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Effects of planning strategies on writing dynamics and final texts☆

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ABSTRACT

Expert writing involves the interaction among three cognitively demanding processes: planning, translating, and revising. To manage the cognitive load brought on by these processes, writers frequently use strategies. Here, we examined the effects of planning strategies on writing dynamics and final texts. Before writing an argumentative text with the triple-task technique, 63 undergraduates were asked either to elaborate an outline with the argumentative structure embedded (structure-based planning condition), to provide a written list of ideas for the text (list-based planning condition), or to do a non-writing-related filler task (no planning condition). Planning showed no effects on the length of the pre-writing pause and cognitive effort, but influenced writing processes occurrences. Compared to participants in the no-planning condition, those in the planning conditions showed a later activation of revising. Moreover, participants in the structure-based condition were mainly focused on translating in the beginning and middle of composition, whereas their peers tended to distribute their attention among all processes. Planning ahead of writing also resulted in texts with longer words, produced at a higher rate. Only the structure-based planning strategy led to an increase in the number of argumentation elements as well as in essays' persuasiveness and overall quality. There was, however, no indication that these improvements in final texts were associated with changes in the dynamics of writing. Overall, the use of structure-based plans seems to be an effective and efficient way of improving undergraduates' argumentative writing.

1. Introduction

Most current cognitive models of writing largely agree that skilled writing entails three cognitive processes, namely, planning, translating, and revising (Berninger & Swanson, 1994; Berninger & Winn, 2006; Hayes, 1996; Hayes & Flower, 1980, 1986; Kellogg, 1996). *Planning* involves the formulation of task goals along with the generation and organization of ideas. *Translating* refers to the conversion of ideas into linguistic forms in working memory, which are then externalized in the form of written text through transcription processes, involving the retrieval of orthographic symbols (i.e., spelling) and the execution of motor movements to produce them (i.e., handwriting/typing; Abbott & Berninger, 1993). *Revising* encompasses the monitoring, evaluation, and changing of the intended and actual written text. These resource-demanding processes interact with each other (Beauvais, Olive, & Passerault, 2011; Hayes & Flower, 1980) and impose heavy demands on writers' limited working memory capacity (Kellogg, 1996, 1999; Olive, 2014). As exceeding this capacity may have a detrimental effect on writing performance, writers ought to manage the cognitive load during writing to produce good texts. Such management is reflected on the dynamics of writing (i.e., cognitive effort and distribution of writing processes) and is likely to influence the characteristics of final texts (Beauvais et al., 2011).

One solution to manage cognitive load effectively and improve final texts consists of reducing the overlap between processes during text production and using strategies to support their enactment (Fayol, 1999; Kellogg, 1994; Torrance & Galbraith, 2006). Planning strategies – implemented before writing to support the planning process – seem to be particularly beneficial for beginning and developing writers (Graham, McKeown, Kiuhara, & Harris, 2012; Graham & Perin, 2007). Still, little is known about their positive effects in undergraduates. This was the main purpose of the present study, in which we examined and compared the effects of planning strategies on the dynamics of writing and on a large set of characteristics of argumentative texts.

1.1. The role of planning in good writing

As writing is a goal-directed activity, goal setting is a critical component of planning (Hayes & Flower, 1986). The formulation of content and rhetorical goals provides clear information about task requirements

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and directs writers' attention towards them. Another key function of planning is generating content (Torrance, Thomas, & Robinson, 1999). Writers plan their text by extracting information from the task environment and by searching for content in their long-term memory. When necessary, this generated material is (re)organized in a written plan that will guide text production (Hayes & Flower, 1986). There is now considerable evidence associating good writing with the use of strategies to support goal setting as well as ideas generation and organization.

The use of elaborated goals tailored to a specific genre seems to be beneficial for argumentative writing. Prior research showed that providing school-aged or undergraduate students with sub-goals for considering major argumentation elements – such as providing and justifying arguments, and considering and rebutting counter-arguments – had a positive impact on the quality of written arguments, promoted the exposition and rebuttal of alternative positions, and increased overall essays' persuasiveness (Ferretti, Lewis, & Andrews-Weckerly, 2009; Ferretti, MacArthur, & Dowdy, 2000; Nussbaum & Kardash, 2005). The great advantage of these type of goals seems to be the explicit evoking of the schema underlying argumentative writing. By prompting the inclusion of key argumentation elements in the text, goals may help writers to apply their knowledge of argumentative discourse, which may serve as a cue for retrieving and reporting relevant information (Coirier, Andriessen, & Chanquoy, 1999).

Another sophisticated and effective form of planning is outlining (Limpo, Alves, & Fidalgo, 2014; Piolat & Roussey, 1996). This involves noting ideas in a well-ordered hierarchy of structural relations. Although only a handful of studies examined the association of outlining with undergraduates' writing, their results are consistent: Outlining increased text quality (Galbraith, Ford, Walker, & Ford, 2005; Kellogg, 1987b, 1988, 1990). As proposed by Kellogg (1994), the advantageous effects of outlining can be explained by two sources: organization of ideas and restructuring of the writing process. First, outlining allows writers to generate and organize ideas in a hierarchy of structural relationships as well as to come up with an action-plan to guide the development of those ideas in the composition. This claim is supported by research showing that planning strategies lacking the organizational and hierarchical component underlying outlining (e.g., clustering) failed to improve text quality (Kellogg, 1990). Second, by separating planning processes from text production, outlining may also reduce writers' need to plan during writing. Consequently, writers may be able to focus more on translating and revising processes, which can be carried out more effectively. Though less empirically supported than the first claim, this second one is mostly grounded on studies examining outlining effects on writing dynamics.

In adult writers, the effects of setting genre-specific goals and elaborating outlines have been studied separately. Nevertheless, intervention studies with school-aged writers have shown the advantages of combining these two planning procedures. Actually, teaching genre-tailored planning strategies is among the most effective ways to promote writing (e.g., Harris, Graham, & Mason, 2006; Limpo & Alves, 2013b, 2017; for meta-analyses see Graham et al., 2012; Graham & Perin, 2007). Typically, students are given structure-based graphic organizers with empty boxes matching the main elements of a specific genre (for graphical examples, see Harris, Graham, Mason, & Friedlander, 2008). These graphic organizers guide students in the process of generating ideas according to the text structure, and in organizing those ideas hierarchically. The effects of this structure-based form of planning not only increased discourse measures of writing performance (e.g., text quality and genre elements), but also enhanced sentence- and word-level aspects of composition (Limpo & Alves, 2013b). Such a result is interpreted as planning ahead of writing allowing writers to concentrate on translation-related aspects during writing. Because these intervention studies usually taught the structured-based planning jointly with self-regulation procedures (Graham & Harris, 2007), little is known about its unique contribution to writing, particularly in older writers. However, there is evidence that providing ninth and tenth graders with an electronic outlining tool specifying major argumentation elements was enough to raise qualitative features of students' texts (De Smet, Brand-Gruwel, Broekkamp, & Kirschner, 2012; De Smet, Brand-Gruwel, Leijten, & Kirschner, 2014).

A word of caution is needed as planning is not a panacea for all difficulties faced by writers (Galbraith, 1999; Kellogg, 1994). Indeed, greatly structured forms of planning may not be effective for writers who prefer to plan during writing (Baaijen, Galbraith, & de Glopper, 2014), or in situations where writers either do not need extensive pre-planning (e.g., short stories) or have no clear ideas on the topic (Kellogg, 1990).

1.2. Study of writing dynamics

The expression “writing dynamics” is used to denote two critical aspects of text production: the recursiveness of writing processes as well as the cognitive effort associated with these (Olive, Kellogg, & Piolat, 2002). A particularly suitable and powerful method to study these two aspects of writing is the triple-task technique. This technique was first used by Kellogg (1987a, 1987b), and further refined by Olive et al. (2002). It allows the analysis of the temporal organization of writing processes along with the cognitive effort allocated to each process. The procedure calls participants to perform three tasks: composing a text, detecting random auditory probes, and categorizing the mental process at the time of the probe (i.e., directed retrospection), according to previously learned categories (viz., Planning, Translating, and Revising; typically, there is another category for unrelated thoughts, labelled Other). Categories occurrences provide reliable estimates of how much planning, translating, and revising is carried out during composition. Reaction times (RTs) to auditory probes provide reliable indices of the cognitive effort of the process interrupted by the signal. To isolate the cognitive effort associated with writing from that of detecting the signal, the final RT is computed by subtracting each participant's RTs from the mean baseline RTs. This latter measure is obtained from a prior session, where participants perform the auditory signal detection only. The longer the interference in RTs, the higher the cognitive effort associated to the process. (Kahneman, 1973).

