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Marie-Laure Barbier and Nicole Spinelli-Jullien, Aix en Provence

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Abstract

The last two decades have witnessed increasing interest in written text production in a second language (L2). Research initially focused on factors affecting writers' performance, such as writing expertise and language skills, the aim being to analyse writing processes, strategies and transfer phenomena. More recently, studies have explored working memory constraints in L2 writing activities, looking at problems with the formulation process in particular and the orchestration of writing processes. Resource allocation is crucial, and studies of L2 writing should systematically take writers' working memory resources into account. So far, most of the researchers studying the resolution of L2 writing processes in real time have used interview and introspection methods, with the analysis of think-aloud protocols. Some have conducted chronometric analyses of text production (pauses and fluency), while others have used dual-task paradigms to measure the allocation of cognitive resources during L2 writing. This article provides an in-depth review of all these data, which are not always congruent, in order to enhance our understanding of how L2 writing strategies depend on working memory resources.

1. Writing processes and strategies in L2

This article sets out the main directions of research in L2 writing and explains why they require the more systematic use of on-line methodologies to track writing strategies and measure cognitive load. The term 'on-line methodologies' refers to assessment tools which focus on writing in real time and produce 'hard' data (i.e. pause analysis, reaction times), not 'soft' data as with introspection methods. The article starts with a summary of these traditional research perspectives in L2 writing, which have long focused on conceptual processes and on the proficiency dependency of L2 learners' cognitive processes while writing. It also deals with the specificities of L2 self-monitoring and cognitive resource allocation during text production.

1.1 Traditional research perspectives in L2 writing: high-level processes

Psycholinguistic studies of L2 writing have traditionally attempted to describe the specific skills required for L2 writing, mainly from an educational perspective. Analysing how L2 writing, L2 acquisition and L1 knowledge interact, researchers have mainly concentrated on learner variables: the level of linguistic knowledge in L2 (Sasaki & Hirose 1996; Yau 1991) and writers' procedural knowledge, depending on their previous writing experience and training (Cumming 1989; Jones & Tetroe 1987). Writing in L2 requires a minimum level of lexical, syntactic and spelling knowledge to express ideas in a correct linguistic form. It also relies on the activation and control of recursive writing processes (planning, translating and reviewing; Hayes & Flower 1980) to achieve writing goals, as in L1. A writer's control capacity basically depends on the repertoire of strategies he or she can activate in order to manage the overall writing task.

Studies of the writing processes implemented by second-language learners have mainly drawn on writing models developed within L1 studies (Hayes & Flower 1980; Kellogg 1996) whose purpose remains to identify monolingual writers' performances. Accordingly, L2 writing research has tended to focus on high-level processes such as planning and revising. Since Cummins proposed his "interdependence hypothesis" in 1980, writing skills acquired in a native language have been regarded as transferable, facilitating linguistic procedures in L2. Researchers have more systematically compared L1 and L2 writing processes, presupposing the existence of a "single writing competence" subtended by conceptual and procedural knowledge, and effective in each language (for a review, see Roca de Larios et al. 2002).

Other studies have suggested that writers' cognitive abilities in L2 writing depend on their metacognitive knowledge. According to Bialystok & Ryan (1985), learners face two problems during first-language development: they have to construct conceptual representations of their world and the linguistic structure of their language, and they acquire control procedures that will enable them to handle these representations. When they learn a second language, adult learners have to reconsider the control of their linguistic process in L2, but by so doing increase their metalinguistic awareness of their language skills and working memory capacity, compared with adult monolinguals (Ransdell et al. 2006).

Then again, some authors hold that writers in a foreign language cannot use their metalinguistic skills as they would in their first language. Devine et al. (1993) analysed the written productions of 10 advanced English students (L2) and 10 American students. All were enrolled in an English writing course centred on writing strategies and syntactic exercises. They answered a questionnaire about their metacognitive representations of their ability to control their communicative intentions, their style and the syntactic aspects of their production, as well as their knowledge about the function of planning and revision strategies. Writers in both L1 and L2 displayed a multidimensional representation of writing activity (emphasising cohesion, consistency of ideas, style and creativeness). However, while most of the L1 writers had a coherent representation in which all these dimensions easily interacted, most L2 writers regarded these dimensions as conflicting and competitive. The authors attributed the differences between the metacognitive representations of L1 and L2 writers to the amount of attention needed to activate each writing component in L2 *(*see also Kobayashi & Rinnert 1992; Sasaki & Hirose 1996).

