

THE TRIPLE TASK TECHNIQUE FOR STUDYING WRITING PROCESSES ON WHICH TASK IS ATTENTION FOCUSED?

Annie Piolat*-Ronald T.Kellogg**-Fernand Farioli***

Abstract: The triple task technique measures the time and cognitive effort devoted to specific writing processes by combining directed retrospection with secondary task reaction time (RT). Writing a text is the primary task and rapidly detecting auditory probes to index cognitive effort is the secondary task. The third task is retrospecting and categorizing the contents of working memory at the time of each probe. The present paper reviews studies on the reactivity and validity of the technique. Further, one recent criticism of the method's validity is tested here: namely, that the primary task for the experimenter is not the primary task for the writer, thus distorting the time and effort measurements. We found that time and effort allocated to planning, translating, executing, evaluating, and revising was the same when the writer was encouraged by instructions to focus either on the speed of responding or the accuracy of retrospection instead of the text itself. Because writing requires sustained thought and attention to produce a cumulative product, it is apparently difficult to make text production anything but the primary task. The triple task technique offers a useful alternative to pause analysis and verbal protocols for investigating the functional features of writing.

Keywords: Cognitive Effort, Attention, Writing Processes, Text Production, Triple Task

* Center for Research in Psychology of Cognition, Language, and Emotion, University of Provence, Aix en Provence, France

** Department of Psychology, University of St Louis, Missouri, USA

*** Laboratory of Cognitive Psychology, CNRS & University of Provence, Aix-en-Provence, France

Address for correspondence to

Annie Piolat email: annie.piolat@up.univ-mrs.fr
PsyCLÉ, Université de Provence, 29 Av. Robert Schuman,
13621 Aix-en-Provence, Cedex France

INTRODUCTION

Writing a text brings together three complex cognitive functions—memory, language, and thinking—in a single task. Considerable progress has been made in understanding the interaction of these functions in discourse comprehension tasks. However, the production of language in writing, or speaking, is not amenable to standard laboratory techniques in cognitive psychology (Bock, 1996). A fundamental problem in production work is identifying and tracking the time course and resource use of planning, sentence generation, and other key processes. In the present paper, we discuss a technique for addressing this problem, provide data on one question regarding its validity, and briefly summarize other studies of the reactivity and validity of the technique.

A central issue in cognitive research on text production concerns the dynamics of writing (Kellogg, 1994). Planning ideas, translating the planned content into sentences, and reviewing ideas and text are three basic production processes. The dynamics of writing refers both to the temporal organization of these processes during a writing session and to their cognitive demands (Kellogg, 1999; Levy & Ransdell, 1995; Piolat & Olive, 2000). To state it simply, researchers study "when" a process is activated and its "cost". It has long been established that planning, translating, and reviewing do not occur in linear order (Hayes & Flower, 1980). They are instead recursive, with one process calling upon another, as when 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 (Kellogg, 1987a, 1988). Consequently, how writers perform should depend on factors that affect when writing processes are activated during a composition (van den Bergh & Rijlaarsdam, 1996).

With respect to the cost of a process, it has long been recognized that writers must juggle simultaneous demands that often overload working memory resources (e.g., Flower & Hayes, 1980; Kellogg, 1994; Torrance & Jeffery, 1999). Because of the complexity of the task and the concurrent demands made on memory, language, and thinking, writing processes are severely resource-limited. Consequently, reliably and validly measuring how writers devote their time and effort to specific processes is an important research goal. Analysis of pauses in writing behavior can be a useful tool for measuring the time devoted to a process, but it is less informative than one would like. A long pause could reflect either planning or evaluating, for example.

Thinking aloud during composition offers another useful tool, but verbal protocols do not index the effort devoted to specific processes.

The triple task technique is specifically designed to answer questions about the time course and cost of writing processes (Kellogg, 1987b). The procedure calls for participants (1) to focus attention on composing a text, (2) to respond as rapidly as possible to auditory probes distributed on a variable interval schedule, and (3) to retrospect about the contents of working memory at the time of the probe. Writing a text is the primary task and detecting unpredictable auditory probes as rapidly as possible is the secondary task. The tertiary task assesses the nature of the cognitive processes that occurred at the time of each probe using concurrent directed retrospection. Participants are trained to categorize their thoughts as examples of planning, translating ideas into sentences and revising. The technique measures the allocation of working memory resources using reaction time (RT) to auditory probes and couples these measurements to specific writing processes engaged during composition (for more information on the triple task, see Olive, Kellogg & Piolat, 2001).

