
9 Towards a Dynamic Approach of How Children and Adults Manage Text Production

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Over the last 30 years, many studies have examined the composition of written text. These studies have mainly dealt with the characteristics of texts and the conditions of their production, as well as the time course of text production. They have made use of a variety of paradigms, namely, the analysis of verbal protocols, the measurement of reaction time (RT) in a secondary task, and the measurement of processing times (Olive & Levy, 2002). However, many of these paradigms were systematically used only with adults because, on the one hand, the low-level processes (translating, spelling, handwriting) are relatively automated in adults and, on the other, adults can perform both composition and a secondary task more or less simultaneously. Consequently, the study of written text production is less advanced in children than in adults. In children, composition skills are mainly investigated through the analysis of texts produced in response to specific requirements or production constraints (Fayol, 1991c). The aim of this chapter is to fill this gap, at least partially, by proposing an on-line approach based on the analysis of two temporal parameters—pause duration and writing rate—and their variations according to particular production constraints.

AN OVERVIEW OF ON-LINE STUDIES OF COMPOSING IN ADULTS

MODELS AND DATA

From a process perspective, the most influential model of the cognitive processes involved in writing was proposed by Hayes and Flower (1980). These authors analyzed the verbal reports of adults who were asked to “think aloud” while composing, to develop a description of the mental operations, that is, the *cognitive processes*, employed during writing viewed as a problem-solving task. Hayes and Flower (1980) distinguished between three cognitive processes—*planning*, *translating*, and *revising*—that operate recursively with one another in the context of the writer’s long-term memory and the task environment, that is, these processes can interrupt each other and are embedded in each other. *Planning* involves setting goals, retrieving ideas from memory, and organizing contents into a writing plan. *Translating* consists of gradually constructing the text from a linear sequence of linguistic units which are ordered hierarchically by level (e.g., words, phrases, sentences, paragraphs). *Reviewing* includes monitoring and editing the text produced so far.

Hayes and Flower also emphasized that skilled writing is a highly demanding cognitive task which involves the more or less simultaneous use and management of several interwoven processes, some of which are clearly conscious and strategic, while others are more or less automated. At a very early stage, researchers started to take an interest in evaluating the cognitive effort involved either in composing as a global activity or in each of its components. Several paradigms have been used, from analyzing pause location and duration and, to a lesser extent, writing rates, to collecting verbal protocols. In some cases, verbal protocols are associated with RTs to a secondary task.

Composing is the primary, main task; during the composition process, probes, in general auditory probes (beeps), are randomly presented and participants have to detect them; the time lapse (in milliseconds) from the presentation of a probe to the detection response of this probe is the RT to the secondary task.

For example, Kellogg (1987b) used auditory probes and verbal categorizations to examine how college students used their time while composing: one-half of their time was devoted to *translating*, and the rest to *planning* and *reviewing*. The time required for planning decreased over the writing session while the time spent reviewing increased. Translating remained approximately constant throughout composition and required less cognitive effort than planning or reviewing. Using the verbal protocol paradigm (thinking-aloud condition), Van den Bergh and Rijlaarsdam (2001) investigated the temporal organization of writing processes in ninth graders producing an argumentative text to examine the link between the temporal organization of the production and the quality of the texts. They reported clear differences among writers, for example, the participants who refrained from translating in written text during the initial and final stages of composition produced texts of a higher quality.

In order to better assess the cognitive effort involved in each of the three major cognitive processes in the Hayes and Flower's model, Kellogg (1986) measured interference between composition and a secondary task. College students were asked to detect randomly presented tones (the secondary task) while they were composing a text (the main task). Kellogg assumed that attentional resources not dedicated to the primary task would remain available to writers who could use them to process the secondary task; the more time it took to identify the tones, the more demanding the composition task was. Kellogg reported that the cognitive processes of planning, translating into text, and reviewing required more cognitive effort than many other human tasks, for example, playing chess or reading simple and complex texts. Kellogg (2001a) compared the cognitive effort expended while composing three different types of texts: narratives, expository texts, and argumentative texts. By measuring RTs on secondary tasks and examining verbal retrospections, he observed that planning, translating, and reviewing competed for common memory resources. He also observed that the cognitive effort is larger when producing expository and argumentative texts than when composing narratives. Finally, Kellogg (2001b) showed that RT was reliably lower for high domain knowledge writers compared to those with low domain knowledge (Kellogg, 1987a). High domain knowledge reduced the transient effort required for planning, translating, and reviewing. Moreover, variations in writers' domain knowledge and verbal ability independently affected quality judgments of both narrative and persuasive texts.