More recent studies have underlined the flexibility of L2 writing activity, recognizing that its dimensions loop backwards and forwards through various subsystems. Manchon et al. (2000) and Zimmerman (2000) attempted to define basic parameters for placing individuals along a continuum of L2 writing expertise. In order to identify the various subsystems involved in L2 writing, these authors underlined the need for more studies describing the formulation process, but not in opposition to the planning and revision processes. The use of L1 for a variety of formulating operations has been analysed not only in terms of transfer, but also as a process directly involved in L2 writing. Manchon et al. (2000) found, for example, that L1 backtracking procedures were used in L2 writing to translate the text produced so far into ideas that were more meaningful to the writer. This role of L1 may be particularly significant in L2 writing, as the text produced so far is constrained by the writers' L2 proficiency.

1.2 The proficiency dependency of cognitive processes while writing

The acquisition of L2 writing ability is about far more than just the appropriation of new graphic codes. For several authors, however, linguistic proficiency is a prerequisite for accessing higher-level processes. Without adequate language skills, these writing

processes cannot be properly implemented and they are less efficient in L2 writing tasks than in L1 ones (Jones & Tetroe 1987; Yau 1991). This point of view is supported by the results of systematic comparisons of L1 and L2 writing processes, showing quantitative differences between the two languages. L2 writers experience greater difficult planning their texts, at both the local and global levels (Campbell 1990). The translation process is also more constraining than in L1. Writers concentrate on their spelling and grammatical choices (Yau 1991). Finally, the revision process is more difficult to activate, as writers re-read and correct their texts less in L2 than in L1 (Hall 1990).

In addition to these quantitative differences, it has been argued that L2 writing is a specific mode of communication that requires new skills and may even lead to a fundamental reorganization of communicative skills: L2 writers not only have to deal with new linguistic knowledge, but also have to modify their orchestration of writing processes by developing efficient writing strategies or inhibiting others. For a long time, composition processes have been treated as static entities, and their analysis has been limited to frequency counts. Recent research on L2 writing processes has yielded new insights into the temporal nature of formulation. Roca de Larios et al. (2002; Roca de Larios et al. 2008) found that EFL writers spent twice as much time on formulation problems in L2 as they did in L1. This allocation of time was not proficiency-dependent. However, in these studies, the more proficient participants tended to increase the interaction between formulation and other processes. L2 proficiency seems to affect the amount of time devoted to finding a better match between intention and expression rather than to compensating for the lack of linguistic resources (Roca de Larios et al. 2008).

1.3 Self-monitoring and cognitive resource allocation in L2

Research during the last decade has yielded some congruent data on learner variables, indicating that L2 writers systematically experience a degree of cognitive overload, which appears to influence the orchestration of their cognitive processes (van Weijen 2008) and makes the problem of resource allocation particularly crucial. Given the effects of limited central capacity (Just & Carpenter 1992; McCutchen 2000), one of the main problems for writers is to decide which operations are most needed to perform the writing task. In several studies of writing and reading in a foreign language, the authors (Gaonac'h 1990; Barbier

1998; Sasaki 2002) have suggested that problems relating to L2 activities cannot be directly linked to the dysfunction of a linguistic process, but rather to a deficit in the automatization of that process. Accordingly, researchers have recently stressed the importance of one particular aspect of language ability, besides linguistic knowledge: the importance of speeded-up language processing skills (in the context of reading skills, see Segalowitz & Segalowitz 1993). Writing is a slower activity than reading and depends on the writer's pace of production (concept-driven task). Although on the face of it, faster lexical access does not seem that crucial to written performance, it is important for conceptualising sentences and handling all the cognitive demands of writing (Schoonen 2005).

Besides learner variables, task variables have also been used over the last decade to understand L2 writers' performances and cognitive capacity (Ellis 2003; Hayes 1996; van den Bergh & Rijlaarsdam 2001). It is the match between learner and task variables (involving the social and material dimensions of the writing task) that activates some necessary processes and thereby inhibits others. The question is how these factors affect process orchestration during L2 text composition.

Some studies have analysed the role of task representation during the writing process (van Weijen 2008). The task representation constructed by the writer at the start of the writing process changes according to the cognitive processes carried out while writing, such as reading the assignment and the text produced so far, generating ideas and formulating. Therefore, writers must constantly adapt the way they deal with each cognitive process (van den Bergh & Rijlaarsdam 2001). In van Weijen's studies (2008), L1 writers displayed the ability to vary the orchestration of their writing processes according to the task situation. Conversely, L2 writers displayed a preference for a particular form of orchestration. This was a common trait in all L2 writers and appeared to remain stable across all tasks. For van Weijen (2008), the cognitive overload experienced by L2 writers to some extent inhibits their ability to adapt their orchestration of cognitive processes over tasks to some extent.