This secondary task technique is based on the assumption that the primary and secondary tasks compete for a limited pool of attentional or executive working memory resources (Kahneman, 1973). Coordinating multiple processes, focusing attention, inhibiting alternatives, and scheduling responses are examples of executive functions that play a role in memory, language, and thinking (Baddeley, 1996). Because executive resources are limited, increases in resource use by the primary task are reflected in slower RTs on the secondary task. The greater the interference in RT to the auditory probes compared with single task, baseline RT to the same stimuli, the greater the cognitive effort required by the writing processes. Cognitive effort refers to the proportion of the available executive resources that is momentarily allocated to a process.

Such a dual task technique has been commonly used in cognitive psychology (e.g. Baddeley & Andrade, 2000; Kellogg, 1994), so the unique advantage of the triple task technique lies in the addition of the third requirement. To couple the RT data with specific writing processes, the writers are asked to categorize the contents of working memory as they write. Directed retrospection can be problematic if called for after task completion because of forgetting (Ericsson & Simon, 1993). This problem is avoided by prompting writers to retrospect concurrently, as they are composing, in a manner similar to verbal protocols. Directed retrospection is less commonly used in research on problem solving and other thinking tasks in comparison to verbal protocols (Levy & Ransdell, 1994; Levy & Ransdell, 1995). However,

directed retrospection has played a critical role in recent research on episodic and semantic memory. After recalling or recognizing an item in an experiment, a participant reflects on his or her state of awareness at the time and categorizes it as knowing or remembering (Gardiner & Richardson-Klavehn, 2000).

Reactivity

As with verbal protocols, the triple task technique may be reactive, causing changes in the cognitive processes underlying the task as a result of taking the measurements. For example, it can be argued that writing performance is disrupted by the secondary RT task or by the retrospection task. Because some evidence suggests that verbal protocols interfere with writing processes (Janssen, van Waes & van den Bergh, 1996), it is important to assess the reactivity problem with the triple task technique. Piolat et al. (1996) compared text produced when writers performed only a composition (single task situation) with a condition in which writers performed the triple task technique. Piolat et al. (1996) evaluated the effect of the secondary task on the number of final words, on the fluency, on the syntactic complexity (number of words by sentence) and on the number of revisions. They observed no significant differences. They further compared interference in dual task (i.e., composition plus secondary RTs only) and triple task situations (composition, secondary RTs, and directed retrospection) and found no reliable differences. The rate of presenting probes affected secondary RT in an unexpected manner. A fast rate (one per 15 sec on average) and a slow rate (one per 60 sec on average) yielded more RT interference than the rate used here (one per 30 sec on average). However, the relative degree of interference observed for planning, translating, and reviewing did not change with this manipulation.

In a test of the reactivity of the retrospection task alone, Kellogg (1987b) compared 30 writers engaged in directed retrospection with 30 control writers who composed as a single task. A 30 seconds variable interval schedule was used for prompting the writers to introspect, but the responses indicating detection of the probe were not required and RTs not collected. As in the Piolat et al. (1996) study, no reliable differences were observed in either writing fluency or quality as measured by text length and judges ratings.

Validity

Accessibility to consciousness. Another potential problem lies in the validity of the retrospective reports. If the products of planning, translating, and reviewing are not readily accessible to conscious report, then concurrent directed probes may not provide a valid picture (Ericsson & Simon, 1993). On this point, Kellogg (1987b) observed substantial agreement between writers' categorizing their own verbal protocols as examples of planning, translating, and reviewing and a trained judge categorizing the same report. After thinking aloud while composing, the writers received training on using the three categories and then listened to a recording of their verbalizations. Despite that nearly 20 minutes passed from the end of the writing task to the stage of categorizing the verbalizations, a mean of 82% of the participants' categorizations matched the experimenter's categorizations of the same verbalizations. Presumably, this figure provided a low estimate of agreement given that forgetting probably occurred over the 20 minutes retention interval. Thus, the results provided a validation of the directed retrospection task.

