dijk and Kintsch (1983) have proposed a more precise explanation of writing strategies, interacting with the Short Term Memory functioning. Such is the case, for example, with the Local Coherence Strategy necessary for sentence planning and linguistic translation (*Cf.* Chapter 2). This supposes the simultaneous upholding of three different knowledge units (the macrostructural unit, the proposition to be translated and the surface form of the previously translated proposition).

Penningroth and Rosenberg (1995) have made obvious the evaluation of the cost to maintain a more or less important number of knowledge units. The authors, inspired by Tetroe (1984), have varied the amount of information simultaneously maintained in Short Term Memory, to proceed to the writing of a narrative text. To perform of which the authors proposed to forty students to write a text whose last sentence was imposed. This sentence comprised a more or less important number of

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arguments, representing units of information that it was necessary to maintain and organise, during the whole text production, to respect the meaning of the last sentence. The nature of writing processes and their cost have been evaluated through an analysis of performances to a secondary task, combined with an analysis of verbal protocols collected during writing (*i.e.*, close to Kellogg's method, 1987a). The authors have observed that the increase of the number of units to maintain led to a decrease in the quality of the text, both for its coherence and cohesion. This alteration was all the more marked that the number of arguments exceeded the Short Term Memory span (as defined by Miller, 1956 or Simon, 1974). Providing more than seven arguments to organise would strongly increase the mental resources necessary for the Planning process, and would lead to a qualitative change in the temporal management of the writing processes. Hence, the Planning process is not correctly managed during the production and the Reviewing process is then more solicited at the end of the period of handwriting. However, according to Penningroth and Rosenberg (1995), this modification of the writing strategy does not allow to maintain the quality of the text content.

It seems therefore, through this experiment, that the role of Short Term Memory limitation, in interaction with the number of constraints to manage, could be an important factor to determine the quality of a text. Jeffery (1996) and Jeffery and Underwood (1996) have also demonstrated the influence of Working Memory on writing at a conceptual level. They have shown that the more or less important manipulated cognitive load could more or less facilitate ideas of recovering and organising. Finally, for McCutchen (1996), the capacity to manage the three processes of writing (such as defined by Hayes and Flower, 1980) depends largely on the efficiency of these processes and on storage constraints that they impose to Working Memory (*Cf.* Chapter 6; *Cf.* also Kellogg, 1994). The 'orchestration' of the three writing processes would be thus constrained by the attentional limits of Working Memory (McCutchen, Covill, Hoyne, & Mildes, 1994).

Two important facts emerge from these works. On the one hand, the role of Short Term and/or Working Memory has been evoked very early on or considered in the activity of text writing, even if there is currently, in the literature, an increasing number of works dealing with this phenomenon. On the other hand, in these works, there are as many definitions of Working Memory as works on it. While Hayes and Flower (1980) mainly speak of the maintaining span of Short Term Memory, Penningroth and Rosenberg (1995) are interested in the mental load in Short Term Memory and McCutchen *et al.* (1994) focus on the notion of Working Memory and attentional cost. This diversity of approaches and theoretical conceptualisation about Working Memory, in the study of writing is certainly due to the fact that several definitions of Working Memory have been proposed and currently coexist, in the more general framework of cognitive psychology.

1.2 Diversity of the definitions of Working Memory

Historically, the concept of Working Memory in cognitive psychology has been characterised by important theoretical evolution. Currently, there is not one precise definition of this concept. Logie (1996), through a review of questions, has distinguished seven different definitions of Working Memory (or Short Term Memory). According to this author, the philosophical concept of memory, conceived as (1) 'Comtemplation' (Locke, 1690), has been replaced by a first psychological description of (2) 'Primary Memory' by James (1905). Then Waugh and Norman (1965) have defined this concept (as opposed to the permanent secondary memory) by its (3) 'Limited Capacity of Storing' and temporary maintaining of information. A more complete definition has been provided by Atkinson and Shiffrin (1968) who, through the concept of Short Term Memory, have introduced some control processes (strategy for coding and retrieving information) added to temporary information upholding processes (rehearsal). According to this idea, Short Term Memory is considered as a 'unique and flexible system', ensuring the storage as well as the strategic processing of information. A fourth idea of Working Memory, conceived by Craik and Lockhart (1972) and opposed to the previous one, relies on the notion of (4) 'Processing Depth'. According to Logie (1996), these authors have rather approached Working Memory as a processor that more or less emphasises the processes than as a real structure of memory. A fifth definition of Working Memory has been more recently proposed by Just and Carpenter (1992), who consider Working Memory as specialised in language processes. According to this 'Capacity Theory', Working Memory would be mainly constituted by a (5) 'Pool of Cognitive Resources' (an activation pool) that it is necessary to share between the different processes, for example, of reading and comprehension. The central point of this approach is that the allocation of resources to a given process would operate to the detriment of resources allocated to another process. A sixth idea of Working Memory relies on narrow relationships that this concept maintains with Long Term Memory. Working Memory can be conceived as an (6) 'Activated Zone of Long Term Memory' (Cowan, 1993; Anderson, 1983a and b), or as completed by an interface between Long Term and Working Memory, which allows Working Memory to strategically extract from Long Term Memory knowledge necessary for a given task. This interface, recently discussed by Ericsson and Kintsch (1995) is called Long Term-Working Memory. Finally, Baddeley (1986, 1990) has provided a seventh and last definition of Working Memory. It is different from the preceding ones since it approaches Working Memory as a (7) 'Composite System of Modules', with three main components, dedicated to process different pieces of information (visuo-spatial and auditory), and each characterised by specific storing and/or processing capacities.