The triple-task technique has raised some questions on its reactivity and validity (for a review, see Olive et al., 2002). It has been suggested that the process and output of text production could be disrupted by either the frequent interruptions prompted by the RT task or by the time taken to label the ongoing process – which is actually very brief, happening 2–3 s after the interruption. However, several studies comparing texts produced by writers using the triple-task technique with writers uniquely writing or only detecting RTs while writing, indicated that this procedure does not disrupt writing (Kellogg, 1987b; Penningroth & Rosenberg, 1995; Piolat, Roussey, Olive, & Farioli, 1996). Except reducing writing fluency (i.e., number of words per minute), this technique neither influenced writing dynamics nor the characteristics of the final texts. At least two major concerns on the reliability and validity of the directed retrospection have also been raised. A first concern is the extent to which writers' categorizations provide valid insights into their own cognitive activity. On this point, Kellogg (1987b) observed substantial agreement between writers' categorizing their own verbal protocols and a trained judge categorizing the same report. Moreover, it was shown that writers' metacognitions about how they compose do not influence the pattern of responses (Levy & Ransdell, 1995). A second concern on the directed retrospection procedure relates to the use of three or four pre-determined categories to characterize cognitive activity during writing. Compared to thinking-aloud protocols – in which writers verbalize their thoughts as writing unfolds – this procedure seems less disruptive of the composing task. Still, it is also less informative in detailing the dynamics of writing and may provide a biased picture of it. Indeed, some writing processes are extremely complex and difficult to classify into few

categories (Kellogg, 1996), even if theoretically and empirically grounded (Hayes & Flower, 1980). Also, writing processes can be activated in parallel, which is not typically considered in the categorization procedure. Though it was suggested that categorization difficulties could increase the use of the Other category, it should be noted that its occurrence is typically negligible (Alves, Castro, & Olive, 2008; Kellogg, 1987a, 1987b). All in all, the triple task technique appears as a non-reactive, reliable, and valid procedure for measuring writing dynamics, providing a useful approximation to writers' thoughts during writing.

Many studies using the triple-task technique showed that translating is the dominant process during composition, taking 40% to 50% of the writing time (Alves et al., 2008; Kellogg, 1987a, 1987b, 1988; Olive, Alves, & Castro, 2009; Penningroth & Rosenberg, 1995; Piolat, Kellogg, & Farioli, 2001). The time allocated to planning and revising varies across studies (Levy & Ransdell, 1995; Penningroth & Rosenberg, 1995). Still, during composition, consistent findings showed that planning time tends to decrease, whereas revising time tends to increase (Kellogg, 1987a, 1987b, 1988). Concerning the cognitive effort of writing processes, research has been yielding mixed results. Some studies reported that the cognitive cost of both planning and revising is higher than that of translating (e.g., Kellogg, 1987a, Exp. 1; Olive, Alves, & Castro, 2009). Other studies found that the most demanding process is planning (e.g., Kellogg, 1988, Exp. 2; Olive et al., 2002), whereas others found that it is revising (e.g., Alves et al., 2008; Kellogg, 2001). Yet another reported that the three processes did not differ in terms of cognitive effort (e.g., Kellogg, 1987a, Exp. 1; Piolat et al., 2001). A reliable finding across these studies is that translating seems the less demanding process.

Despite the potential of the triple task to allow for a fine-grained investigation into the effects of planning on writing dynamics, and likely to unravel some of the mechanisms by which planning is critical to writing, few studies explored the effects of planning strategies on the process of composing text. A seminal study is that of Kellogg (1988, Exp. 2), in which he used the triple-task technique and showed that planning in the form of an outline did not impact cognitive effort, but it did influence occurrences of writing processes. Specifically, undergraduates who outlined spent less time planning and more time translating during writing than those who did not outline. Results were interpreted as supporting the claim that the advantages of outlining may result from a reduction in planning during writing, paralleled by an increase in translating and revising (Kellogg, 1994). It should, however, be noted that this association between changes in writing dynamics and improvements in final texts as a result of planning was not statistically tested.

2. Present study

The goal of this study was to examine the effects of planning on writing dynamics and characteristics of final texts. For that, undergraduates were asked to produce an argumentative text on a keyboard preceded by a handwritten plan in an outline format with the argumentative structure embedded (structure-based planning condition), by a handwritten plan in a list format (list-based planning condition), or by a filler activity not related to the writing task (no-planning condition). The structure-based planning format combined two powerful planning procedures, those of elaborating an outline (Kellogg, 1988) and prompting the inclusion of key argumentation elements (Nussbaum & Kardash, 2005). The list-based planning format was chosen because, when requested to plan ahead of writing, this is one of the most common forms of planning in school and college (Limpo et al., 2014; Piolat & Roussey, 1996). The no-planning condition is particularly relevant from an educational viewpoint. It represents a typical writing session, where students tend to barely engage in any form of planning, when not explicitly requested to do it (Beauvais et al., 2011).

All participants produced their argumentative texts using the triple-task technique, which allowed us to examine the dynamics of writing. Planning effects were scrutinized on general temporal parameters (pre-writing pause and writing fluency) as well as on writing processes cognitive effort and occurrences. As for the general temporal parameters, we expected that, by not being requested to plan, participants in the no-planning condition would display a lengthier pre-writing pause. This pause corresponds to the time elapsed between the end of the instructions and the beginning of the writing assignment, and is typically devoted to initial planning (Kellogg, 2004). Moreover, as a result of the structure-based planning, we expected to observe an increase in writing fluency (De Smet et al., 2014; Kellogg, 1988), as well as a restructuring of the writing process (Kellogg, 1994). This should be evident in a decrease in the amount of planning parallel by an increase in the amount of translating and revising (Kellogg, 1988). In line with prior findings, planning was not expected to influence cognitive effort (Kellogg, 1988, Exp. 2). As in past studies (De Smet et al., 2014; Kellogg, 1988), planning effects on writing processes occurrences were examined for across three phases of composition (i.e., beginning, middle, and end).

We further investigated planning effects on large set of characteristics of final texts, namely, composing time, text length, clause length, word length, argumentation elements, persuasiveness, and overall text quality. As previously surveyed, giving writers elaborated goals to include major argumentative parts (Ferretti et al., 2000; Ferretti et al., 2009; Nussbaum & Kardash, 2005), as well as asking them to elaborate outlines either with text structure support (De Smet et al., 2012; De Smet et al., 2014; Graham et al., 2012; Graham & Perin, 2007) or without it (Galbraith et al., 2005; Kellogg, 1987b, 1988, 1990), has been consistently associated with better writing performance from primary school to college. We thus anticipated that undergraduates in the structure-based condition would show a longer composing time, write longer texts, include more argumentation elements, and write more persuasive and better texts than their peers in the list-based and no-planning conditions. On the assumption that planning allows students to focus on translation-related aspects (Kellogg, 1988), we additionally hypothesized an enhanced use of language in the structure-based condition. Compared to their colleagues, participants in this condition were expected to display higher syntactic and lexical complexity, respectively measured through mean clause length and mean word length. Grounded on the claim that these expected benefits of planning are at least partly related to a restructuring of the writing process (Kellogg, 1994), we finally predicted an association between writing processes occurrences and the characteristics of final texts.

2.1. Contributions to extant research

Findings may provide relevant and original contributions to the field of writing research from both scientific and educational viewpoints. Indeed, despite the assumed importance of planning in nearly all cognitive models of writing (e.g., Flower & Hayes, 1980; Hayes, 1996; Kellogg, 1996), evidence supporting this claim came primarily from correlational research (Limpo et al., 2014), or intervention studies with children (Graham et al., 2012; Graham & Perin, 2007). By experimentally testing the role of different planning strategies in undergraduates, this study may not only contribute to empirically support those models of adult writing, but also indicate more and less useful forms of planning. Furthermore, to the best of our knowledge, this is the first study testing the effects of a planning strategy combining two planning procedures, with complementary strengths and weaknesses. Whereas outlining help students to hierarchically organize their ideas and establish relationships among them, it does not necessarily entail a genre-based schema supporting discourse knowledge usage. Conversely, whereas establishing genre-specific goals does provide that genre-based schema, it may not support the organization and connection of ideas before writing. Combining these two procedures may result in a powerful strategy to improve undergraduates' argumentation and writing skills, involving little investment from both teachers and students. Finally,

only a handful of studies with adult writers examined the effects of planning strategies on a large set of texts characteristics from word- to discourse-level, and even less studies analyzed the effects of these strategies on writing dynamics, as here done. This is a noticeable omission as such studies may contribute to unravel some of the poorly understood mechanisms through which planning strategies may help writers to produce better texts. This information may be valuable to guide the design of brief, evidence-based practices that may easily boost text production in adult writers, who have typically few opportunities to benefit from prolonged writing instruction.

