THE TRIPLE TASK TECHNIQUE FOR STUDYING THE PROCESS OF WRITING

THIERRY OLIVE*, RONALD T. KELLOGG**
& ANNIE PIOLAT***

** CNRS & University of Paris VIII (France), ** Saint-Louis University (USA), & *** University of Provence (France)*

Abstract. In this chapter, we first present two variants of a technique of secondary reaction time task and verbalization task that allow researchers (1) to estimate the general temporal organization of the writing process, (2) to analyse the recursiveness of writing and (3) to measure the amount of resources allocated to the writing processes (Kellogg, 1987b; Levy & Ransdell, 1994, 1995). Next, we present a series of experiments that evaluated the validity of the method. We then synthesize studies that used the triple task method to address questions concerning the way by which situation-specific or writer-specific factors affect functional characteristics of writing. We describe results from experiments that investigated the role of writers' knowledge, type of text planning, writing medium and cognitive capacity on resources allocation to the writing processes and on their temporal organization. Finally, we delineate how the triple task technique can be varied to answer future research questions.
Keywords: secondary task, verbalization, think-aloud protocols, working memory, cognitive resources, writing processes, dynamic of writing,

1. INTRODUCTION

A central issue in cognitive research on text production concerns the dynamics of writing. 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 (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 and 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. Consequently, how writers perform should depend on factors that affect when writing processes are activated during a composition (Rijlaarsdam & van den Bergh, 1996b).

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With respect to the cost of a process, it has long been recognized that writers must juggle simultaneous demands (Flower & Hayes, 1980) that often overload working memory resources (Grabowski, 1996; Kellogg, 1996, 1998, 1999; Lea & Levy, 1999; Levy, 1997; McCutchen, 1994, 1996; Ransdell & Levy, 1996; Torrance & Jeffery, 1999). Indeed, writing processes are resource-limited. Consequently, exploring the allocation of cognitive resources to the writing processes highlights how writers deal with working memory limitations as a function of the demands of the task.

The present chapter describes the use of a triple task technique designed to answer questions about the time course and cost of the writing processes. Writing a text is the primary task and detecting auditory probes as rapidly as possible is the secondary task. The tertiary task assesses the contents of the writer's working memory at the time when an auditory probe occurred through the collection of verbal protocols. One variant uses directed retrospection (Kellogg, 1987a, 1987b) and another uses thinking aloud protocols (Levy & Ransdell, 1995) to achieve this. Each variant has is own advantages and focus. However, the two are based on the same design: secondary RTs to the probes are associated with the writer's activity. The variables collected allow the researcher (1) to estimate the general temporal organization of the writing process, (2) to analyse the recursiveness of writing and (3) to measure the amount of resources allocated to the writing processes.

First, we detail the design, material, procedure and dependant variables of each one of the two variants. Then, we present a series of experiments that evaluated the extent to which the method is reactive and valid. It is argued that both variants of the triple task method are useful research tools. Although the validity of the verbal protocol method is more valid than directed retrospection, it is also potentially more disruptive of working memory resources needed for writing. Conversely, the directed retrospection is less reactive, but also it sacrifices detailed information about the nature of the writing processes. Before concluding, we synthesize several studies that used the triple task method and provided new data about invariant functional characteristics of writers. Specifically, we suggest that planning and reviewing tend to demand more cognitive effort than translating, but more time is typically devoted to translating during composition. Further, individual differences in domain-specific knowledge, verbal ability, audience representation, and working memory capacity affect the time and effort allocations. Similarly, time and effort allocations are further affected by situational factors, such as the medium of production. We end by trying to delineate how the method can be modified to answer future research questions.

2. THE TRIPLE TASK TECHNIQUE

The general design of the method involves measuring the allocation of working memory resources using reaction time (RT) to an auditory probes and coupling these measurements to specific writing processes engaged in during composition. The procedure calls for participants to focus attention on composing a text composition and to respond as rapidly as possible to auditory probes distributed in a variable interval schedule. This secondary task technique is based on the assumption that the primary and secondary tasks compete for a limited pool of attentional or working memory resources (Kahneman, 1973; Kerr, 1973; Power, 1986). Therefore, performance in the

secondary task decreases, as the demands of primary task increase. The greater the performance degradation 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. Such a dual task technique is commonly used in cognitive psychology, 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 think aloud or to categorize the contents of working memory as they write.

The original variant of the triple task technique was proposed by Kellogg (1987a, 1987b). With this method, after each probe detection, participants perform a directed and immediate retrospection about their thoughts at the moment the probe occurred. This kind of verbal protocol is an example of what Ericsson and Simon (1993) called concurrent probing, in which information still available in working memory is reported. For this purpose, participants are requested to choose among response categories referring to particular writing processes. In the second variant of the technique (Levy, 1997; Levy & Ransdell, 1995), while composing with a word processor, writers are engaged in a thinking aloud task, verbalizing information in the current focus of attention. The probe RTs are then associated to writing processes that are identified by analysing both the verbal report of the writer and the data of a keystroke record program.

2.1. Directed retrospection protocols

2.1.1. General design

The primary task requires the composition of a text and the secondary RT task requires the detection of auditory probes (*e.g.*, tones or beeps). When participants hear auditory probes during the composition of a text (the primary task), they are asked to say 'stop' as quickly as possible whenever they detect such a probe (RT secondary task). A voice-operated relay interfaced with a computer recorded the time from the presentation of the probe to the detection response in milliseconds. The spoken response has the advantage of freeing both hands for either writing in longhand or typing on a word processor. Another alternative is for the writer to click a mouse button with the non-dominant hand that is free during handwriting.