Distortion from forgetting. A second study of the validity of directed retrospection assessed whether the categorizations are subject to distortion because of forgetting or because participants respond randomly (Levy, Marek, & Lea, 1996). The writers were given a large number of categories (15, including "other"), as in a study by Schumacher, Klare, Cronin & Moses (1984), and instructed to retrospect concurrently with composing when auditory probes occurred. Then, at the end of a 20 minutes writing session they reviewed videotape of the entire writing session. At the points when probes occurred, they were asked to re-categorize their thoughts at that point in the composing process. Levy et al. found that some writers matched their earlier categorizations about 75% of the time. However, others showed little consistency, not much better than random responding. Their results indicate that delaying retrospection until after the task is completed risks distorting the validity of the data, at least when a large number of response categories are used. The use of concurrent retrospection during writing itself minimizes the forgetting problem. Also, even with a 20 minute delay, using only three rather than 15 categories improves the validity of the procedure judging from Kellogg's (1987a) findings.

Distortion from metacognition. It is also important to test whether metacognitive knowledge about the writing process influences the pattern of responses given to directed retrospection. Levy and Ransdell (1995) found that self-reports on a survey of how one typically composes overestimate

the time and effort given to evaluating and revising compared to lab measurements. Without being able to recall and report on a specific episode, writers probably rely on a metacognitive belief that reviewing is common in answering the survey. Another metacognitive belief might be that writers first plan, then write, and then revise. Perhaps writers used this belief rather than gaining access to the current contents of working memory. If that is so, then even categorizing the behavior of someone else writing ought to show the same pattern of first planning, then translating, and finally reviewing. So, Levy, Marek, and Lea (1995) had participants decide whether the research assistant was engaged in planning, translating, reviewing, or other activities whenever an auditory probe occurred as the assistant appeared to be writing. The results showed a flat pattern of responses over time: planning, translating, and reviewing were reported equally often as the writing session progressed. Thus, metacognitive knowledge appeared to have little effect when tested in this manner.

Levy and Ransdell (1995) suggested that with directed retrospection writer's overestimate the amount of time they spend reviewing, because of metacognitive beliefs that reviewing is common. During composition their verbal and written protocols revealed little if any reviewing. In contrast, self-reports given on a survey about their typical composing process revealed that nearly a third of their time and effort was spent on reviewing. This outcome could be interpreted to mean that self-reports of any kind, including directed retrospection, are subject to distortions inherent in the writers' metacognitive beliefs about writing processes. However, Levy and Ransdell underscored that the self-reports they analyzed were convergent with the pattern of temporal organization of the writing processes that Kellogg observed (1987a, 1988, 1994). That different retrospective and observational methods converge weakens the case that the patterns reflect belief rather actual working memory allocations.

OBJECTIVE

The triple task technique allows one to (1) analyze the temporal organization of writing processes, (2) measure the degree of attentional or executive resources of working memory allocated to these processes. Although the technique appears to be non-reactive and to provide valid measurements, the multiple demands made on the participant raises a potential problem. If participants fail to focus attention on writing as the primary task, as the experimenter intends, then the effort and possibly the time measurements would be distorted. For example, if participants focused on responding rapidly

to the auditory probes, then RT interference would be artificially low. Or, focusing primarily on retrospection about the processes engaged in might alter time given to, say, planning or editing. Thus, the outcome of an experiment would change depending on the priorities assigned by the participant to the three tasks, as argued by Richard (1997). How does one verify that the primary task for the experimenter is also the primary task for the participant?

It can be argued that the design of the triple task procedure itself ensures that writing is the primary task. Writing is the only task that requires sustained thought and attention to produce a cumulative product. The secondary RT task requires a discrete, non-cumulative response at unpredictable times. The directed retrospection task also requires a discrete, non-cumulative response, although the participant knows it will occur after each secondary signal. In contrast, the writing task occurs continuously throughout the experimental session, punctuated only on occasion, and requires a cumulative response in the form of a coherent text. Thus, the writing task is the only aspect of the technique that requires the participant to focus over an extended period of time in order to generate a product that must be completed by the end of the experimental session. Further, the written product requires integrating mental representations generated over time into a coherent structure.