3. Method

3.1. Participants and design

In this study participated 63 Portuguese-speaking undergraduate Psychology students (M_{age} = 20.0 years, SD = 1.40; 56 females), who were recruited within the Psychology of Language course (Year 2). They participated voluntarily by registering through an online form and were compensated with credits on that same course, which did not provide any kind of explicit writing instruction, including in argumentation. Participants were randomly assigned to three conditions (n = 21): structure-based planning (2 males), list-based planning (3 males), and no planning (2 males). There were no age differences among conditions, $F(1, 60) = 0.33$, $p = .85$, $\eta_p^2 = 0.01$.

3.2. Procedure

All participants were tested individually, in the same room and using the same equipment, during a 60-min session composed of five tasks. First, participants completed a short questionnaire on writing mode preference and writing frequency.

Second, participants did a simple auditory RT task to record the average baseline RT. They were instructed to lay their hands on the keyboard, as if they were writing, and to react as quickly as possible to auditory signals by pressing the F5 key with their dominant hand. There were 30 beeps presented at an average interval of 10 s, ranging from 5 to 15 s.

Third, participants were trained in the directed retrospection procedure. For that, the experimenter presented a poster with simple definitions of the verbalization categories (Planning, Translating, Revising, and Other), along with examples of thoughts associated with them. Afterwards, participants read a list with 30 sentences representing thoughts during writing and identified the corresponding category (e.g., Planning: *I am organizing my ideas*; Translating: *I am typing*; Revising: *I am changing my text*; Other: *I am hungry*). If there was a categorization error, the experimenter recapped the definitions and discussed additional examples, until the categorization was clear. After training, participants were presented with a poster containing the writing topic, which was visible during the remaining time of the session. At this point, the experimenter only told participants that they would be asked to write the most convincing argumentative text to the prompt: "*Give your opinion about* Praxe Académica". *Praxe Académica* is a very polemic tradition in Portuguese universities that includes a set of initiating rites for freshman.

Fourth, the experimenter explained to participants that, before writing the text, they would perform another task. This was the unique task that differed across experimental conditions. To control for the time elapsed between knowing the prompt and start writing, participants in the no-planning condition did a filler activity, which was the Letter Number Sequence test from the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 2008). Participants listened to a random string of numbers and letters and were asked to recall the numbers in ascending order followed by the letters in alphabetical order.[1] In both planning conditions, participants were explained that they would be given 10 min to generate and organize their ideas before writing, and that they would be notified 5 and 2 min before the end of the time limit. They were given a paper sheet and a pen to do the plan, which would be accessible to them for the full duration of the subsequent composing task. In both planning conditions, though instructions were given orally, they were also summarized on the planning sheet. In the list-based planning condition, participants were given a blank sheet and were asked to produce a list of ideas for the text to be written. In the structure-based planning condition, participants were asked to fill in a graphic organizer with empty boxes that corresponded to the major argumentation elements: premise, arguments, counter-arguments, and conclusion. They were explicitly told to organize their ideas hierarchically, by using multilevel bullets. Average planning time did not differ across planning conditions, $F(1, 40) = 1.73$, $p = .20$, $\eta_p^2 = 0.04$ (M = 8.5 min, SD = 2.0), and all participants correctly followed planning instructions (i.e., those in the list-based-condition organized their ideas into a list, whereas those in the structured-based condition fill in the graphic organizer as requested).

Finally, similarly across the three conditions, participants were asked to compose their texts on a keyboard. The experimenter recapped the writing prompt and the importance of writing a convincing text. She then said to participants that, though there were no limits in terms of the number of words to be written, they would have to write for a minimum of 15 min and a maximum of 25 min. Participants were also explained that they would be notified 10, 5, and 2 min before the end of the maximum time limit. While writing, participants listened to auditory signals presented at random intervals between 15 s and 45 s (average of 30 s). They were asked to react to each beep as quickly as possible by pressing the F5 key. After this, they were instructed to immediately choose the label that best described the ongoing mental process (viz., planning, translating, revising, and other) by pressing the corresponding key (respectively, F1, F2, F3, and F8). These keys were covered with stickers with the first letter of the respective label (i.e., P, T, R, and O). This procedure was also recapitulated just before the writing task has started.

3.3. Apparatus

The texts were written using a QWERTY keyboard. Two computer programs were used. KeySpy, which was developed in 2008 by Lionel Granjon from the University of Poitiers and CNRS, was used to implement the triple-task technique. The software launched random auditory signals, collected RTs, and gathered the verbalization responses. ScriptLog served as a basic word processor for typing and logging typing speed (Strömqvist & Karlsson, 2002).

3.4. Measures assuring conditions equivalence

The three conditions were compared on variables that could potentially influence results, namely, writing mode preference and writing frequency, baseline RTs, and typing speed. Writing mode preference and writing frequency were assessed through a questionnaire with three sets of questions: preference for writing by hand or by keyboard; frequency of writing by hand and by keyboard in a scale ranging from 1 (*very rarely*) to 5 (*very often*); and frequency of writing different types of texts (viz., literary texts, e-mails, letters, diary, blog, poetry, posts in social networks) in a scale ranging from 1 (*very rarely*) to 5 (*very often*). These last questions were averaged to create a composite score of overall frequency of writing (Cronbach's Alpha = 0.55). The average baseline RT was calculated by averaging participants RTs to the last 25 trials during the baseline RT task (the first five trials were considered as training). Typing speed was measured through the Median Transition Time (MTT) during the composing task, which corresponds to the median duration between typing two consecutive tokens and it is provided by ScriptLog (Strömqvist, 1999).

[1] There was no relationship between performance on this task and any characteristic of the final texts.

3.5. Writing dynamics measures

3.5.1. Pre-writing pause

The pre-writing pause corresponds to the time that elapsed between the end of the instructions and the beginning of the text (i.e., first token pressed).

3.5.2. Writing fluency

Writing fluency was measured by the number of words written per minute, which was calculated by dividing text length by composing time. Text length was calculated with the Computerized Language Analysis (CLAN) software (MacWhinney, 2000), and composing time was recorded by KeySpy.

3.5.3. Interference in RTs

The interference in RTs (hereafter, iRTs) was computed by subtracting the average baseline RT of each participant from each RT collected during writing. iRTs were computed separately for planning, translating, and revising, by considering the mental process that each participant reported to be enacting when the beep sounded. This measure was used as an index of the cognitive effort associated with each process, with higher iRTs indicating more effort.

3.5.4. Writing processes occurrences

The occurrences of writing processes were measured through the number of times each participant pressed the planning, translating, and revising keys during writing. On average, there were 46 directed verbalizations per participant, ranging from 33 to 59. Among all verbalizations, only 0.2% referred to the category Other. This was considered negligible, and thus not entered into any analysis.

3.6. Final texts measures

3.6.1. Composing time

This measure corresponds to the duration of the writing task in minutes, starting from the end of the task instructions, and it was provided by KeySpy.

3.6.2. Text length

This measure refers to the number of words appearing in the final text and it was provided by CLAN.

3.6.3. Clause length

To examine syntactic complexity, we computed the average number of words written per clause. This measure was provided by CLAN, after dividing all texts into clauses. A clause was defined as a unit with a unified predicate and expressing a single situation (Berman & Slobin, 1994). Half of the texts were divided into clauses by a second rater and inter-rater agreement was high (using a two-way mixed effects model, ICC for single measures was 0.92).

3.6.4. Word length

To examine lexical complexity, we computed the average number of characters per word using CLAN.

3.6.5. Argumentation elements

A trained research assistant counted the number of arguments, counter-arguments, rebuttals, and elaborations present in each text (based on Ferretti et al., 2000; Graham, 1990; Nussbaum & Kardash, 2005; Scardamalia, Bereiter, & Goleman, 1982). Arguments corresponded to reasons supporting the writer's premise (e.g., *I am against this ritual because some practices involve physical and psychological violence.*). Counter-arguments referred to reasons contrary to writer's premise (e.g., *Some people say this ritual is good because it helps freshmen social integration.*). Rebuttals were claims that refuted the counter-argument (e.g., *There are other ways for freshmen to be integrated into the University.*). Elaborations were any separate ideas supporting a specific argument (e.g., *When I participated in this ritual, I had to be laid down on the floor for hours.*), counter-argument (e.g., *This ritual helps freshmen to know each other better.*), or rebuttal (e.g., *My University as a Mentorship program aimed at integrating freshmen.*). A composite score was obtained by counting the total number of argumentation elements in each text. Half of the texts were scored by a second rater and inter-rater agreement was high (using a two-way mixed effects model, ICC for single measures was 0.96).

3.6.6. Persuasiveness

Two research assistants, blind to study purposes, assessed all essays' persuasiveness based on the scale reported by Ferretti et al. (2000). Using an 8-point scale, judges were asked to consider the extent to which writers assumed a clear position on the topic; provided supporting, elaborated, and convincing reasons; were free of inconsistent and irrelevant ideas; and addressed opposing positions and responded to these. As the inter-judge agreement was high (using a two-way mixed effects model, ICC for average measures was 0.91), the final score was the average across judges.