Another interesting issue in task-based language learning concerns the influence of task complexity on the quality of the text, at different levels of L2 proficiency. For a long time, the relationship between task complexity and writing performance was regarded as clear: expository and personal prompts were commonly expected to be the easiest, associated

with the highest writing scores, while argumentative and public prompts were associated with the lowest scores. However, some authors have recently discussed other possible relationships between task type and performance (Hamp-Lyons & Mathias 1994; Kuiken & Vedder 2008), suggesting that writers faced with a cognitively more difficult task are goaded to reach higher goals. This interpretation is based on studies of L2 speech production (Iwashita et al. 2001) and more particularly on Robinson's cognition hypothesis (Robinson 2005), which states that learners can access multiple and non-competitive attentional resources. If the dimensions of a given cognitive task draw on different attentional resource pools, increasing task complexity should not impair linguistic output. Rather, it should lead to greater structural incorporation of forms made salient in the input. According to this author, cognitively demanding tasks – those requiring greater attention – can trigger greater linguistic complexity and accuracy in order to meet the functional demands placed on the learner.

In a recent study, Kuiken & Vedder (2008) concluded that increasing task complexity along resource-directing variables can lead learners to pay more attention to linguistic form so that their written output becomes more correct, but not necessarily more syntactically complex or lexically varied. These authors claimed that the effects of cognitive task complexity were partly constrained by the level of language proficiency, as the participants were all beginners in L2 Italian. With respect to the influence of task complexity, a threshold level may exist, similar to that hypothesised by Cummins (1980). For example, below a certain (unspecified) level of L2 proficiency, learners may be unable to use their L1 skills to perform an L2 task. An alternative conclusion is that increasing task complexity does not lead to linguistic development per se, but rather to more control over the existing interlanguage. In particular, the slower and more decontextualised pace of writing offers writers greater opportunities for planning, focusing on form and drawing on their explicit knowledge. It is this increase in control that leads learners to make fewer errors, but nothing is said in Kuiken & Vedder's study about the quality and coherence of the resulting texts.

What these studies show is that the role of attentional resources in L2 writing in relation to task demands is still controversial and more research is needed to establish whether single- or multi-resource models of attention are more likely to predict L2 writing

proficiency. More precise data about the cognitive demands of L2 writing are now needed. Traditionally, this information has been gathered using think-aloud protocols, but recently, both on-line recording and dual-task paradigms have been used. These are described and discussed below.

2. On-line measures of L2 writing processes

In-depth studies of the temporal distribution of writing processes have become an essential component of research on L2 writing processes over the last 10 years. The methods presented in this section have all been extensively used in L1 writing research and constitute potential tools for studying L2 writing specificities. They would, however, have to be adapted and/or interpreted specifically within the framework of L2 writing research. This section briefly describes how each of these methods has been used in L2 writing studies to gather data and resolve methodological issues.

2.1 Think-aloud protocols

Since the 1980s, think-aloud protocols have mainly been used to ask questions about the temporal dynamics of cognitive processing. They involve asking writers to express their thoughts during a writing task, without making any judgements (Ericsson & Simon 1993). The resulting "blow-by-blow account" provides direct information about the way writers deal with writing processes during composition. Investigating conceptual cognitive activities is almost impossible without resorting to thinking aloud, either concurrently or retrospectively. The same is true when studying the use of L1 during L2 writing.

Studying think-aloud protocols could appear more problematic in L2 than in L1, because of the greater cognitive complexity. However, all the authors who use this method regard it as a valuable tool for L2 writing research. Concurrent verbalizations are preferred to retrospective interviews, even with video recording (Roca de Larios, et al. 2008; van Weijen 2008). Participants in these studies are generally free to voice their thoughts in L1 or L2 while writing in both languages, and there are many examples to show that L1 is regularly used in short bursts or comments while thinking aloud in L2. For van Weijen

(2008: 166), "the fact that writers frequently resorted to L1 while thinking-aloud in L2 instead of falling silent indicates that they did not appear to have much difficulty verbalizing their thoughts while writing in L2".

