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Janet G. van Hell [a]; Ludo Verhoeven [a]; Liesbeth M. van Beijsterveldt [a]
[a] Behavioural Science Institute, Radboud University Nijmegen, The Netherlands

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Pause Time Patterns in Writing Narrative and Expository Texts by Children and Adults

Janet G. van Hell, Ludo Verhoeven, and Liesbeth M. van Beijsterveldt
Behavioural Science Institute
Radboud University Nijmegen, The Netherlands

How do beginning and skilled writers compose a text in the course of time? To gain insight into the temporal aspects of planning and translating activities during writing, this article examined writing in real time and analyzed pause time patterns in writing in relation to linguistic characteristics of the written product. Fourth-grade children and adults wrote a narrative text (a personal experience) and an expository text on a socially relevant issue. They wrote their texts by hand, and a computer-controlled digitizer tablet recorded handwriting movements. Developmental patterns in pause duration as a function of genre and linguistic features of pause locations (word, clause, sentence) were studied. In a more detailed analysis, pause time patterns related to the syntactic linking of clauses were examined, and whether pause time patterning varies with different types of clauses was also examined (i.e., main clauses, coordinate clauses, finite and nonfinite subordinate clauses, and restrictive and nonrestrictive relative clauses). Analyses showed that pause time duration is different in narrative and expository texts, and varies with syntactic location in that both 4th-grade children and adults take more time to plan and decide at higher syntactic levels. Pause duration also varies with the syntactic linking of clauses: Children and adults pause longer before writing main clauses than before coordinate clauses, and pause longer before writing coordinate clauses than before subordinate clauses—a pattern found in narrative and expository texts. This suggests that the time beginning and adult writers take to decide on how to express their ideas in syntactically linked clauses depends on grammatical and functional aspects of clauses.

Correspondence concerning this article should be addressed to Janet G. van Hell, Behavioural Science Institute, Radboud University Nijmegen, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands. E-mail: j.vanhell@pwo.ru.nl

A central question in psycholinguistic studies on language production is how people express their thoughts into language and how they organize and convey the contents of their thoughts. Models of writing converge on the basic assumptions that writing a connected text entails the initial planning of ideas, translating them into a linguistic structure, transcribing the words into written symbols, and reviewing and revising the text (e.g., Fayol, 1991; Flower & Hayes, 1980; Graham & Harris, 2000; Kellogg, 1996; McCutchen, 1996; van Galen, 1991). Planning involves retrieving relevant information in long-term memory and deciding how to organize these ideas to suit the addressee and the writing goal. The conceptual content must then be translated into linguistic structures, which involves grammatical and lexical encoding. Planning and translating, being subcomponents of the overall formulation process, are considered higher level processes. In the lower level transcription process, the linguistic structure must be transformed into written symbols.

The seminal works of Flower and Hayes (1980) instigated important studies on the cognition of written language production that examined the nature of the cognitive operations and problem-solving processes involved in composition (for a review, see Hayes, 1996), the role of working memory in writing (e.g., Kellogg, 1996; McCutchen, 1996), or the lower level psychomotoric aspects of handwriting (e.g., van Galen, 1991). Linguistic researchers provided rich information on linguistic characteristics of the final written products including pragmatic, semantic, syntactic, and lexical aspects (e.g., see Berman & Verhoeven, 2002). Together these studies led to important insights on the linguistic quality of written products and the cognitive resources engaged in higher and lower level processes in writing. Considerably less is known, however, about the temporal aspects of the planning and translation processes of writing. How do proficient and beginning writers temporally organize these higher level processes when writing a coherent text? In this study, we adopt a process-oriented approach to writing (rather than a product-oriented approach), and explore cognitive processes involved in writing as they unfold in real time by analyzing the pause time patterns in writing. Pauses during writing are considered as observable and measurable traces of a person's cognitive activities during writing, and variations in pausing are interpreted as variations in the cognitive demands of writing (Chanquoy, Foulin, & Fayol, 1990; Foulin, 1998; Martlew, 1992; Matsuhashi, 1987; van Waes & Schellens, 2003) or speaking (e.g., Clark & Wasow, 1998; Hawkins, 1971; Holmes, 1995; Schilperoord, 1996). Silent pauses during language production (as response times in the cognitive stimulus-response paradigm) cannot reveal exactly which types of activities occur at a given time in production, but they can be used as indexes of points of where and how long the writer–speaker halts to plan and decide what to write or say next. The linguistic output (e.g., sentence, type of clause) provides cues as to the nature of the (hidden) planning and decision processes. Therefore, an analysis of the location

and duration of pauses, in combination with a coding of linguistic aspects of the written or spoken text, may serve as a window to cognitive and linguistic processes involved in text production.