Overall, the Hayes and Flower model has proved very useful both for describing the cognitive processes involved in text production and for studying their organization and global cost in adult composition. However, the models and data have so far focused almost exclusively on high-level processes, for example, idea generation and organization. The most probable reason is that verbal protocols have proved to be elusive concerning the translation and handwriting processes, which are largely unconscious processes in adults and thus difficult to verbalize. Moreover, the study of the temporal organization of the production processes has remained global in nature and is therefore unable to take account of the step-by-step progress of text production.

ON MANAGING WRITTEN COMPOSITION IN REAL TIME

Both theoretical models and empirical data stress that composing requires the efficient on-line coordination of both low-level processes and high-level processes. All higher-level processes, such as elaborating ideas and conceptual relations, **processing thematic**, maintaining coherence and cohesion, and respecting text-type constraint processes, are involved in the production of texts and discourses, whatever the modality (Berninger & Swanson, 1994; Fayol, 1991a,b, 1997). As far as lower-level processes are concerned, some of them relate to verbal production in general, for example, lexical access or syntactic frame construction (Bock & Levelt, 1994; Levelt, 1989),

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is not yet published (Fayol & Stephant, 1991). We will first summarize the paradigm and the previously reported effects before going on to analyze the impact of certain low-level factors: word rank and length and consistency of spelling (Lété, Peereman, & Fayol, 2008). This will place us in a better position to understand the dynamic of composing in real time. The second experiment compared the temporal organization of composition and written recall of the same narrative texts by the same participants, children and adults (Fayol & Stephant, 1991). Its aim is to distinguish between the cost of the high-level processes and that of motor execution on the temporal parameters of production, that is, the pauses and the writing rate.

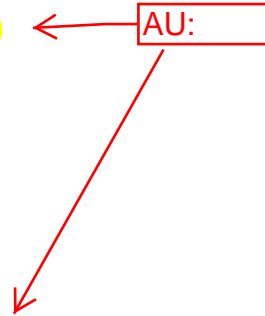
FROM HIGH-LEVEL TO LOW-LEVEL DIMENSIONS IN WRITTEN PRODUCTION

The aim of this experiment was to determine the impact of a number of different variables on the on-line management of written production in third and fifth graders as well as in adults. The authors were primarily interested in the effects of familiarity with the content, the type of text and syntactic complexity. Sixty-four participants—16 adults (mean age = 20), 16 fifth graders (mean age = 10; 7) and 16 third graders (mean age = 8; 11)—were asked to produce endings from oral text beginnings, which were either narrative (e.g., “Mary goes to the restaurant. She reads the menu. She goes in.”) or expository (e.g., “It’s a car. It is parked in the car park. It’s shining.”) (Holmes, 1984). All the participants were required to produce endings that were either highly predictable (script-like endings) or unpredictable. The endings had to consist of three (for the adults) or two (for the children) events (in the narratives) or states (in the expository texts). The adults had to formulate the endings in either one or three sentences, whereas the children had to use either one or two sentences. To adapt the difficulty and duration of the task to the participants, the children produced eight endings (four narrative and four expository; one-sentence or two-sentences long; four predictable or four unpredictable) whereas the adults produced 16 endings (eight for each condition). All the participants, but especially the children, were trained before performing the task.