3.6.7. Overall text quality

Two research assistants, blind to study purposes, assessed all essays' overall quality with a holistic scale (based on Cooper, 1997). Judges were asked to evaluate each text with a single score ranging from 1 (*low quality*) to 7 (*high quality*). This score should consider to the same extent the following factors: creativity (i.e., originality and relevance of the ideas), coherence (i.e., clarity and organization of the text), syntax (i.e., syntactic correctness and diversity of the sentences), and vocabulary (i.e., diversity, interest, and proper word usage). To avoid transcription biases on quality assessments, all texts were corrected for typos and spelling errors (Berninger & Swanson, 1994). Several prior studies showed the validity of this procedure to assess text quality (e.g., Harris et al., 2006; Limpo & Alves, 2013a).

Before assessing participants' texts, judges were trained in using the holistic scale. Initially, the trainer explained the four above-mentioned factors, presented anchor essays representing low-, middle-, and high-quality scores, and discussed the distinctive features of anchor points. Then, judges practiced applying the scale collaboratively under the trainer's guidance. As soon as the rating procedure was fully understood, judges rated a set of essays independently. Scores were then compared and disagreements were resolved through discussion. After achieving full agreement, judges started rating participants' essays. As the inter-judge agreement was high (using a two-way mixed effects model, ICC for average measures was 0.93), the final score was the average across judges.

4. Results

4.1. Conditions equivalence

The equivalence between conditions was examined on undergraduates' preference for handwriting or typing, frequency of writing by hand and keyboard, overall frequency of writing, baseline RT, and MTT in the composing task. There were no differences among conditions on the preferred mode for writing, $\chi^2(2,\ N = 63) = 0.30,\ p = .86$. Respectively, in the structure-based planning, list-based planning, and no-planning conditions, 67%, 70%, and 62% of the undergraduates reported to prefer to write by hand. A 3 × 2 (Condition [structure-based planning, list-based planning, no planning] × Writing mode [handwriting, keyboarding]) Analysis of Variance (ANOVA) revealed that conditions did not differ on the frequency of writing by hand or by keyboard ($Fs < 1.17, ps > 0.28$). Two one-way ANOVAs showed that undergraduates in the three conditions did not differ on overall writing frequency, $F(2, 60) = 2.41$, $p = .10$, $\eta_p^2 = 0.07$ ($M = 2.19$, $SD = 0.52$ for the whole sample), as well as on MTT in the composing task, $F(2,$

60) = 0.36, $p = .55$, $\eta_p^2 = 0.01$ ($M = 167$ ms, $SD = 25$ ms for the whole sample). However, despite the random assignment, participants' baseline RT did differ across conditions, $F(2, 60) = 6.55$, $p = .003$, $\eta_p^2 = 0.18$, with participants in the list-based planning condition ($M = 676$ ms, $SD = 100$) showing longer RTs than participants in the no-planning ($M = 570$ ms, $SD = 154$; $p = .01$) and structure-based planning conditions ($M = 549$ ms, $SD = 103$; $p = .001$). Because these differences on baseline RT could potentially influence results, baseline RT was introduced as a covariate in subsequent analyses.

4.2. Effects on writing dynamics

4.2.1. Pre-writing pause

Condition effects on the pre-writing pause were analyzed with a one-way Analysis of Covariance (ANCOVA) with baseline RT as a covariate. The analysis revealed no differences among conditions, $F(2, 59) = 1.34$, $p = .27$, $\eta_p^2 = 0.04$ ($M = 4.59$ s, $SD = 3.50$ for the whole sample).

4.2.2. Writing fluency

Condition effects on writing fluency were analyzed with a one-way ANCOVA with baseline RT as a covariate. The analysis revealed differences among conditions, $F(2, 59) = 4.57$, $p = .01$, $\eta_p^2 = 0.13$. Participants in the structure-based planning condition ($M = 21.62$, $SD = 5.48$, $M_{adjusted} = 21.81$) produced more words per minute than those in the no-planning condition ($M = 17.07$, $SD = 5.26$, $M_{adjusted} = 17.18$; $p = .004$, $d = 0.88$). The difference between writing fluency in the no-planning and list-based planning condition ($M = 20.53$, $SD = 4.26$, $M_{adjusted} = 20.23$) did not however reached statistical significance ($p = .07$, $d = 0.70$).

4.2.3. Interference in RTs

To examine condition effects on iRTs associated to each process (i.e., planning, translating, and revising), we computed a 3 (Condition) × 3 (Writing Process) ANOVA, with repeated measures on the last factor. Baseline RT was not introduced as covariate, because iRT already takes into account differences on this variable. Results showed neither a main effect of Condition nor interaction, but there was a main effect of Writing Process, $F(2, 59) = 19.04$, $p < .001$, $\eta_p^2 = 0.39$. Follow-up analyses revealed that iRTs for revising were longer than iRTs for planning, $t(62) = 3.48$, $p = .001$, $d_c = 0.64$[2]) and iRTs for translating, $t(62) = 6.12$, $p < .001$, $d_c = 1.11$; and that iRTs for planning were longer than iRTs for translating $t(62) = 3.25$, $p = .002$, $d_c = 0.58$ (respectively, in ms, $M = 898$, $SD = 266$; $M = 831$, $SD = 220$; $M = 770$, $SD = 233$).

4.2.4. Writing processes occurrences

The effect of condition on the occurrences of writing processes was examined across three phases, which were calculated by dividing each participant's composing time into thirds. This division was made for each individual participant separately. Skewness and kurtosis of writing processes occurrences across phases were below |2.2|. We thus computed a 3 × 3 × 3 (Condition [structure-based planning, list-based planning, no planning] × Writing Process [planning, translating, revising] × Phase [phase 1, phase 2, phase 3]) ANCOVA with repeated measures on the two last factors and baseline RT as a covariate. Results showed a Condition × Writing Process × Phase interaction, $F(8, 114) = 2.45$, $p = .02$, $\eta_p^2 = 0.15$. This three-way interaction, plotted in Fig. 1, was decomposed with simple effects analyses. In what follows, we detail significant differences observed between (a) conditions, (b) phases, and (c) writing processes occurrences.

[2] For within-subjects comparisons, effect size estimates (Cohen's *d*) were corrected for the correlation between means (Morris & DeShon, 2002). This correction is hereafter indicated with a lower script c, d_c.

There were *differences between conditions* only in Phase 2 for revising occurrences, $F(2, 59) = 8.99$, $p < .001$, $\eta_p^2 = 0.23$. Pairwise comparisons revealed that participants in the list- and structure-based planning conditions displayed more revising occurrences than those in the no-planning condition, respectively, $t(40) = 2.72$, $p < .001$, $d = 0.88$, and $t(40) = 4.12$, $p = .01$, $d = 1.16$.

Moreover, there were *differences between phases* for both planning and revising occurrences across the three conditions, Fs(2, 58) > 3.84, ps < 0.03, η_p^2s > 0.12. In the no-planning condition, planning occurrences decreased from Phase 1 to Phase 3, $t(20) = -2.77$, $p = .01$, $d_c = -0.79$, and revising occurrences increased from Phase 1 to Phase 2, $t(20) = 5.19$, $p < .001$, $d_c = 1.70$. In the list-based planning condition, planning occurrences decreased from Phase 2 to Phase 3, $t(20) = -2.83$, $p = .01$, $d_c = -0.91$, and revising occurrences increased from Phase 2 to Phase 3, $t(20) = 3.10$, $p = .003$, $d_c = 1.02$. Likewise, in the structure-based planning condition, planning occurrences decreased from Phase 2 to Phase 3, $t(20) = -3.96$, $p < .001$, $d_c = -1.33$, and revising occurrences increased from Phase 2 to Phase 3, $t(20) = 4.67$, $p < .001$, $d_c = 1.74$. Translating occurrences remained constant throughout writing for all conditions.