COGNITIVE PROCESSES IN WRITING CONNECTED DISCOURSE

Researchers who have examined pause duration during text writing found that pause duration varies with the syntactic location of the utterance (Foulin, 1998; Matsuhashi, 1987; van Waes & Schellens, 2003). For example, van Waes and Schellens asked adult writers to write texts on a new system of bank charges and on company regulation for in-service training, and observed that pause duration before paragraphs was longer than before sentences, which, in turn, was longer than pause duration before sentence-internal words. In a developmental study, Foulin (1998) examined pause duration in a different genre. He presented 10 second graders, 10 third graders, and 10 adults a short simple text introducing a report on a personal tour and asked the writers to finish the report. It appeared that children differed from adults in the cognitive costs of writing: Children's overall pause durations were longer than those of adults. However, both children and adults paused longer before clauses than before phrases, and longer before phrases than before phrase-internal words. Foulin's study thus shows that children and adults pause longer as the syntactic level of the unit increases, which suggests that both beginning and more skilled writers need more time to plan and decide at higher syntactic levels. It also suggests that already at an early stage in the development of writing skills, beginning learners are aware of the linguistic structure of a written text. It remains to be seen, however, whether this knowledge is restricted to the narrative genre (which children are highly familiar with) or whether it is also evident in other genres. To investigate genre effects in a more systematic way, from a developmental perspective, we examined the temporal patterning of planning and decision activities in narrative and expository text writing, in children and adults.

Texts of different genres have different hierarchical and linguistic structures. In constructing a text, different genres, like narrative or expository texts, make specific demands on the hierarchical organization of ideas and on their subsequent translation into linguistic structures. With regard to the latter, studies on genre observed that the linguistic structures writers use to convey their ideas are different for narrative and expository texts including the expression of discourse stance (Reilly, Zamora, & McGivern, 2005; van Hell, Verhoeven, Tak, & van Oosterhout, 2005), the use of passives (Jisa et al., 2002), verbal structure (Ragnarsdóttir, Aparici, Cahana-Amitay, van Hell, & Vigué-Simon, 2002), noun phrase patterning (Ravid, van Hell, Rosado, & Zamora, 2002), and

clause packaging (Verhoeven et al., 2002; Verhoeven & van Hell, 2008). For example, van Hell et al. found that children and adults use personal and impersonal pronouns and passive constructions systematically to express discourse stance in genre-specific ways.

Studies on how ideas are organized in narrative and expository texts indicate that both text types are hierarchically structured (e.g., Englert, Stewart, & Hiebert, 1988; Fitzgerald & Teasley, 1986; Katzenberger, 2004), but differ in the way in which the information retrieved from long-term memory is organized. The major organizational principle in narrative is the temporal sequence of the recounted events (e.g., Berman & Slobin, 1994; Labov, 1972). Narratives are also causally structured (e.g., Trabasso & Nickels, 1992), but the causal connectivity in narratives is less elaborate than in expository texts (Verhoeven & van Hell, 2008). In expository texts, on the other hand, the role of temporality depends on the type of rhetorical structure. Temporality can be present in causal scientific structures, but arguments and logical justifications have a non-temporal logical argumentative organization (e.g., Britt & Larson, 2003; Britton, 1994) and can contain problem–solution, cause–effect, comparison–contrast, sequence, enumeration, or description structures. The cognitive operations involved in expository text writing are complex and approach a knowledge-transforming model: Writers carry out extensive problem-solving operations on the retrieved information, juggling with the joint solution of content-related and rhetorical problems (Bereiter, Burtis, & Scardamalia, 1988; Fayol, 1991). Compared to expository text, relatively little transformation of knowledge is required when writing a narrative text, and the operations performed on the retrieved knowledge come close to a knowledge-telling model (e.g., Bereiter et al., 1988).

What do differences between narrative and expository texts in the organization of ideas imply for the *process* of writing? If the organizational principle in narrative is basically a temporal and causal sequence of recounted events, writing a narrative on a personal event would imply the retrieval of this episode from memory, and framing the retelling of the episode in a clearly defined text structure, a "story grammar." The logical argumentative structure of an expository text places higher cognitive demands on the writer. As compared to narrative text writing, expository text writing involves more complex and effortful knowledge transformation and demands more cognitive resources. Moreover, writing a narrative on a personal event involves writing about a familiar topic, and previous research showed that familiarity with the subject matter leads to shorter pauses in spoken production (Butterworth, 1980), less subvocalization (Williams, 1987), and less interference on secondary tasks (Kellogg, 2001). Therefore, it can be expected that writers will pause longer and need more time in writing expository texts than in writing narrative texts.