If it is correct that the triple task technique inherently constrains the participant to regard writing as a primary task, then it ought to be difficult alter this focus. Here we explicitly instructed different groups of participants to focus attention on aspects of the procedure other than the text itself. If such instructions cause changes in the temporal organization and cognitive effort demands of writing processes, then such an outcome would raise questions about whether the writing task is inherently primary. It further would raise the possibility that participants alter their focus spontaneously, introducing errors in the time and effort measurements. Here we examined whether the measurements vary when the instructions explicitly encourage participants to focus on aspects other than producing the text. We predicted from the altered focus hypothesis an interaction of instructions with the process reported. That is to say, the estimates of processing time and RT time interference observed for planning, translating, motor execution, reading, and editing ought to differ across the instructional conditions. Failure to obtain the expected interaction would suggest that it is difficult to force the participants away from regarding the writing task as primary.

Three groups were examined in the present experiment to test the altered focus hypothesis. In the text focus group, the writers were asked to incorporate precise and relevant information into the text, regardless of other

task requirements. In the speed focus group, the writers were asked to respond as quickly as possible in the experiment, regardless of other task requirements. In the retrospection focus group, the writers were asked to be fully aware of the processes engaged by writing, regardless of other task requirements. Of interest was whether the pattern of time devoted to writing processes and the cognitive effort allocations changed as a result of this instructional manipulation.

METHOD

Participants

A total of 29 participants (first year psychology students who received credits for their participation to the experiment) were assigned randomly to the three instructional groups, text focus ($n = 9$), speed focus ($n = 10$), and retrospection focus ($n = 10$).

Design

The key segment of the instructions differed for each of the groups in the following way:

Text Focus. "... The goal of this study is to evaluate the stability of your capacity to write a quality text when distracted by other events, even when you must react and quickly cope with these distractions. In certain actual human activities such as work at the office, taking notes, it is paramount, above all, to produce a text in a very controlled way, even if you are distracted by external events to which you must react, like the ringing of the telephone or someone's arrival. You must write information that is precise, complete and relevant, regardless of the nature of additional demands..."

Speed Focus. "... The goal of this study is to evaluate the stability of your capacity for vigilance while doing a complex task, even a high level cognitive task. In certain actual human activities such as air traffic control, it is **paramount, above all, to maintain vigilance at the** highest level, even if you are occupied with completing another task such as evaluating a plane trajectory or writing an incident report. You must be able to react as quickly as possible, regardless of your principal occupation on a physical or intellectual task..."

Retrospection Focus. "...The goal of this study is to evaluate your capacity to analyze the production processes used during the writing of a text, even when specific distractions interrupt this analysis. In certain actual human activities, such as

demonstrating a mathematical solution, it is paramount, above all, to be consciously aware of the what one is doing, even if you are engaged in a high level mental activity like complex logical reasoning. You must be fully aware of the processes used in the task..."

Procedure

The experimental procedure involves the following steps: (1) participants were informed to focus their attention on either the text, the task's speed or the retrospection task (see above); (2) the collection of baseline RTs; (3) the directed retrospection training; (4) participants were informed that they will have to compose a text concurrently with RT probes followed by retrospection; (5) a recall of the focus of the task; (6) execution of the triple task (for more information see Olive, Kellogg & Piolat, 2001). Participants were individually tested. All steps of the experiment took between 60 and 90 minutes. During the second step of the experiment, the participant is trained in the method of directed retrospection. The experimenter begins with instructions that define the writing processes under investigation: "Planning is *said to occur when the writer generates ideas in order to know what to write. Planning is also referred to when the writer thinks about the best way to organize ideas and this organization is made as a function of the topic and the audience. Translating of ideas means that ideas are converted into words, into sentences, into paragraphs and text. Mental translation of ideas into a linguistic form means selecting syntactical forms, words, and spelling. Executing means to write down on the paper the content to which the writer refers. In other words executing means a concrete transcription of the refereed words and sentences and that were translating into a linguistic form. Evaluating means that the writer will judge what s/he thought about and what the writer translated. The writer can ask himself/herself if ideas or projects are satisfying. The writer examines if the written output is appropriate in terms of content, organization, sentences, words, and spelling. Revising means transformation for the purpose of correction that follows the detection by the writer of inadequacy in his/her ideas or in his/her writing. Thus the writer will change his ideas or his/her writing in term of content, organization, sentences, words, and spelling.*". Moreover, a category unrelated to the writing process must be systematically used: "category other". This unrelated category concerns all thoughts that do not fit the defined writing processes (e.g., daydreaming). The instructions then continued with examples of thinking-aloud protocols to illustrate further each writing process. Next, participants were required to categorize several examples of thinking-aloud protocols. Each time an