The way that different cognitive processes are implemented during writing varies between writers. They differ not only in the amount of attention they pay to each process but also, more importantly, in the time at which they engage in the process. For a long time, studies focused on the role of a single process during writing, such as planning, formulating, or revising. These studies recorded the *frequency* with which this process occurred during writing. However, L1 writing research has shown that it is the *time* at which a process occurs, and not its frequency of occurrence, that is related to text quality (van den Bergh & Rijlaarsdam 2001). This finding has been confirmed by van Weijen (2008) for L2 writing. Therefore, in order to provide more specific advice about how to teach writing strategies, detailed research is first required to find out how cognitive processes influence each other during L2 writing and affect text quality. This research would certainly benefit from using think-aloud protocols, chronometric analyses (with keystroke recording protocols) and dual-task methods.

2.2 Chronometric recording (analysis of pauses, fluency)

Unlike think-aloud protocols, chronometric recording constitutes a non-obtrusive tool for studying writing process in real time. It enables researchers to detect cognitive operations by measuring their processing times during language production. At least two major variables are generally used: pauses and fluency. A pause happens without external intervention or experimental manipulation, and is directly observable because there is an interruption in transcription (Matsuhashi 1982; Schilperoord 1996). Fluency corresponds to the volume of text produced in relation to total writing time.

Recording tools have evolved since chronometric analysis was first used to study on-line writing. The tedious system of a camera with built-in chronometer has been replaced by digital recordings on graphic tablets or word processors (Faraco et al. 2002; Ransdell et al. 2002; Spellman-Miller 2005; Van Waes & Leijten 2006). Whatever their form, all the writer's actions (pressing a key, calling a function) are recorded with their respective temporal and spatial information. To avoid having to take account of the participants'

typing skills, as well as their writing skills, the use of a graphic tablet is preferable. In both cases, spatiotemporal data about the layout of the handwriting are processed by specially-designed software that can display it on a computer screen (this is less useful for research than for educational settings, e.g. students' self-assessments, see Spellman-Miller 2005).

The location of the pause, its duration and the nature of the process underway at that particular time are the main discussion points in chronometric analysis. Some pauses directly result from the actual process of handwriting (e.g. dotting the "i"s, adding the accents, etc.) and may have to be eliminated from the analysis. In this case, a threshold value must be chosen, but very few studies have directly tested different thresholds. This is a critical element in pause analysis, as values can vary from 200 ms (Barbier 1998; Faraco et al. 2002) to one second (Schilperoord 1996) according to the research objectives. Above the chosen threshold value, pauses are generally interpreted in the light of information processing theories. Due to their limited processing capacities, writers cannot undertake all the reading, planning, generating, formulating and revising at exactly the same time as they transcribe their texts. Pauses are thus interruptions in production that take place when the writers run short of resources. Therefore, pauses reveal processes that are initiated in order to keep on writing and can be regarded as direct indicators both of processing times and of cognitive load. Fluency can be viewed as a similar indicator. Barbier (1998) and Ransdell et al. (2002) have suggested that writers generally deal with an increase in cognitive load by decreasing their rate of production. This enables them to modify the orchestration of their cognitive processes and prevent a decrease in the quality of their texts. Therefore, long and frequent pauses, as well as decreased production rates, may occur during long and costly processing. Short and infrequent pauses, and fluent rates of production reflect inexpensive and rapid processing.

Congruent results have emerged from various studies of pauses and fluency in L1 and L2. For a long time, these experiments sought to detect separate processing units in language production. The hypothesis was that pauses would more frequently be located at the semantic and/or linguistic boundaries of these units. Despite some divergences, most studies have revealed a covariation between the duration or frequency of pauses and their syntactic location (end of paragraph, sentence, clause or word). The higher the unit in the text's syntactic organization, the longer the pause (Barbier 1998; Matsuhashi 1982). The

duration of intra-clause pauses seems to be affected by lexical variables, such as word frequency (Goldman-Eisler 1972) and the contextual consistency of the word within the sentence (Beattie & Butterworth 1978).

To summarize, the difficulty of interpreting pauses in the light of one particular process (planning or revision) has resulted in only a few studies of L2 composition. Some studies have used this approach to examine the argumentative text production (Barbier 1998) and notetaking processes (Faraco et al. 2002) of students in L1 French and L2 English. These studies have yielded consistent data. At every level of processing, in both argumentative text production and notetaking, writing processes generate longer or more frequent pauses for L2 writers, even the most advanced students. These writers develop strategies that differ from those in L1, essentially focusing their production on a direct transcription of their ideas, with neither sufficient nor efficient conceptual operations (Whalen & Ménard 1995). However, it should be noted that training in specific strategies (e.g. an all-at-once strategy, such as continuous planning, translating and revising, or a step by step strategy, such as planning, translating and lastly revising, see Ransdell et al. 2002) in turn affects fluency and text quality in both L1 and L2 writing.