The text productions were video recorded and analyzed using a videotape recorder with an image reading accuracy rate of 1/10th of a second. We collected: (1) the prewriting (PW) duration, which corresponded to the time lapse between the end of the instructions and the beginning of transcription; (2) the between-clause (BC) pause duration, which was the time lapse between the end of the n th clause and the beginning of the $n+1$ th clause; the adults had 2 BC pauses (between clause 1 and clause 2, and between clause 2 and clause 3) whereas the children had only one BC pause (between clause 1 and clause 2); and (3) the within-clause writing rate (in seconds/character), that is, the mean duration for the transcription of one character between the beginning and the end of the same clause. This writing rate includes both the writing duration and the duration of the within-clause pauses (~~see below for a further differentiation between these two dimensions~~). The participants could change their text while composing, but rewriting behaviors were very rare. When revision occurred, the time devoted to the first production and the revision time were counted as pause time (before-word pause, or BWP). Only the time devoted to the revised text was included in the measure of writing rate.

We start with a brief summary of the main results (see Table 8.1). First, there was a significant increase in writing rate and a significant decrease in BC pause duration as a function of age and/or school level. Moreover, the PW pause duration was significantly longer in the adults than the children. Second, familiarity with the content impacted on the PW pause duration in the three groups, as well as on the BC pause duration and the writing rate in adults and fifth graders but not in the third graders. The text type (narrative versus expository) had no effect on pauses or writing rate. Third, the writing rate of the adults and fifth graders increased in the last clause (i.e., the third or the second, respectively), thus suggesting that its management imposed a lower load on the participants. Overall, these results show that the speed and the flexibility of composing increase as a function of age or school level: the oldest participants took shorter pauses, wrote more quickly, and were more skilled in modulating the speed of processing of the different dimensions of composing (familiarity

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TABLE 9.1
Main Results from Experiment 1

	Adults	Fifth Graders	Third Graders
Initial pause			
Low predictable endings	13.5 sec	11.3 sec	9.7 sec
Highly predictable endings	8.3 sec	6.3 sec	8 sec
Before word pause	1.3 sec	1.7 sec	2.24 sec
Writing rate	0.34 sec/car	0.62 sec/car	0.94 sec/car

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with the content, syntactic complexity). The same trends have been reported using slightly different methodologies (Van Hell, Verhoeven, & Van Beijsterveldt, 2008; Verhoeven & Van Hell, 2008). This suggests that, with increasing age and experience, people become both more skilled in dealing with the low-level components of writing and more able to strategically distribute the management of the other components of composing. However, no precise data are available regarding the processing of the low-level dimensions of composing; the writing rate provided only a rough indicator of the processing of transcription. In light of a number of new results and theories, we decided to go a step further in the study of the dynamic of composing, and examine the potential impact of two dimensions: the length of words and their spelling consistency. Indeed, writing words raises two problems. First, people have to access a mental lexicon as in oral production. Naming objects takes more time when the lexical labels are rare than when these labels are frequent (Levelt, 1989). This frequency effect explains at least a part of the variation in between-word pauses and hesitations in oral production. Bonin, Fayol, and Gombert (1997) studied the naming and writing of frequent compared to rare nouns on the basis of pictures depicting well-known objects. Frequency effects were observed in writing as well as in naming from pictures. Lexical production therefore appears to be a costly process in the written as well as in the oral modality. Its cost depends on the difficulty of retrieving more or less frequent or familiar words from memory. Interestingly, the frequency effect appears very early in both reading and spelling.

In a spelling-from-dictation task, Martinet, Valdois, and Fayol (2004) reported that after only 3 months of literacy instruction, first-grade French children spelled irregular graphemes more accurately when they appeared in words that occurred frequently in their school course books than when they were present in words that occurred infrequently. Given that word frequency is closely related to length, a consideration of the impact of word length (in number of letters) should provide an easy way to evaluate the effect of word frequency on composing. Also, word writing demands spelling processing, the difficulty of which differs between spelling systems depending on the consistency of the phoneme-grapheme correspondences (Jaffré & Fayol, 2005).