error occurs, the experimenter had provided feedback to correct the participant's understanding of the meaning of the different categories. After the training, participants were shown a computer keyboard on which were pasted different colored labels corresponding to each process. Participants were to indicate what they thought about what they were doing by pressing on designated keys

During the third step of the experiment, participants were informed that during the coming task they would occasionally hear an auditory signal ("beep"). They were asked to react as quickly as possible to these beeps by clicking the mouse with their non-dominant hand while handwriting with the dominant one. After delivering these instructions, a series of 30 single-task RTs were collected. The first five trials were treated as warm-up signals and the mean baseline RT was calculated from the 25 other RTs. The probes were distributed in a random interval with a mean interval of once every 10 s and a range of 5 sec to 15 sec. During the composition, probes were distributed with a mean interval of once every 30 s and a range of 15 sec to 45 sec. In the fourth step, directly after the collection of the baseline RTs, the experimenter read the writing assignment and gives the topic of the composition to the participant (an argumentative text about the increase of academic tuition; see Kellogg 1988, Experiment 2). Participant was informed while writing, he had to perform the two added tasks: the reaction time task and the retrospection task (no limit was imposed for duration and composition's length).

Before the realization of the triple task (sixth step), the fifth step consisted in recalling the focus of the task (text, speed and retrospection) to the participants who were told that they had to be attentive to the focus without neglecting the realization of the two other tasks.

The computer program SCRIPTKELL recorded both RTs and the categorizations (Piolat, Olive, Roussey, Thunin & Ziegler, 1999).

RESULTS AND DISCUSSION

Cognitive effort. The mean RT for baseline trials (detecting auditory signals as the sole task) was calculated and compared across the three instructional groups. As anticipated, the participants assigned to the text focus ($M = 562$ ms), speed focus ($M = 544$ ms), and retrospection focus ($M = 526$ ms) groups were equally proficient in detecting the signals. The baseline RT was subtracted from the mean RT obtained when participants reported each of the

five processes, providing a RT interference score. The greater the RT interference, the more cognitive effort was given to the process in question. The mean RT interference scores for each process as a function of instructional group are shown in Table 1.

Table 1
Mean of RT Interference Scores (in sec.) and Standard Deviations (in parenthesis) for Each Writing Process by Instructional Group.

Process	Text	Instructional Focus Group		Average (total)
		Speed	Retrospection	
Planning	557 (78.7)	437 (51.8)	518 (61.9)	504 (64.1)
Translating	493 (78.9)	429 (38.4)	533 (58.2)	485 (58.5)
Executing	516 (90.3)	465 (57.3)	621 (39.3)	534 (62.3)
Evaluating	515 (86.8)	490 (78.7)	551 (51.8)	518 (72.5)
Revising	554 (92.2)	487 (73.6)	653 (38.4)	565 (68.0)
Average (total)	527 (63.1)	461 (44.6)	575 (51.5)	

Averaged over the three instructional groups, revising ($M = 565$ ms) and executing ($M = 534$ ms) showed higher RT interference scores than planning ($M = 534$ ms), translating ($M = 485$ ms), and evaluating ($M = 518$ ms). But in an analysis of variance (ANOVA) on these data, the main effect of process was statistically unreliable, $F(4, 104) = 1.35, p > .25, MSE = 19907$.

The main effect of instructional group was also unreliable, although the absolute degree of RT interference tended to be less in the speed focus group, $F(2, 26) = 1.19, p > .31, MSE = 135485$. Asking participants to remain vigilant and respond quickly resulted in somewhat faster RT overall. Of key importance, the instructions did not interact with reported process, $F(8, 104) = 0.054, p > .82, MSE = 19907$. The degree of RT interference or cognitive effort associated with planning, translating, executing, evaluating, and revising was not reliably different across the three instructional conditions. Revision and execution required relatively high degrees of cognitive effort regardless of the instructional group differences.