In one of the very few studies examining the impact of genre differences on the temporal management of writing, Chanquoy et al. (1990) presented 8- and

10-year-old children and adults with the beginnings of narrative and descriptive texts. They then asked writers to write down an ending for each text consisting of three propositions. For both adults and children, no differences between narrative and descriptive texts were found in the prewriting time. However, the mean duration of pauses between propositions was longer for descriptive than for narrative text endings in the adults and 10-year-olds, but not in the 8-year-olds. Chanquoy et al. attributed the weakness of this genre effect to the fact that the text beginnings their writers had to finish were short and oversimplified. In our study, we therefore explored genre effects in pause time patterning by asking child and adult writers to write a *complete* expository and narrative text. Learning to distinguish between different text genres is a hallmark in children's later language development, although in many school systems teaching genre distinctions remains implicit (Kress, 1994). Previous developmental studies examining genre effects in text production showed that children as young as fourth graders can produce well-structured narratives in which events are described in a temporal-causal sequence. Mastery of the logical-argumentative structure in expository text appears to be manifested at a later point in development—often not before high school (e.g., Berman & Verhoeven, 2002; Kress, 1994). To conclude, we expect that pause duration in both children and adults will vary with the syntactic location of the utterance, but that overall pause duration in children's narrative and expository text will not differ. In the adult writers, however, we expect that overall pause durations will be longer in expository than in narrative text writing.

The previous studies on temporal management of writing (Foulin, 1998; van Waes & Schellens, 2003) focused on the hierarchical planning of broad syntactic units (i.e., paragraphs, sentences, clauses, and words). These studies did not further specify the linguistic contents of these units (e.g., the syntactic characteristics of clauses). When translating their message into a linguistic structure, writers must express their thoughts into a meaningful sequence of information, and must retrieve the appropriate linguistic forms to encode this sequence. An important step in this translation process entails the linearization of clauses (Fayol, 1991); clauses are considered to be the basic idea units in which speakers–writers encode their thoughts during production (e.g., Foulin, 1998; Holmes, 1995). Therefore, we made a first attempt to gain more insight into pause time patterns of the syntactic linking of clauses in writing.

LINKING CLAUSES IN DISCOURSE PRODUCTION

In translating a conceptualized message into connected discourse, proficient speakers–writers do not simply list their ideas, but arrange their ideas into hierarchical constructions by combining clauses within a text. Speakers–writers

can express connectivity between clauses by means of different clause-linking devices (e.g., syntactic conjunction) that can be used to express different discourse functions depending on, for example, the temporal or causal relations the speaker–writer wants to express.

Syntactic linking of clauses involves the marking of coordination and subordination (e.g., Holmes, 1995; Matthiesen & Thompson, 1988). Coordinate clauses are autonomous and can be linked with coordinating conjunctions like *and* or *but.* In subordinate constructions, a main clause is modified by one or more subordinate clauses. Subordinate clauses are grammatically dependent on the main clause and typically do not express a complete thought. A subordinate clause is introduced by a subordinate conjunction (i.e., an adverbial conjunction) or by a relative pronoun. A subordinate clause introduced by an adverbial conjunction (hence, an adverbial clause) expresses how, when, where, why, or to what extent the action denoted by the verb in the main clause is done. For example, in the sentence, "Mary drinks milk *because she is thirsty,*" the adverbial clause "because she is thirsty" explains why Mary drinks milk. A subordinate clause introduced by a relative pronoun (e.g., *who, which, that*) is called a relative clause, and functions as an adjective clause modifying or limiting a noun or a pronoun in the main clause. For example, in the sentence, "I read the classic novel *that Mary recommended,*" the relative clause "that Mary recommended" modifies the referent in the main clause. Relative clauses can be restrictive or nonrestrictive. A restrictive relative clause helps to identify the referent of the noun or pronoun it modifies, and provides information essential to its meaning and restricts its scope as in, "I read the classic novel that Mary recommended." A nonrestrictive clause provides additional information that is not essential to the meaning of the noun or pronoun in the main clause as in, "The classic novel, *which Mary recommended*, has 350 pages."