Finally, there were *differences between writing processes occurrences* in Phases 1 and 3 for the three conditions, Fs(2, 58) > 4.21, ps < 0.02, η_p^2s > 0.13, and in Phase 2 only for the structure-based planning condition, $F(2, 58) = 9.79$, $p < .001$, $\eta_p^2 = 0.25$. In the no-planning condition, planning and translating occurred more frequently than revising in Phase 1, respectively, $t(20) = 2.44$, $p = .02$, $d_c = 0.74$, and $t(20) = 2.42$, $p = .02$, $d_c = 0.75$; and revising occurred more frequently than planning in Phase 3, $t(20) = 2.63$, $p = .01$, $d_c = 0.77$. Similarly, in the list-based planning condition, planning and translating occurred more frequently than revising in Phase 1, respectively, $t(20) = 2.08$, $p = .04$, $d_c = 0.64$, and $t(20) = 3.26$, $p = .002$, $d_c = 1.15$; and revising occurred more frequently than planning in Phase 3, $t(20) = 2.90$, $p = .01$, $d_c = 0.81$. In the structure-based planning condition, translating occurred more frequently than revising $t(20) = 3.60$, $p = .001$, $d_c = 1.12$, but not than planning in Phase 1, $t(20) = 1.81$, $p = .07$, $d_c = 0.68$ (planning and revising occurrences did not differ as well); both planning and translating occurred more frequently than revising in Phase 2, respectively, $t(20) = 2.24$, $p = .03$, $d_c = 0.76$, and $t(20) = 4.31$, $p < .001$, $d_c = 1.22$; and translating and revising occurred more frequently than planning in Phase 3, respectively, $t(20) = 2.83$, $p = .01$, $d_c = 0.63$, and $t(20) = 4.14$, $p < .001$, $d_c = 1.95$.

4.3. Effects on final texts

Descriptive statistics for all measures by condition are presented in Table 1.

4.3.1. Composing time

A one-way ANCOVA, with baseline RT as a covariate, revealed no differences between conditions on the duration of the composing task, $F(2, 59) = 0.84$, $p = .44$, $\eta_p^2 = 0.03$.

4.3.2. Text length

A one-way ANCOVA, controlling for baseline RT, showed no condition effects, $F(2, 59) = 2.84$, $p = .07$, $\eta_p^2 = 0.09$. In spite of this, we controlled for text length in subsequent analyses due to the moderate-to-high relationships between text length and final texts characteristics (see Table 2). Including this control provided a more robust test to our hypotheses, by assuring that condition effects on final texts characteristics were not simply explained by the dimension of the text. As expected, text length contributed to all variables, excepting number of counter-arguments elaborated.

4.3.3. Clause length

After adjusting for differences in baseline RT and text length, we found a significant condition effect on the number of words written per

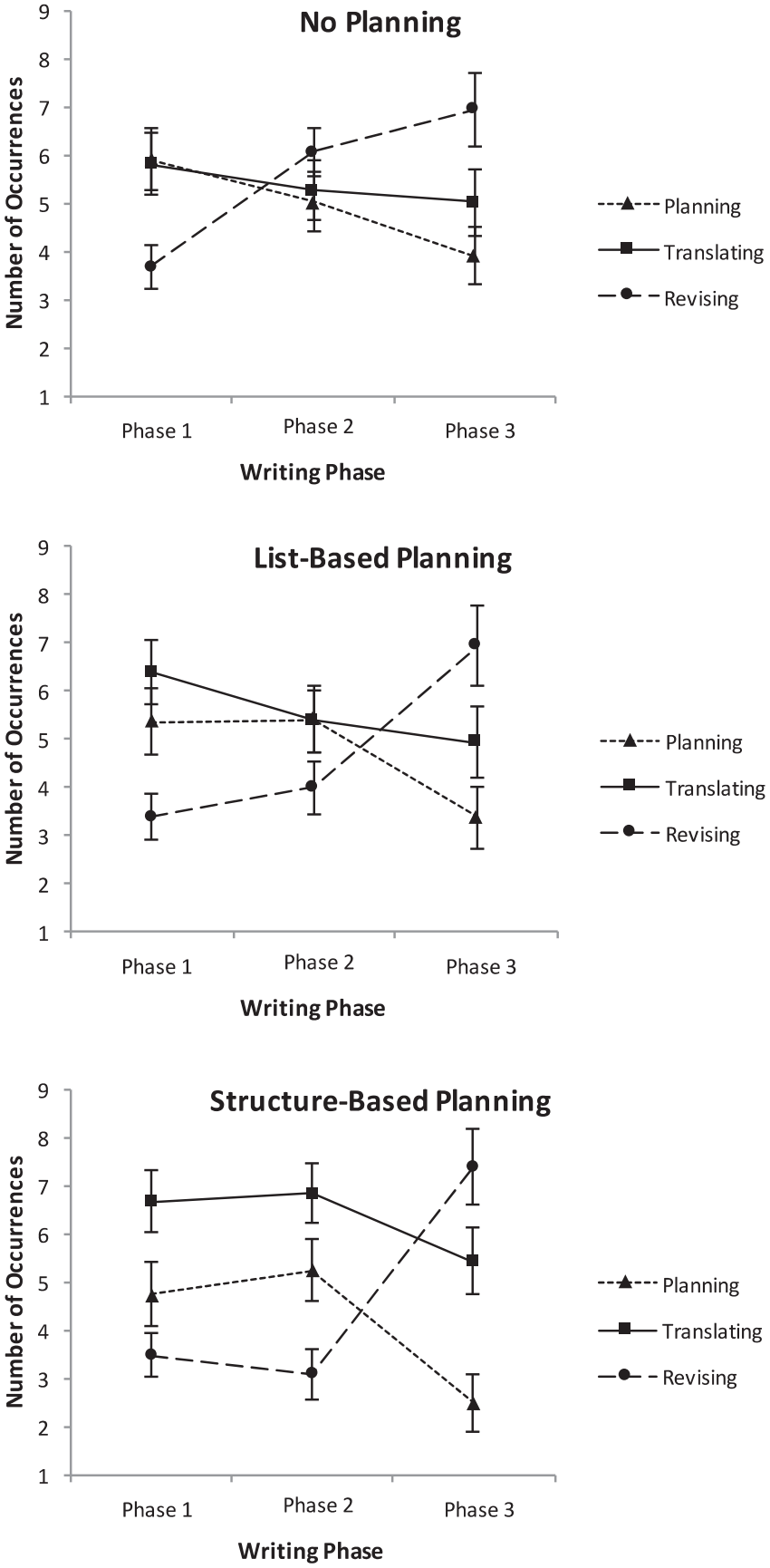

Fig. 1. Distribution of writing process occurrences across conditions and throughout writing. Error bars represent standard errors.

Table 1
Means, standard deviations, and adjusted means of the characteristics of final texts across conditions.

Measure	Structure-based planning			List-based planning			No planning		
	M	*SD*	Adjusted *M*	*M*	*SD*	Adjusted *M*	*M*	*SD*	Adjusted *M*
Composing time	21.33	2.15	21.45	22.26	2.71	21.68	22.23	1.67	22.30
Text length	461.52	126.03	468.02	436.48	92.68	434.95	380.71	122.01	384.46
Clause length	8.96	0.89	9.05	8.48	1.31	8.50	8.10	0.92	7.99
Word length	4.84	0.23	4.87	4.80	0.23	4.80	4.71	0.19	4.68
Argumentation elements (total)	10.57	3.60	10.21	8.57	2.11	8.03	7.90	2.57	8.81
Arguments	3.33	1.39	3.27	2.86	1.18	2.58	2.62	1.07	2.87
Elaboration of arguments	2.00	1.18	1.95	2.00	0.74	1.95	1.48	0.81	1.63
Counter-arguments	2.19	0.87	2.07	1.71	0.81	1.78	1.86	1.01	2.01
Elaboration of counter-arguments	0.90	0.83	0.95	1.00	0.67	0.85	0.71	0.64	0.78
Rebuttals	1.43	1.08	1.34	0.76	0.83	0.69	1.00	0.89	1.17
Elaboration of rebuttals	0.71	0.78	0.64	0.24	0.70	0.19	0.24	0.54	0.36
Persuasiveness	4.64	1.10	4.58	3.92	0.94	3.77	3.74	0.80	3.96
Overall text quality	4.67	1.24	4.57	4.02	1.17	3.83	3.45	1.35	3.79

Note. Composing time and text length were adjusted for baseline RT, whereas all other variables were adjusted for both baseline RT and text length.

Table 2
Correlations between characteristics of final texts for the whole sample (in bold) and separately by condition.

	Clause length	Word length	Argumentation elements	Persuasiveness	Text quality
Text length	**−0.16**	**−0.34****	**0.71*****	**0.48*****	**0.60*****
Structure-based planning	0.16	−0.59**	0.70***	0.58**	0.70***
List-based planning	−0.63**	−0.10	0.52*	0.35	0.42*
No planning	−0.35	−0.60**	0.82***	0.33	0.51*
Clause length		**0.33****	**−0.04**	**0.15**	**0.02**
Structure-based planning		0.30	−0.12	0.23	−0.02
List-based planning		0.18	−0.35	−0.15	−0.30
No planning		0.46*	−0.11	0.11	0.02
Word length			**−0.19**	**0.03**	**0.10**
Structure-based planning			−0.52*	−0.23	−0.40
List-based planning			0.10	0.20	0.43*
No planning			−0.34	−0.07	0.02
Argumentation				**0.64*****	**0.59*****
Structure-based planning				0.62**	0.59**
List-based planning				0.50*	0.38
No planning				0.60**	0.59**
Persuasiveness					**0.51*****
Structure-based planning					0.50*
List-based planning					0.28
No planning					0.56**

* $p < .05$.
** $p < .01$.
*** $p < .001$.

clause, $F(2, 58) = 5.02$, $p = .01$, $\eta_p^2 = 0.15$. Pairwise comparisons revealed that participants in the structure-based planning condition produced longer clauses than those in the no-planning condition, $t(40) = 3.17$, $p = .002$, $d = 1.17$.