Processing Time. The writing session was divided into thirds and the percentage of responses was calculated for each process during the first, second, and third phase of production.

The means are presented in Table 2 for each process as a function of instructional focus group.

Table 2

Mean Percent of Time Reported and Standard Deviations (in parenthesis) for Each Writing Process by Instructional Group.

Process	Instructional Focus Group			
	Text	Speed	Retrospection	Average (total)
Planning	16 (2.4)	19 (2.1)	22 (2.3)	19 (2.3)
Translating	24 (4.9)	12 (2.1)	22 (2.6)	19 (2.3)
Executing	36 (6.4)	43 (3.9)	30 (3.2)	36 (4.5)
Evaluating	14 (2.8)	13 (1.1)	16 (2.2)	14 (2.0)
Revising	10 (1.5)	13 (2.6)	10 (3.2)	11 (2.4)

For planning, evaluating, and revising, there was relatively little variation among the three instructional groups. Further, the text and retrospection groups were similar also with respect to translating and executing. The lower mean value for the time spent translating in the speed focus condition may have reflected an attempt by the participants to rapidly initiate motor execution during sentence generation compared with the text focus ($t(17) = 2.43, p < .026$) and the retrospection focus ($t(18) = 2.67, p < .016$) conditions. The drop in translating time was offset by an increase in executing in the speed focus group. However, the overall ANOVA on these data failed to yield a reliable interaction of instructions and process, $F(8, 100) = 1.26, p > .26, MSE = 8.36$.

Thus, there is at least one difference in the processing time estimates given as a result of instructions in the present experiment. Motor execution is often considered part of translation, because the two are so closely locked in time during text production (Berninger & Swanson, 1994). Most studies conducted with the triple task technique have not tried to separate translation from motor execution (Olive, Piolat & Kellogg, 2000). The present data imply that participants can retrospectively distinguish between formulating how to linguistically express an idea and the subsequent motor execution of the sentence. Furthermore, instructions to speed responding results in a decrease in the formulation or translation time per se. Combining the two estimates here leads to comparable allocations of time for the text focus (.60), speed focus (.55), and retrospection focus (.55) conditions.

Averaged across the three instructional groups, planning was reported most frequently during the first phase, followed executing and translating (see Table 3). Evaluating and revision were rarely reported during the first third of the writing session. During the second phase, executing was most common, followed by translating and planning. Again, evaluating and revising were relatively rare. The ANOVA revealed a main effect of reported process

($F(4,100) = 24.95, p < .001, MSE = 8.36$, and an interaction of process and phase ($F(8, 200) = 10.05, p < .001, MSE = 8.36$, and no other reliable effects. Of key importance, the instructions failed to alter significantly the time devoted to the various writing processes, $F(2, 25) = 0.86, p > .43, MSE = 12.12$.

Table 3

Mean Percent of Time Reported and Standard Deviations (in parenthesis) for Each Writing Process by Phase of Composition.

Process	Phase of Composition			Average (total)
	First	Second	Third	
Planning	29 (2.9)	17 (1.9)	12 (2.1)	19 (2.3)
Translating	26 (2.5)	19 (3.1)	14 (2.4)	19 (2.7)
Executing	29 (3.1)	41 (4.1)	38 (3.8)	36 (3.7)
Evaluating	8 (1.6)	12 (1.8)	23 (2.6)	14 (2.0)
Revising	9 (1.4)	11 (2.1)	14 (2.2)	11 (1.9)

The only reliable contrast observed was that the amount of planning and translating was greater than the amount of evaluation and revision combined for the text and retrospection focus groups in comparison to the speed focus group, $F(1, 25) = 6.72, p < .01, MSE = 22.67$. Evaluating and revising were relatively uncommon in all three instructional groups. The speed instructions appears to have encouraged participants to generate text with no more time given to the formulation of plans and sentences than to their monitoring. However, neither the main effect of instructions nor any of the interactions of process and phase with instructions were reliable. Thus, the participants did not significantly change the way they allocated time to the various writing processes as a function of instructions.