Phonology-to-orthography consistency refers to the level of variability in the orthographic codes that can be assigned to a particular phonological unit. For example, phoneme-to-grapheme consistency is lower when a number of different graphemes can be mapped to a particular phoneme (e.g., /o/ in French is spelled o in “mot” [word], au in “saut” [jump], and eau in “oiseau” [bird]) than when a single grapheme is always associated with a particular phoneme (e.g., again in French, /u/ is always spelled “ou” as in the words “fou,” “cou,” and “bijou”). In a large-scale regression study involving 3430 French words and examining the influence of lexical (word frequency, lexical neighborhood) and sublexical (feedforward and feedback consistency) variables on spelling accuracy among first, second, and third to fifth graders, Lété et al. (2008) reported that feedforward consistency (from phoneme to grapheme) and word frequency had independent effects. Beginning spellers exhibited a small frequency effect that suggested moderate reliance on lexical access, but the effect was limited to monosyllabic words. Performance on polysyllabic words in the same frequency range revealed no indication of a frequency effect for beginning spellers, whereas word frequency turned

TABLE 9.2
Results of the Forward Regression Analyses Displaying
the Independent Contribution of Consistency (R² changes)
on Both Pauses (BWP) and Writing Rate (WR)
as a Function of School Level

Age or Level	Change in R ²	Beta	t ^a
Third Grade			
BWP	.005	-.072	-2.35*
WR	.011	-.104	-3.44**
Fifth Grade			
BWP	.003	-.052	-1.76 ^{ns}
WR	.002	-.048	-1.63 ^{ns}
Adults			
BWP	.002	-.048	-3.09**
WR	.005	-.071	-4.59**

^a : ** : $p < .01$; * : $p < .05$; ^{ns} : $p > .10$.

higher dimensions of text production. We have complemented this classical approach, which took account of only the high-level dimensions of text production, by introducing a new perspective. We were able to show that both pauses and writing rates varied as a function of a dimension specific to the words used, namely their spelling consistency. The more consistent the words were, the shorter the pauses occurring just before them and the faster the writing rate during their transcription. This enables us to gain a better understanding of how high-level processes and low-level processes can interact in real time and make text production more or less easy or difficult to manage, as described in **Graham's and Berninger's** results.

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DISSOCIATING HANDWRITING COST FROM THE COST OF IDEA GENERATION AND LINGUISTIC FORMULATION

What emerges from a series of studies, including the one reported here, is that the temporal parameters of composing become more differentiated between the age of eight and adulthood. However, the data remain difficult to interpret, especially regarding the youngest children (here, third graders), because written composition involves many operations. As a consequence, as reported above, variations in pause duration and writing rate cannot be attributed to only one operation. Moreover, these variations are themselves dependent on age or school level. **Berninger and Graham** have shown that spelling and handwriting skills are important determinants of composition performance and that their cognitive cost decreases with age. One possibility would be that the cost of handwriting is so high and writing is so slow in young children that it is only during pauses that they are able to deal with other dimensions.

To test this hypothesis, we decided to compare the written composition and the written recall of the same text-endings in the same children and adults. The activity of the written recall of a linguistic text fragment is theoretically a much simpler task than composition since the contents have been elaborated and the syntactic frames and the lexical items have been selected. The task merely consists of writing down a series of strings of linguistic elements from working memory. This suggests that the cognitive load associated with conceptual and linguistic processing could be measured by comparing the pauses and writing rate associated with each linguistic segment in composition and in transcription after rote learning.