4.3.4. Word length

After adjusting for differences in baseline RT and text length, we found a significant condition effect on the average number of characters per word, $F(2, 58) = 4.94$, $p = .01$, $\eta_p^2 = 0.15$. Pairwise comparisons revealed that participants in the structure-based planning condition wrote longer words than those in the no-planning condition, $t(40) = 3.08$, $p = .003$, $d = 0.91$. The difference between participants in the list-based and no-planning conditions did not reach statistical significance $t(40) = 1.89$, $p = .06$, $d = 0.57$.

4.3.5. Argumentation elements

After controlling for differences in baseline RT and text length, there was a significant condition effect on the number of argumentation elements included in the essays, $F(2, 58) = 5.25$, $p = .01$, $\eta_p^2 = 0.15$. Pairwise comparisons showed that participants in the structure-based planning condition included more argumentation elements in their essays than participants in the list-based planning and no-planning conditions, respectively, $t(40) = 3.18$, $p = .002$, $d = 0.74$, and $t(40) = 2.13$, $p = .04$, $d = 0.45$. We additionally conducted a set of ANCOVAs, with baseline RT and text length as covariates, to test whether the condition effect on argumentation elements was due to a particular element or to the combination of all elements. Results supported this latter hypothesis, as there were no differences between conditions in any argumentation element considered in isolation, Fs$(2, 58) > 2.56$, $p > .09$, $\eta_p^2 < 0.08$.

4.3.6. Persuasiveness

After adjusting for differences in baseline RT and text length, we found a significant condition effect on essays' persuasiveness, $F(2, 58) = 3.22$, $p = .03$, $\eta_p^2 = 0.11$. Pairwise comparisons revealed that essays in the structure-based planning condition were evaluated as being more persuasive than those in the list-based planning and no-planning conditions, respectively, $t(40) = 2.56$, $p = .01$, $d = 0.79$, and $t(40) = 2.05$, $p = .05$, $d = 0.64$.

4.3.7. Overall text quality

After controlling for differences in baseline RT and text length, there

was a significant condition effect on overall text quality, $F(2, 58) = 3.36$, $p = .04$, $\eta_p^2 = 0.10$. Pairwise comparisons showed that the texts in the structure-based planning condition were judged as being of better quality than those in the list-based planning and no-planning conditions, respectively, $t(40) = 2.12$, $p = .04$, $d = 0.61$, and $t(40) = 2.35$, $p = .02$, $d = 0.60$.

4.3.8. Supplementary analyses

As reviewed before, prior research showed that providing writers with a goal to consider opposing positions increased the number of counter-arguments, which was associated with more persuasive texts (Ferretti et al., 2000; Ferretti et al., 2009; Midgette, Haria, & MacArthur, 2008; Nussbaum & Kardash, 2005). These findings raised the question of whether the previously reported benefits of the structure-based planning could be largely explained by the inclusion of counter-arguments, as this was explicitly induced by the graphic organizer. This question was examined in two ways. First, adjusting for differences in baseline RT and text length, we examined the condition effects on a new variable of argumentation elements, from which we removed the number of counter-arguments and respective elaborations. The main effect of condition persisted, $F(2, 58) = 3.83$, $p = .03$, $\eta_p^2 = 0.12$, with the structured-based planning condition surpassing the other two. Second, we conducted a set of ANCOVAs examining condition effects on argumentation elements, persuasiveness, and overall text quality, controlling for baseline RT and text length as well as for the number of counter-arguments and respective elaborations. Again, the main effect of condition remained on argumentation elements, $F(2, 57) = 4.67$, $p = .01$, $\eta_p^2 = 0.14$, persuasiveness, $F(2, 57) = 3.16$, $p = .05$, $\eta_p^2 = 0.10$, and overall text quality, $F(2, 57) = 3.09$, $p = .05$, $\eta_p^2 = 0.10$, with a superiority of the structured-based planning condition.

Table 2 reports the correlations between characteristics of final texts. Text length was related to word length, argumentation elements, persuasiveness, and text quality across conditions, though smaller correlations were found for the list-planning based condition. Correlations involving word length varied across conditions: it was correlated positively with clause length for the no-planning condition, negatively with argumentation elements for the structured-based condition, and positively with text quality for the list-based condition. Except for the list-based condition, text quality was positively associated with argumentation elements and persuasiveness, which were related with each other across the three conditions.

4.4. Effects of writing processes occurrences on final texts

We computed a set of hierarchical regression analyses to examine whether writing processes occurrences were associated with the characteristics of final texts. Similar to the previous analyses, on Step 1, we entered baseline RT and text length. On Step 2, we entered condition, which was dummy coded with the no-planning condition as the reference variable. Because these two first steps replicated conducted ANCOVAs, results are not detailed in text (but see Table 3). On Step 3, we entered planning, translating, and revising occurrences, which were previously mean centered. On Step 4, we entered the two-way interactions between condition and writing processes. Because entering all writing processes by phase would result in a total of 31 predictors, which would be excessive for the sample size ($N = 63$), we tested separate regression models for each phase.[3] Results of regression analyses by dependent variable and step are presented on Table 2.

Including writing processes occurrences on Step 3 increased the amount of variance explained only for word length in the Phase 1 model, $\Delta R^2 = 0.10$, $F_{change}(3, 55) = 2.79$, $p = .05$, and overall text quality in the Phase 2 model, $\Delta R^2 = 0.08$, $F_{change}(3, 55) = 3.09$, $p = .03$. Specifically, planning and translating occurrences in Phase 1 (respectively, $b = 0.37$, $t = 2.64$, $p = .01$; and $b = 0.29$, $t = 2.08$, $p = .04$) were associated with the use of longer words. Moreover, translating occurrences in Phase 2 were associated with better quality ($b = 0.39$, $t = 2.99$, $p = .004$). Adding the interaction terms on Step 4 did not increased the amount of variance explained for any dependent variable.

The same regression analyses were performed introducing percentage of processes occurrences rather than frequencies as predictors on Step 3. Results showed no significant effects of percentage of planning, translating, and revising for clause length, word length, argumentation elements, and persuasiveness, either in each of the three phases separately or in the three phases collapsed. Concerning effects on text quality, results showed a significant increase in the amount of variance in explained in Phase 3, when percentage of writing processes occurrences were added to the model, $\Delta R^2 = 0.06$, $F_{change}(2, 56) = 3.33$, $p = .04$. Specifically, at the end of composition, more translating in comparison to planning was associated with better texts ($b = 0.30$, $t = 2.54$, $p = .01$).

5. Discussion

This study aimed to examine the effects of planning on writing dynamics and final texts. For that, undergraduates were randomly assigned to three conditions: structure-based planning, list-based planning, and no planning. Whereas participants in the structure-based planning condition were given a graphic organizer to hierarchically generate and organize ideas according to the argumentative structure, participants in the list-based planning condition were asked to list their ideas before writing and those in the no-planning condition did not engage in any pre-planning task.

5.1. Planning effects on writing dynamics

Results on general temporal parameters of compositions partially confirmed our hypotheses. We found no differences among conditions on the length of the pre-writing pause, typically devoted to initial planning (Beauvais et al., 2011; Kellogg, 2004). Contrary to our hypotheses, participants in the no-planning condition did not exhibit a longer pre-writing pause than those in the two planning conditions. Regardless of being asked or not to plan ahead of writing, undergraduates began writing about 4.59 s after being given the instructions for the writing assignment. This is a very short time frame devoted to initial planning of an argumentative text (see Beauvais et al., 2011), in particular for participants in the no-planning condition, who were not explicitly requested to plan ahead of writing as their peers. Concerning writing fluency, participants in the structure-based planning conditions produced more words per minute than those in the no-planning condition (despite the large effect size, $d = 0.70$, the list-based vs. no-planning difference did not reach statistical significance, $p = .07$). Overall, it seems that, regardless of the strategy, planning tends to increase the writing rate of undergraduates (for similar results, see De Smet et al., 2014; Kellogg, 1988). This finding indicates an association between planning ahead of writing and an enhanced efficiency of all writing processes (McCutchen, 1988).