A closer linguistic analysis of the different subordinate clauses suggests that some subordinate clauses are less dependent on the main clause than others and may, in fact, contain new information not expressed in the main clause. Adverbial clauses like, "Mary drinks milk *before she goes to the movies*" are structurally subordinate clauses, but may function to introduce new information rather than background information already presupposed in the main clause (Holmes, 1995; Matthiessen & Thompson, 1988; Thompson, 1987). It is proposed that adverbial clauses function as coordinate clauses, and are combined with the main clause to which they are attached rather than being embedded within it. This would imply that speakers–writers plan adverbial clauses independently, as independently as the main clause to which they are attached (Holmes, 1995). Subordinate clauses containing a nonfinite verb (e.g., "Mary drinks milk *[in order] to grow*"), on the other hand, are not only grammatically but also functionally dependent on the main clause. The nonfinite subordinate clause "in order to grow" functions as an argument of the verb in the main clause, and is thus embedded in the main clause.

Relative clauses can also have different functions. Restrictive relative clauses provide information essential to identify the noun or pronoun in the main clause, whereas nonrestrictive relative clauses provide additional information. Nonrestrictive relative clauses, unlike restrictive relative clauses, may convey information that is functionally similar, and as independent, as information that can be conveyed in a coordinate clause. This would imply that nonrestrictive relative clauses are planned more autonomously than restrictive relative clauses.

How do writers plan the expression of their ideas in syntactically linked clausal structures? If coordinate clauses are autonomous and subordinate clauses depend grammatically and functionally on the main clause, the formulation of the ideas the writer seeks to express will take longer in coordinate clauses than in subordinate clauses (at least in those subordinate clauses that are grammatically and functionally dependent on the main clause). To the best of our knowledge, no study has examined this question in written language production, but findings on spoken language production can be informative.

In studies of spoken language production in English (Holmes, 1988) and French and English (Holmes, 1995), Holmes observed that speakers more often paused or hesitated before formulating main clauses and coordinate clauses than before formulating subordinate clauses that were embedded within the main clause. In a more detailed analysis taking into account variations among subordinate clauses in terms of their functional dependency on the main clause, Holmes found that the frequencies of silent pauses and hesitations before adverbial (finite) clauses were not different from those before main and coordinate clauses. Furthermore, speakers more often paused or hesitated before formulating nonrestrictive relative clauses than restrictive relative clauses. These results suggest that speakers of English and French plan and output coordinate clauses and various forms of subordinate clauses differently, depending on the autonomy of the information expressed in the clause. In this study, we examine the extent to which the autonomy of information and the packaging of clauses is also an organizing principle in the temporal flow of people's writing.

TECHNIQUES TO STUDY THE PROCESS OF WRITING

To conclude the introduction, we discuss methodologies that are used to gain insight into the temporal characteristics of writing connected discourse (Matsuhashi, 1987; Olive & Levy, 2002). One of the early techniques used by researchers adopting a process-oriented approach to the study of writing is thinking-aloud protocol analysis. With this technique, writers speak aloud anything that comes to mind while composing. Analysis of the resulting thinking-aloud protocols provides insight into the cognitive processes involved in writing. On the basis of this technique, Flower and Hayes (1980) developed their

influential model, which incited a cognitive, process-oriented approach to the study of writing. Subsequent technological advancements enabled less obtrusive recordings of the writing process than the thinking-aloud technique.

One of such less-obtrusive techniques is the videotaping of handwriting (Chanquoy et al., 1990; Foulin, 1998; Matsuhashi, 1987). Participants are videotaped while writing, and video recordings are later played back in slow motion to assess temporal characteristics of the writing movements, like pause duration between words or writing time. New technologies in computer and software further enhanced methods to study writing in real time. One such technique is the keystroke method in which a specially designed text editor software program (e.g., Scriptlog; Strömqvist & Malmsten, 1997) records all keystrokes and mouse operations in a logfile (van Waes & Schellens, 2003). On the basis of information recorded in the logfile, text operations and their temporal characteristics can be analyzed. Rather than recording type-written text, a second high-accuracy method records handwriting movements using a digitizer tablet connected to a computer (e.g., van Galen & Weber, 1998; see the Method section for more details).

Both keystroke and digitizer tablet recordings are inobtrusive techniques that enable highly accurate and reliable recordings. A prerequisite for using the keystroke method is that writers are fluent typists, which constrains the applicability in using this method in, for example, young writers. In a pilot study using keystroke recordings in fourth graders, we observed that, although all children were highly skilled in using the computer and the mouse, the typing skills of many children were not yet very fluent, which interferes with the process of writing. A method recording handwriting movements is a more suitable technique to examine the writing process in young writers. We, therefore, decided to use this technique in our study.