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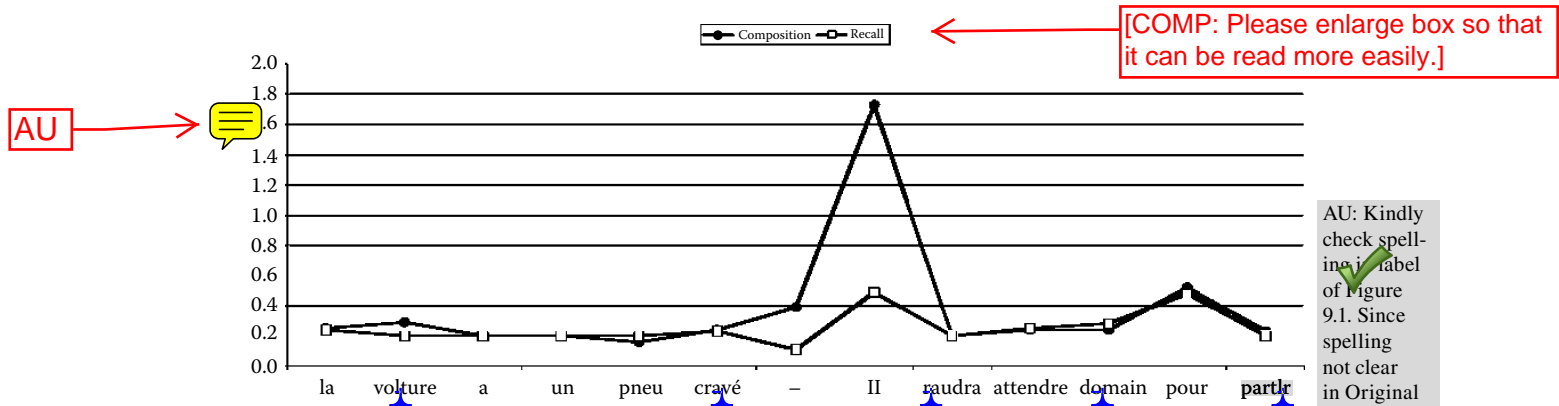


FIGURE 9.1 Variation of pause durations as a function of the conditions of production: composition versus recall of the same text by the same child.

As in the experiment described above, children and adults listened to the start of a story (Holmes, 1984) and were asked to compose a two-action ending for each beginning. The endings had to be either predictable or highly unpredictable, and the two actions had to be inserted in either one or two separate sentences. After training, each of the 24 participants (12 third graders and 12 adults) produced four endings each. After composing, each participant was asked to read every ending he/she has composed and memorize it thoroughly until he or she could write it down again by rote. The participants were video recorded while composing and recalling the text endings. The films were then analyzed for temporal parameters relating to both composition and recall: initial prewriting pause duration (composition only), between-clause pause duration, within-clause pause duration, and within-clause writing rate. Figure 9.1 illustrates the comparison between composition and recall of the same text by a child. We simply provide an overview of the main results. As reported in the previous experiment, the mean prewriting pause duration was significantly longer with unpredictable than with predictable endings in adults (9.27 versus 4.86 seconds, respectively) but not in children (8.36 versus 8.34 seconds, respectively). However, the most important point is that recalling the text endings was always faster than composing the same texts, and this was observed in both the adults and the children. Figure 9.1 shows that there were dramatic decreases between the composition and the recall durations and rates: in between-clause pause duration: -5.55 sec (-69%) in children and -1.76 sec (-72%) in adults; in within-clause pause duration: -0.56 sec in children (-39%) and -0.15 sec in adults (-33%); in writing rate: -0.13 sec/car in children (-14%) and -0.04 sec/car in adults (-10%). The decrease was approximately of the same magnitude in children and in adults. This is an unexpected result which suggests that the relative cost of graphic transcription is approximately the same in children and adults and cannot therefore explain the differences in composition patterns between children and adults. However, the pause durations and word transcription times were far higher in children than in adults. It is possible that the length of the pauses and the time required for transcription prevent children from retaining and/or from retrieving from memory the information which they need in order to generate and organize ideas. Further studies will be necessary in order to provide support for this hypothesis.

CONCLUSION

The main aim of this chapter was to examine questions about the development of the dynamic of composing. In adults, this dynamic has been studied using a variety of methods which have led researchers to distinguish between a number of processes (e.g., planning, translating, revising) and to assess and compare the variations of their respective cost throughout production. The available data concerning the on-line management of composing in children and its development as a function of age and level of expertise are much less advanced because the analysis of the processes involved in written production is considerably more complex.

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