Results on processes' cognitive effort were aligned with prior research showing that revising and planning were the most effortful processes, and that translating was the least effortful one (Kellogg, 1987a, Exp. 1; Olive, Alves, & Castro, 2009). Also as expected, we found no interaction between condition and writing process, meaning that planning did not impact processes' cognitive effort, likewise results of Kellogg (1988). Olive, Favart, Beauvais, and Beauvais (2009) also showed that, in Grades 5 and 9, genres imposing different planning

[3] As prior research found the pre-writing pause to be associated with text quality (Beauvais et al., 2011), we conducted an additional regression analysis with Phase 1 predictors, to which we added the pre-writing pause on Step 3 and interactions with condition on Step 4. Results showed neither a main effect of the pre-writing pause nor interactions for any dependent variable.

Table 3
Contribution of writing processes occurrences at Phase 1 (Model 1), Phase 2 (Model 2), and Phase 3 (Model 3) to final texts characteristics.

	Clause length		Word length		Argumentation elements		Persuasiveness		Text quality	
	b	*t*	*b*	*t*	*b*	*t*	*b*	*t*	*b*	*t*
Step 1 (Models 1–3)										
R^2 (*p*)	0.02 (0.48)		0.12 (0.02)		0.50 (< 0.001)		0.23 (< 0.001)		0.37 (< 0.001)	
Baseline RT	−0.01	−0.09	0.11	0.93	0.04	0.41	0.04	0.33	0.11	1.07
Text length	−0.15	−1.19	−0.35	−2.87**	0.70	7.62***	0.48	4.15***	0.58	5.56***
Step 2 (Models 1–3)										
ΔR^2 (*p*)	0.14 (0.01)		0.13 (0.01)		0.08 (0.01)		0.09 (0.03)		0.07 (0.04)	
SBP vs. NP	0.46	3.17**	0.43	3.10***	0.22	2.13**	0.27	2.05*	0.28	2.35*
LBP vs. NP	0.22	1.47	0.27	1.91	−0.12	−1.16	−0.08	−0.61	0.02	0.14
Step 3 (Model 1)										
ΔR^2 (*p*)	0.09 (0.10)		0.10 (0.05)		0.001 (0.98)		0.07 (0.12)		0.03 (0.46)	
Planning	0.37	2.52*	0.37	2.64*	−0.004	−0.04	0.23	1.76	0.12	0.95
Translating	0.22	1.49	0.29	2.08*	0.04	0.32	0.22	1.65	0.19	1.52
Revising	0.19	1.31	0.12	0.80	0.02	0.17	0.30	2.31*	0.04	0.36
Step 3 (Model 2)										
ΔR^2 (*p*)	0.04 (0.43)		0.06 (0.22)		0.02 (0.53)		0.03 (0.51)		0.08 (0.03)	
Planning	0.21	1.23	0.33	2.05*	−0.17	−1.37	−0.05	−0.29	0.25	1.80
Translating	0.04	0.27	0.17	1.08	−0.05	−0.39	0.07	0.44	0.39	2.99**
Revising	−0.05	−0.31	0.08	0.52	−0.08	−0.66	0.16	1.06	0.09	0.68
Step 3 (Model 3)										
ΔR^2 (*p*)	0.09 (0.09)		0.08 (0.12)		0.01 (0.74)		0.01 (0.89)		0.07 (0.07)	
Planning	0.37	2.37*	0.28	1.89	−0.04	−0.30	−0.01	−0.05	−0.03	−0.20
Translating	0.20	1.36	0.27	1.91	−0.09	−0.83	−0.02	−0.13	0.25	2.10*
Revising	0.08	0.52	0.34	2.29*	0.02	0.16	0.08	0.53	0.17	1.34

Note. Despite interactions between condition and writing processes occurrences were introduced on Step 4, these were omitted from the current table as Step 4 did not produce any significant increase in the amount of variance explained in any outcome variable. SBP = structure-based planning condition; LBP = list-based planning condition; NP = no-planning condition.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

constraints (narrative vs. argumentative) did not impact cognitive effort during composition. As suggested by Olive, Kellogg, and Piolat (2002, p. 58) "potential sources of variation differently affect the allocation of cognitive effort and/or the general pattern of temporal organization of the writing processes". It seems that writer-specific factors (e.g., domain knowledge) tend to affect cognitive effort, but not the temporal distribution of processes; whereas situation-specific factors (e.g., pre-planning strategies) tend to affect the temporal distribution of processes, but not cognitive effort.

This dissociation effect was observed here as well. Planning strategies were found to influence writing dynamics not by reducing attentional load, but by changing the way writers composed their texts. Two main findings on planning effects on the occurrences of writing processes are noteworthy. One of these results concerns processes activation throughout writing. Though translating was kept constant for the three conditions, planning and revising showed a distinct pattern between the no-planning condition and the two planning conditions. Specifically, participants in the no-planning condition showed a smooth decline in planning attended by an earlier activation of revision, likely indicating they were facing difficulties in composing (Baaijen et al., 2014; Van den Bergh, Rijkaarsdam, & Van Steendam, 2016). The lack of a plan might have forced them to start evaluating and revising their texts earlier than those participants who had previously worked out a plan to guide their writing, leaving revising for a later stage. Indeed, regardless of the planning strategy, students who were given time to plan ahead of writing kept planning and revising occurrences constant in the first two thirds of composition, displaying a decline in planning paralleled by a marked increase in revising only in the last third.

Another main finding concerns the different activation of writing processes in each third of composition across conditions. In this case, participants in the list-based condition displayed an activation pattern more similar to those in the no-planning than in the structure-based condition. Specifically, undergraduates who either did not plan or elaborate a list tried to attend to both planning and translating in the beginning of composition and to all processes in the middle of composition. On the contrary, undergraduates in the structure-based condition were mainly focused on translating in the beginning and middle of composition, and on both translating and revising at the end. This pattern of writing dynamics is aligned with Kellogg's (1988) findings, showing that writers who outlined before writing focused more on translating during writing. Because this effect was not found in the list-based condition, the enhanced focus on translating seems to be the result of the structure-based type of planning rather than a general effect of planning ahead of writing.

5.2. Planning effects on final texts

The effects of the structure-based planning on the characteristics of final texts were clear cut. Compared to participants in the list-based planning and no-planning conditions, those in the structure-based condition produced argumentative texts that included more argumentation elements and that were judged as more persuasive and of better quality ($0.45 < ds < 0.79$). Results were however less straightforward for syntactic and lexical complexity: Participants in the structure-based planning condition wrote longer clauses and longer words than those in the no-planning condition, but did not surpass those in the list-based planning condition. It is worthy to highlight that, despite a tendency for participants in the list-based planning condition to write longer words than those in the no-planning condition ($p = .06$, $d = 0.57$), the characteristics of the final texts produced by undergraduates asked to elaborate a list of ideas before writing and to embark in writing without pre-planning were virtually the same. This is an important finding from an educational viewpoint. It suggests that, despite the importance of planning in argumentative writing, some forms of planning may be no better than engaging in writing without planning. Therefore, it does not seem useful to ask writers to plan ahead of writing, without supporting them in carrying out this key writing process effectively for the benefit of writing.

As shown here, providing students with graphic organizers that prompt the elaboration of outlines tailored to the argumentative schema seems an effective scaffold for argumentative writing. Prior research already showed the benefits of planning ahead of writing in an outline format without text structure support (Galbraith et al., 2005; Kellogg, 1987b, 1988, 1990) as well as of providing writers with elaborated goals to include major argumentative parts (Ferretti et al., 2000; Ferretti et al., 2009; Nussbaum & Kardash, 2005). Still, this is the first time that the advantage of embedding text structure in the outline is shown for undergraduates argumentative writing. This result matches similar research with students in Grades 9–10 (De Smet et al., 2012; De Smet et al., 2014). Moreover, it aligns well with intervention research with school-aged students, showing the benefits of teaching planning strategies to elaborate outlines matched to the structure of the text to be written (Graham et al., 2012; Graham & Perin, 2007). It is however worth mentioning that, contrary to these intervention studies, we did not implement instructional procedures to foster maintenance effects of the structure-based planning. Considering the complexity of argumentative writing (Coirier et al., 1999), it seems unlikely that a single use of the graphic organizer would result in persistent gains in writing. Even its repeated use was shown to have limited learning effects (De Smet et al., 2012; De Smet et al., 2014). Additional instructional procedures seem needed to assure that the benefits of effective planning strategies extend beyond the current task and influence future assignments (Graham & Harris, 2007). Those procedures may also help to further improve their argumentation and writing skills. Indeed, in spite of their improvement, undergraduates' texts still remained of medium persuasiveness and quality (averages of 4.6, out of 7).

