

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) 'Comptemplation' (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).

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