Writing performance. The length of texts, total production time, and words produced per minute showed no reliable differences among the instructional groups. Also, the number of sentences and length of sentences in words were not reliably affected by the instructions. The only measure of writing performance that showed an instructional effect was the number of words changed during revision, $F(1,25) = 5.27, p < .03, MSE = 200.56$. In the speed group ($M = 27.4$), self-corrections were significantly more numerous, compared to the text ($M = 11.7$) and retrospection ($M = 17.7$) groups. This outcome reflects the greater number of typographical, mechanical, and other more substantive errors that were made when participants focused on responding rapidly in the experiment. With the exception of this finding,

the performance measures did not suggest that instructions altered writing processes and the resulting text.

CONCLUSIONS

When writers were instructed to focus attention on text production, fast responding, or careful retrospection the allocation of time and effort to writing processes did not vary reliably. Planning and translating decreased across the first, second, and third phases of writing, whereas evaluation, revision, and execution increased slightly. This pattern held regardless of the instructions to focus on different aspects of the triple task technique. Furthermore, these temporal patterns have been observed now in studies using not only directed retrospection (Kellogg, 1987a, 1988; Levy & Ransdell, 1995; Piolat, Roussey, Olive & Farioli, 1996) but also undirected verbal protocols (Levy & Ransdell, 1995; Penningroth & Rosenberg, 1995; Rau & Sebrechts, 1996) and videotaped observations of writing behavior (Levy & Ransdell, 1994, 1995; Breetvelt, van den Bergh & Rijlaarsdam, 1994). The absolute magnitudes of the time estimates given to writing processes are not identical across studies, possibly because of differences in the measurement technique, writing topics, and other procedural matters, but the relative patterns are stable across methods.

The instructions to respond quickly caused a reduction in the time allocated to translating an idea into sentence, because more time was given to motor execution compared with the other instructional conditions. Also, the speed instructions caused more words to be changed during revision, possibly because the time taken to translate the sentence was rushed. There was apparently a greater need to alter words selected in haste, to fix spelling, or to amend punctuation when the instructions focused on speed. However, fluency measures plus text and sentence length failed to show any differences across the instructional conditions. Some theorists regard motor execution as a subprocess of translation (Berninger & Swanson, 1994). If the two were combined into one category, as is typically done in studies using the triple task technique, then the time estimate given for both aspects of translation, formulating the sentence plus motor execution, was also invariant across the speed, revision, and text focus conditions.

The triple task technique appears to be a stable procedure for measuring the dynamics of written composition. There are clear limitations on our conclusions. First, we found an exception with respect to the speed condition and translating-motor execution as just discussed. Second, a conclusion that the

technique is valid depends on accepting the null hypothesis of no reliable interaction. However, this is an inevitable problem in testing the reactivity and validity of techniques that track cognitive processes. For example, Ericsson and Simon (1980) relied on the failure to find that verbal protocols interfered with task performance to support the conclusion that it is non-reactive. Similarly, the present data show that the time and effort measurements afforded by the triple task technique were not much if at all altered even when participants tried to focus on speed or retrospection rather than the text itself. The data afford at least some assurance that alterations in focus do not arise spontaneously when the instructions stress treating writing as the primary task.

The writing task itself is primary for reasons other than instructions alone. Only the writing task requires a sustained train of thought and the development of a final product. Hence it is not surprising that writers treat the text as their primary task even when instructed to focus attention elsewhere. Instructions alone did not interact with the type of process reported on the processing time and cognitive effort measures. If error is introduced in the measurements by participants spontaneously adopting a focus other than the text itself, then it is not easy to demonstrate this validity problem by the method studied here.

Additional work is needed on the reliability, validity, and reactivity of the triple task technique. However, it offers a relatively powerful way to track not only the time given to writing processes but also the degree of momentary cognitive effort. It also avoids the problem of how to segment a verbal protocol. Instead of the experimenter needing to segment the protocol after the fact, the writer does so through the categorization process during production itself. Writing and other complex, productive activities need to be understood in terms of their temporal dynamics. The triple task technique, along with verbal protocols and behavioral pause analysis, are viable ways of achieving this goal.

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