Further analyses were conducted to examine whether the occurrences of writing processes were related to these benefits on final texts characteristics. Surprisingly, there was barely any reliable effect of processes occurrences on final texts, nor interactions with condition. This finding seems to imply that, contrary to Kellogg's (1994) claim, the restructuring of the writing processes due to planning might not be associated with its beneficial effects on final texts. However, to draw such a conclusion from our data looks premature, mainly because this is the first study statistically testing this association. Studies using the triple-task technique have rarely tried to statistically examine the relationship between writing dynamics and final texts (e.g., Alves et al., 2008; Kellogg, 1987a, 1988; Olive, Alves, & Castro, 2009; but see Beauvais et al., 2011). Moreover, we cannot dismiss the hypothesis that writing processes occurrences are not the best indicator of writing dynamics, at least, to unravel its relationship with final texts. Rather than being influenced by the number of times a process is activated, final texts might be influenced by how that process is carried out – which can be examined by means of thinking-aloud protocols (Olive et al., 2002) – or by how writers shift between one process and the others – which can be examined by means of matrices of transition probabilities (Levy & Ransdell, 1995). Overall, more research investigating how writing dynamics relate to final texts and which factors may influence this link is clearly warranted.

5.3. Caveats about planning benefits

Despite the proved beneficial effects of structured-based planning here demonstrated as well as of other hierarchically-organized planning strategies such as outlining, these forms of planning may not always be useful (Galbraith, 1999; Kellogg, 1994). Indeed, their effectiveness may depend upon the characteristics of either the writer or the task. For example, a writers' characteristic identified to moderate outlining effects on text quality is transactional beliefs. Writers holding high transactional beliefs view writing as a reflective process for expressing their own thoughts (White & Bruning, 2005). These writers typically display better writing performance than low transactional writers. Baaijen et al. (2014) found that outlining helped low transactional writers to improve their writing, but not that of high transactional writers. For these latter, making an outline or a single-sentence summary before writing impacted text quality similarly. It seems that prompting writers to elaborate hierarchically-organized plans before writing may not benefit writers who prefer to generate and organize their ideas in the course of writing. These writers may benefit from revising strategies employed after a first draft has been produced (Kieft, Rijlaarsdam, Galbraith, & van der Bergh, 2007).

Concerning the writing task, in assignments requiring little if any idea generation or organization, such as producing routine documents, creating short narratives, or describing a scene, writers may not benefit from structured plans. This was demonstrated by Kellogg (1990), who asked undergraduates to outline under different conditions, varying in the amount of information provided: topic; topic and ideas; or topic, ideas, and organization. The best texts were produced by writers who were only given the topic. When they were also provided with ideas, the beneficial effect of outlining decreased. This effect was completely eliminated when a suggestion for organizing those ideas was added. In writing assignments where writers have no clear ideas about the topic, planning strategies favoring creativity may also be more useful. One of those strategies is clustering, in which ideas and their relations are visually depicted in a network. Though clustering failed to improve text quality, it did result in a larger amount of ideas generated than outlining (Kellogg, 1990). Actually, writing without preplanning may be more advantageous in situations where writers lack ideas. For example, Galbraith (1992) reported that, compared to outlining, producing an unplanned rough draft lead to the production of more new ideas during writing.

5.4. Limitations and future research directions

Findings should be considered in view of at least six limitations. First, whereas the time elapsed between knowing the prompt and start writing was kept constant across conditions, during this interval, participants in the planning conditions were engaged in a writing-related task, but those in the no-planning condition were not. Thus, even if composing time was similar, the no-planning condition entailed lesser total time-on-task than the other conditions (for a discussion on this, see Hayes & Nash, 1996). As noted, the no-planning condition were designed to match typical writing assignments and increase the experiment's ecological validity. In any case, despite spending less total time-on-task, undergraduates in the no-planning condition exhibited a writing performance similar to those in the list-based planning condition, which was poorer than that of their peers in the structure-based planning condition. This result shows that the reported benefits of the structure-based planning cannot be attributed to time-on-task, and suggests that more important than total time-on-task, is the way writers use that time.

Second, the measures chosen to assess handwriting and keyboarding preference, frequency of writing by hand and keyboard, as well as overall frequency of writing were limited. In particular, writing modality preference and frequency were measured with single items, which are known for their psychometric disadvantages, such as their vulnerability to measurement error. Moreover, the frequency of writing measure, computed by averaging a set of questions about frequency of writing different genres, showed low internal consistency ($\alpha = 0.05$). In spite of the random allocation of participants to condition as well as to the statistical controls introduced in the analyses, future studies should include stronger measures to assure conditions equivalence in terms of writing frequency, and, eventually, add other measures specifically related to participants' argumentation skills.

Third, our design does not support inferences about the specific components of the structure-based planning associated with its positive effects on final texts. Prior research showed the isolated benefits of either asking undergraduates to outline before writing (Galbraith et al., 2005; Kellogg, 1987b, 1988, 1990) or providing them with goals for including the major parts of argumentative writing (Nussbaum &

Kardash, 2005). The current study extended these findings by showing that the combination of these two approaches into a structured-based planning strategy was particularly powerful for undergraduates, improving both general and argumentation-specific characteristics of final texts (see also De Smet et al., 2012; De Smet et al., 2014). However, further research seems needed to disentangle the effects of giving participants critical elements of the text to be written from those of asking them to create an outline not tailored to a specific genre.

Fourth, all undergraduates were asked to write a text on the same topic. Although this procedure was similar to prior research (e.g., Beauvais et al., 2011; Midgette et al., 2008; Nussbaum & Kardash, 2005), others studies have used two topics to control for potential prompt effects and increase external validity (e.g., Ferretti et al., 2000; Kellogg, 1988, 1990). Still, though Ferretti et al. (2000) reported a topic effect on persuasiveness in children, Kellogg (1988) found no interactions between planning and topic on writing dynamics and text quality in undergraduates (see also Kellogg, 1990). Based on these findings, and given that every undergraduate was familiar with the topic and that current results were generally consistent with other studies, we have no strong reasons to suspect that findings would change with a different prompt, as long as topic knowledge was comparable (cf. Kellogg, 1987a). Nevertheless, it does seem important to replicate the current study using different prompts and to examine the extent to which findings generalize across them.

Fifth, as most research into planning effects on writing (De Smet et al., 2012, 2014; Galbraith et al., 2005; Kellogg, 1988), we focused on the argumentative genre. Still, genre differences are well described in terms of organization principles, language usage, writing dynamics, and planning demands (Beauvais et al., 2011; Berman & Nir-Sagiv, 2007). One cannot assume that current findings generalize beyond argumentative writing for at least two reasons. First, as discussed above, genres that demand little idea generation or organization may not benefit from a hierarchical organization of information ahead of writing. Some genres heavily dependent on writers' creativity may inclusively suffer from this form of planning (Kellogg, 1990). Second, the structure-based planning condition gave students a graphic organizer tailored to the argumentative genre. This might have been helpful due to students' difficulties in applying discourse knowledge in writing, as evident in the reduced consideration and rebuttal of alternate positions (Nussbaum & Kardash, 2005). However, writing in other genres, such as narratives, whose underlying schema is early acquired (Berman & Slobin, 1994), does not seem likely to benefit from planning strategies based on the text structure. Future studies should aim at examining how genres with varying planning and discourse knowledge requirements may be influenced by different planning strategies.

Finally, it is well known that writers may vary in the way they activate and distribute planning, translating, and revising during a writing session with equal success (Kellogg, 2008). Still, the number of participants per condition ($n = 21$) precluded us to examine the effects of individual differences within conditions or how these might have moderated planning effects. It is not unlikely that there were different but equally effective profiles of writers within conditions. In fact, this could perhaps be another reason for the lack of association between writing dynamics and final texts. A fine-grained analysis of the impact of planning and individual differences on writing might be worth considering in future studies. These may use larger samples and implement hierarchical modeling approaches in order to accommodate individual- and group-level differences.

6. Conclusion

This study analyzed the effects of planning on writing dynamics and final texts produced by undergraduates. The use of planning strategies led to a restructuring of the writing process. Still, there was no indication that occurrences of writing processes were associated with final texts features, which were greatly influenced by planning. Regardless of the strategy, planning resulted in texts with longer words, produced at a higher rate. Moreover, the structure-based planning proved to be highly beneficial, resulting in more persuasive and better texts, including more argumentation elements. Taken together, these findings highlight the advantages of elaborating a structured plan aligned with the argumentative schema on several key features of argumentative texts. In addition to supporting prior theoretical claims and empirical findings on the importance of planning to produce good writing, this conclusion is also of great educational value. Indeed, from an applied viewpoint, our findings provide a strong empirical support for introducing structure-based planning in higher education. At least when argumentation is requested, teachers may efficiently and effectively improve their students writing by providing them with graphic organizers, or by teaching them to elaborate their own. Despite structure-based planning may not be a panacea for writing problems in higher education, its use can certainly help some undergraduates to put their thoughts into more persuasive and better texts.

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