2.3 Dual-or triple task paradigms

Dual-task procedures deliberately seek to interfere with the train of thought by asking participants to carry out the writing task while simultaneously performing a secondary task, such as reacting to auditory probes, listening to irrelevant speech or recalling series of random digits (Barbier 1998; Ransdell et al. 2001; Sasaki 2002). They are most suitable for exploring the allocation of cognitive resources to writing processes and highlighting how writers deal with working memory limitations according to task demands.

The triple-task method has been used in some L1 and L2 studies to gauge the time course and cost of writing processes (Olive et al. 2002). It consists of asking writers to react to randomly-distributed secondary probes, and to perform a directed retrospection task (which is different from a think-aloud task in that the writer has to choose between preselected processes). Scripkell software (Piolat et al. 1999) was designed to use the triple-task technique to achieve three goals: estimating the general temporal organization of writing processes, analysing the recursiveness of writing and measuring the amount of

resources allocated to different processes. The triple-task technique provides data that can be used to describe the pattern of changes in the cognitive load of the writing processes throughout the composition session, by comparing reaction times during different writing phases. The first analysis concerns the pattern of activation of a single writing process across all the writing phases. The second analysis concerns the activation and orchestration of the writing processes in each composition phase. At a third level of inquiry, the temporal organization and recursiveness of the writing processes can be studied by describing the shifts between different processes (e.g. from planning to translating or from reviewing to planning, see Levy & Ransdell 1995).

Most of the research using the triple-task technique has focused on L1 composition. The two main drawbacks of this technique are its possible negative effects on writing and the validity of categorizing writers' thoughts. A review by Olive et al. (2002) suggested that the triple-task technique measures the cognitive cost of writing processes without fundamentally hindering these processes. Nor is the quality of the text produced in a triple-task situation affected. Although directed retrospection does not provide as exhaustive a picture of process orchestration as the analysis of think-aloud protocols, it does produce the same pattern of results and is less labour-intensive. Translation always appears to be the most frequently used process. As the composition unfolds, the activation of planning decreases, while the activation of revision increases, but the activation of translating remains unchanged. The triple-task technique has also provided data on how task or learner variables may affect these patterns of allocation of time and effort (Olive et al. 2002). In short, the translation process in L1 does not seem to be particularly affected by task or learner variables, unlike planning and revision. The stable cost of translating suggests that it is an automatic process in L1.

Very few studies have used the triple task to analyse L2 writing strategies and their working memory load. As L2 writing has long been associated with cognitive overload, one would expect significant differences in reaction times, specifically during the translation process. However, the three studies conducted by Barbier (1998), Faraco et al. (2002), and Piolat et al. (2008) failed to reveal any of these expected differences between L1 and L2. In Barbier (1998), the main writing task in both languages consisted of reorganizing an argumentative text, adding the connectors and putting verbs into the right

tenses. In Piolat et al. (2008), students had first to listen then to take notes on the main ideas in a lecture, after which they had to write a summary of the lecture based on their notes. In Barbier et al. (in press), students had to navigate around an experimental website, take notes on paper or with the help of a word processor, and write a descriptive letter based on their notes using the same tools.

Reaction times did not depend on the language in any of these studies, although L2 writers experienced more difficulties than L1 writers. These difficulties were reflected in the way they adapted their writing strategies. In Barbier (1998), L2 writers spent more time reorganising their texts. They reduced their production rates in order to activate the planning process – as in their native language –, which was clearly required and identified in the task situation. Barbier et al. (in press) showed that, by relying almost exclusively on the copy-and-paste function to retrieve information from the website, the L2 participants using a word processor made reading a less costly activity and performed similarly to the L1 notetakers. The L2 students' difficulties only became apparent when they wrote on paper. They explored fewer website pages, did not abbreviate as much as in L1, and consequently jotted down fewer ideas; also, they did not take the time to work on the selected information either during the initial reading or subsequent letter composition phases. Both these studies show that L2 writers reduce the cognitive load arising from their situation by adapting their writing strategies. In any case, the task situation affects the ability of L2 writers to adapt their strategies, and the degree of control needed for formulation and execution is clearly of great consequence.