After probe detection, the writers are asked to identify the mental process in which they were engaged when they perceived the probe. Because they are given response categories to choose among, their immediate retrospection is directed, unlike the undirected form used in thinking aloud protocols. Specifically, they choose among four response categories (for example, planning, translating, reviewing or other) by pressing a labelled button on a response box or labelled keys on a computer keyboard. The writers are first trained to identify their thoughts as examples of the four categories.

Although a finer grained distinction among processes could be used, a small number of possible choices helps to insure reliable categorizations. It may be difficult for writers to distinguish between generating ideas and organizing ideas, for example, but both thoughts could be labelled accurately as planning. At the same time, the validity of the method suffers to a degree by combining two distinct sub-processes into the broader category of planning. Another strength of the method is that the participant decides which category best fits their thoughts at the moment. With verbal protocols,

the researcher must make this decision from examining the writer's statements and other behaviour.

In theory, the immediate, directed retrospection task makes it possible to find out which mental process was interrupted by the auditory probe. That is, the writer could have been planning, translating, reviewing or thinking of something unrelated to the three basic writing processes when the auditory probe occurred. Thus, the extra time it takes to detect the auditory signal and to say 'stop' can be taken as a measure of the degree of effort or capacity associated with the writing process interrupted by the signal. An RT interference measure is computed for each participant subtracting from the mean or median RT associated with each process, the mean or median baseline RT obtained when participants responded only to the auditory probe task. Furthermore, by analysing the mean frequency with which the writing processes are reported, the directed reports provide an estimate of the processing time devoted to planning, translating, and reviewing.

2.1.2. Procedure

The experimental procedure involves the following steps: the directed retrospection training, the collection of baseline RTs, and the experimental task in which writers perform a composition concurrently with RT probes followed by retrospection. For 30 minutes of composition, the total length of the experiment is between 60 and 90 minutes.

During the first 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 (for example, planning, translating, and reviewing). The number and nature of writing processes can be varied as a function of the research goals. Nevertheless, a category unrelated to the writing process must be systematically used (for instance, 'other'). This unrelated category is for all thoughts that do not fit the defined writing processes (*e.g.*, daydreaming). The instructions then continue with examples of thinking-aloud protocols to illustrate further each writing process. Next, participants are required to categorize several examples of thinking-aloud protocols. Each time an error occurs, the experimenter provides feedback to correct the participant's understanding of the meaning of the different categories.

During the second step of the experiment, the reaction time task is introduced. Participants are informed that during the composition they would occasionally hear an auditory signal ('beep'). They are asked to react as quickly as possible to these beeps by saying 'stop' or by clicking the mouse with their non-dominant hand while handwriting with the dominant one. After delivering these instructions, a series of single-task RTs are collected. Generally, when 30 RTs are collected, the first five trials are treated as warm-up signals and the mean baseline RT is calculated from the 25 other RTs. The probes are distributed in a random interval with a mean interval of once every 10 s and a range of 5 s to 15 s. During the composition, probes are distributed with a mean interval of once every 30 s and a range of 15 s to 45 s[1].

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1 Note that Kellogg's procedure samples the writing processes only about every 30 s, whereas Levy and Ransdell's procedure allows a much finer temporal resolution (every 1 s).

In the last step, directly after the collection of the baseline RTs, the experimenter reads the writing assignment and gives the topic of composition to the participant.

2.1.3. ScriptKell: A software for implementing the triple task

In his first studies Kellogg (1987a, 1987b, 1988, 1993) used a PASCAL program for implementing the triple task technique, but it was not designed in a flexible way that allowed one to vary parameters of the experiment. ScriptKell is a computer-assisted experimental tool that has been designed to easily modify Kellogg's technique (Piolat, Olive, Roussey, Thunin, & Ziegler, 1999). This software can be used to investigate writing and other complex cognitive activities. It runs on Apple Computers with Macintosh environment (system 7.0 or higher). It is programmed in Hypertalk in a HyperCard 2.3 environment. Since version 1.0, ScriptKell has been compiled and thus can be used without HyperCard.

ScriptKell has been designed so as each critical parameter of the triple task technique can be freely adapted to the experimental goals. Thus, it is possible to specify the essential parameters of the procedure and the global configuration of the secondary tasks. ScriptKell should, therefore, facilitate the realization of experimental designs to address new questions concerning the functional characteristics of writing and other complex cognitive activities.

When ScriptKell is started, the program displays a configuration window that allows the experimenter to specify the multiple parameters of the experimental procedure by selecting or not the different secondary tasks. For example, it is possible to choose only the baseline RT task, the writing task, the directed retrospection task or all three. Furthermore, the entire configuration of these secondary tasks can be defined (*e.g.*, duration of the baseline RT phase, interval between the probes, number and nature of response categories during the directed retrospection task, response keys, auditory signals, writing duration, etc.) for any given experiment. By default the program gives the values of the parameters that had been used in the previous session. The selected parameters can be saved in file that is located in ScriptKell's folder. With this function, particular parameters can be loaded at any time.

In the baseline RT task, participants are presented only with a number of probes (auditory signals) that they have to detect as rapidly as possible. But instead of reacting by saying 'stop' into a microphone in Kellogg's procedure, with ScriptKell participants react to the probes by clicking on the computer mouse with their non-dominant hand. The baseline RT task allows measuring the mean baseline RT of each participant against which the RTs in the triple task procedure can be compared. The probes are pseudorandomly distributed in an interval that can be specified by entering its inferior and superior boundaries (in seconds). The experimenter also needs to specify the total number of probes and the number of final probes that are used to calculate the baseline RT. Speeded responses are given by clicking on the computer mouse. In the secondary RT task, participants perform a primary task and a secondary RT task to auditory probes. Again, inferior and superior boundaries are entered to specify the distribution interval. The duration of the composition is either unlimited or limited. In the last case, the experimenter can define its duration (in seconds) depending on the goals of the experiment.