Even if, today, the concept of Working Memory is often associated with Baddeley's conception (1986), the two preceding conceptions (Working Memory as a pool of specialised cognitive resources and Working Memory as an Activated Zone of Long Term Memory, or completed by the concept of Long Term-Working Memory) are always investigated and can be considered as competing approaches

with Baddeley's theory (1986). We will have the opportunity, in this chapter as well as in Chapter 6, to describe more precisely these three different conceptions and to envisage in what measure each of them can be relevant in the framework of the study of text writing.

1.3 Precising the definition and the role of Working Memory in text writing

Models that attempt to define and/or to specify the role and the impact of Working Memory in text production can sometimes show a certain heterogeneity concerning the definition to characterise Working Memory. These differences are mainly due to the fact that these models are largely inspired by the theoretical ideas of Working Memory in the more general area of cognitive psychology. The problem (or, conversely, the interest), as previously highlighted, is that these ideas are themselves heterogenous and are very rapidly evolving. The question is then to determine which memory model is the most adapted and/or the most heuristic to explain the specific characteristics of written production. It seems that the consideration, in the first models of text writing (Hayes and Flower, 1980; van Dijk and Kintsch, 1983) of the role of Short Term or Working Memory has mainly been approached in terms of limitation of cognitive resources and storing capacity. The role of Working Memory in text writing has stayed relatively obscure for a long time and close to a 'black box' whose processing and storing modalities, although evoked, were not systematically clarified. By the number and the diversity of processes that underlie the writing activity, a more differentiated approach was required. This has notably enabled distinguishing process costs, according to their conceptual or linguistic nature, and to specify constraints that weigh on the execution of these processes, according to the nature of the processed knowledge (*i.e.*, phonological, visuo-spatial or semantic). It was indeed necessary to go from a passive and descriptive approach of Working Memory constraints to a dynamic and explanatory approach of the functioning of these constraints (*Cf.* Torrance & Jeffery, 1999).

Until the beginning of the 90s, such research relative to the dynamic role of Working Memory in language activities was limited to the analysis of comprehension and reading (*Cf.*, for example, Just & Carpenter, 1980, 1987). It is only very recently that writing researchers have been interested in Working Memory and in the different constraints that it makes weigh on writing, according to the different processes. This recent approach focuses more on the definition of the nature of mnemonic processes than on limited Working Memory cognitive resources. This more qualitative orientation of studies on the role of Working Memory in the activity of text production has been enhanced by the recent models proposed by Hayes (1996) and more especially by Kellogg (1996). This one has elaborated an architecture combining a writing model (Brown, McDonald, Brown, & Carr, 1988) and a Working Memory model, as conceived by Baddeley (1986).

2 INTEGRATION OF BADDELEY'S MODEL OF WORKING MEMORY IN MODELS OF TEXT WRITING

2.1 *Hayes's proposals (1996)*

According to Hayes (1996), Working Memory plays a central role in the activity of text writing and occupies, symbolically, the central position in his revised model (*Cf.* General Introduction, page 16). Within this model, all writing processes are in relation with Working Memory, with knowledge stored in Long Term Memory (Domain and Linguistic knowledge, knowledge about the Genre of the Text, *etc.*), and equally with the writer's motivations and affects. Hayes (1996: 8) postulates that the potential framework of Working Memory, that plays the role of a maintaining and processing interface of these different kinds of knowledge, can be relatively close to that defined by Baddeley.

2.1.1 *Baddeley's (1986) Working Memory model*

Baddeley and Hitch (1974), as well as Baddeley (1986, 1990), have described Working Memory as a temporary storing and processing system of information, implied in most of cognitive tasks and composed of three major components: the 'Central Executive' and two slave systems, the 'Articulatory Loop' and the 'Visuo-Spatial Sketchpad'.

- The Central Executive is the most important system of Working Memory, even if it still remains vague and underdeveloped on a theoretical viewpoint (*Cf.* Baddeley, 1996; Ehrlich & Delafoy, 1990). Its functions essentially concern the spreading of attentional resources. It is in this view very close to that of the Supervisory Attentional System (S.A.S.) described by Norman and Shallice (1980). It equally controls the regulation of the flow of information circulating in Working Memory, the retrieval of information situated in other systems (as Long Term Memory), the information processing and storing. Globally, the role of the Central Executive is to manage some activities and to inhibit some others, so as to avoid exceeding the limited capacities of the processing system. To help it in these different tasks, the Central Executive has two slave systems that it controls and co-ordinates:
- The Phonological-Articulatory Loop is specialised in the processing of verbal information, and allows to store and to manipulate acoustic and verbal equipment (storing and maintaining by rehearsal, *Cf.* Gathercole & Baddeley, 1993). It is built with a unit of phonological storing, able to contain linguistic information and a process of articulatory rehearsal (or recapitulation), relying on the subvocal self-rehearsal, that allows to maintain verbal information by repetition (Saito, 1997) and that is equally used to phonologically encode non phonological entries (*Cf.* Gathercole & Baddeley, 1993).
- The Visuo-Spatial Sketchpad allows the short term storing of visual and spatial information, as well as the elaboration and the manipulation of mental images (*Cf.* Logie, 1995 for a more detailed description of this system).