3. Conclusion and perspectives

This article discusses three main issues in L2 writing research. The first one concerns the orchestration of writing processes during a writing session (Olive et al. 2002; Rijlaarsdam & van den Bergh 1996). Since the ground-breaking work by Hayes & Flower (1980), it has been assumed that writing processes (planning, translating and reviewing) are recursively activated, with one process leading to another (e.g. translating an idea into a sentence prompts the writer to engage in further planning). Writing processes interweave

and the pattern of their activation reflects the writer's strategy for coping with the task demands. The next important question concerns the cognitive demands of the writing processes. It has long been recognized that writers juggle with simultaneous demands that often overload working memory resources (Kellogg 1996; McCutchen 2000). The third issue more specifically concerns the methods available to track the orchestration of writing processes and their associated cognitive load. At least three sets of methods are identified and described in depth here in order to identify their advantages and disadvantages. Taken separately, each method has its limitations: think-aloud protocols and dual tasks are highly intrusive, but allow the on-line identification of processes and their associated cognitive resources. Chronometric recording is non-obstrusive and it is useful for detecting the times when one writing process is particularly resource-demanding, but this process cannot be clearly identified. Therefore, researchers would certainly gain in the future by combining these methods. All too few studies have attempted to do so thus far.

One issue worth investigating in the future is the potential for language learning offered by written production, "particularly in foreign language settings where contact with the printed word affords more varied and frequent opportunities for learning than oral language" (Manchon & Roca de Larios 2007: 549). Such language learning potential could be related to the nature of the attentional processes implemented during the act of producing written language. Robinson's above-mentioned hypothesis (2005) explains how writers could benefit from cognitively demanding tasks, prompting greater awareness and thereby greater linguistic accuracy. It is, however, too soon to state clearly the modalities where L2 writers can experience a relevant cognitive load. The studies described earlier indicate that L2 writers consistently develop specific strategies, such as decreasing their production rate or focusing on formulation, to avoid cognitive overload. Consequently, L2 writing does not systematically demand more cognitive resources than L1 writing (Barbier 1998; Barbier et al. in press; Piolat et al. 2008). More information about the nature of attentional processes is therefore needed, and this could be obtained through the combined use of chronometric recordings and dual tasks.

From a teaching perspective, this study concludes that learner variables influence the way L2 writers manage their writing processes and cognitive resources. Language skills,

particularly the speed of language processing in L2 written production (lexical retrieval and sentence building), therefore need to be practiced so that they become automatic. Only through repetition can this be achieved; and repeatedly practising form-meaning connections within the controlled framework represented by writing may even lead to later increases in the frequency of their production in speech. The question is whether graphemes connect directly with semantic content, or whether any conversion from graphemes into phonemes occurs during L2 writing. Similarly, do grapheme-phoneme conversions and form-meaning connections depend on automatic L1 procedures that will interfere in L2? More research is needed to evaluate the effect of L1 writing expertise on L2 formulation in writing and speaking.

Finally, the automatization of formulation should allow L2 writers to allocate more cognitive resources to orchestrating the overall writing task, as in L1. The task variables also need to be adapted in order to save working memory resources (e.g. by breaking up each task into a series of clearly-identified stages or reducing the level of expected lexical and syntactic performance). Then again, an increase in cognitive complexity might actually lead to higher linguistic accuracy in learners, as has already been suggested (Robinson 2005).

More research is clearly needed to study the cognitive processes of L2 writers in real time and improve the way teachers adapt these task variables. As computers become ever more present in the classroom, teachers will be increasingly keen to use key-logging tools. These ones could help the teachers, or the students themselves (for self-assessments, Spellman-Miller 2005), to understand the degree of automatization of formulation and even more the temporal resolution and the organisation of the L2 writing processes on the whole. Whatever the case may be, research on the use of computers in class must include a thorough analysis of how teachers might use chronometric indicators to help them detect students' writing difficulties. Further studies along this line could lead to the development of new tools for teachers.

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Biographical information

Nicole Spinelli-Jullien is responsible for the primary school teachers' training in English at the IUFM of Aix-Marseille (teacher training college, University of Provence, France). Her teaching activity and research focus mainly on the use of cross-modal activities to develop the student's oral and writing skills in English L2.

Dr. Marie-Laure Barbier is affiliated as a senior lecturer to the IUFM of Aix-Marseille (teacher training college, University of Provence, France) and to the centre for research in Psychology of Cognition, Language and Emotion (University of Provence, France). She has 15 years experience of educational research, focussing on the development of written communication skills in second language and the use of information and communication technologies.