METHOD

Participants

Fourteen fourth graders (age: $M = 10.2$ years, $SD = 0.6$; 10 girls and 4 boys) and 14 adults (age: $M = 25.3$ years, $SD = 6.0$; 6 women and 8 men), all native speakers of Dutch, participated in the experiment. The children were enrolled in a regular primary school in a small town in the Netherlands. A literacy questionnaire revealed that all children regularly read books ($M = 3.6$ per month, $SD = 2.1$), magazines, or newspapers. All children had a computer at home (and at school), and used it regularly. Thirteen of the 14 children wrote outside school hours: diary ($n = 7$), stories ($n = 5$), letters ($n = 8$), book ($n = 2$), poems ($n = 4$), or songs ($n = 1$). In all, the participating children

read and wrote regularly, both at school and outside school. In the analyses reported later, pause durations of the 4 boys fell within the range of the girls' pause durations. All adult participants were university students or graduates, and received a small fee for their participation.

Materials, Apparatus, and Procedure

All participants were individually tested, in a quiet room. Children were tested at school and adults at the university. Participants first viewed a 3-min video clip without words that showed vignettes of teenagers involved in different social, moral, and physical conflicts. Participants were then asked, in a counterbalanced order, to write a narrative and an expository text. For the narrative text, writers were instructed to write a story about a situation in which they had been involved or an incident they had experienced of interpersonal conflict. For the expository text, writers were instructed to write an essay discussing the issue of interpersonal conflict.

Participants wrote with a wireless electronic ball-point pen on paper that was placed on a digitizer tablet (WACOM Ultrapad A3), connected to a laptop computer. All movement data were recorded and analyzed using the OASIS software package, Version 7.19 (de Jong, Hulstijn, Kosterman, & Smits-Engelman, 1996). This software package has been extensively tested and is widely used in writing research. The data were collected with a sampling frequency of 206 Hz and a spatial accuracy of 0.02 cm.

RESULTS

Linguistic Coding

All texts were transcribed and divided into sentences, clauses, and words. We used Berman and Slobin's (1994) definition of a clause as a unified predicate describing a single situation (an activity, event, or state). For example, the following sentences were divided into two and three clauses, respectively: "*I argued with a girl // because she did not let me play on the monkey bars*" (Ellen, narrative, 4th grade), and "*I tried to explain // why I had done it this way // but he obviously did not agree*" (Jos, narrative, adult). Texts were coded using the CLAN programs of the CHILDES International Child Language Data Base (MacWhinney, 1995).

Clause coding categories were based on the so-called *Standard Dutch Grammar* (Haeseryn, Romijn, Geerts, de Rooij, & van den Toorn, 1997), and comprised six categories: main clause (independent clause with no clause attached to it), coordinate clause, adverbial clause (finite), nonfinite subordinate clause,

relative clause, and nonconjunction connected main clause (being direct speech clauses as in, "He said: '*Go home*' " or main clauses preceded by a subordinate clause; this [rare] category comprised 4.5% of all clauses); for more details on these coding categories, see Verhoeven et al. (2002) and Verhoeven and van Hell (2008).

Pause Coding

Movement trajectories were analyzed using the computer program OASIS (de Jong et al., 1996). To analyze temporal aspects of the writing process, the writing trace of each story was segmented into pauses. Following previous studies on pause duration in writing (Chanquoy et al., 1990; Foulin, 1998; Martlew, 1992), pause time was defined as the time that elapses between the writing of two consecutive words in which the pen does not touch the paper (i.e., the time that elapsed between pen tip up and pen tip down). Because OASIS keeps track of all pen movements on paper, with millisecond accuracy, pause time could be defined to the nearest millisecond.

Every pause was coded relative to its position in the text into one of four pause locations: initial pause of sentence, initial pause of clause, pause before word within a clause (i.e., all pauses except sentence-initial and clause-initial pauses), and pause after clause-linking word.

The following pause times were discarded from the analysis: pause before the first word of the text (prewriting time) and after the final word of the text, pause between the end of a line and the beginning of a new line, pause between a word and a punctuation mark, pause times related to revisions in word or preceding text, and pause times longer than 30 s (6 observations in adult data, 3 observations in 4th-grade data).

Text Length

The mean length of the texts (with standard deviations in parentheses), expressed as the mean number of clauses, for the fourth-grade narrative, fourth-grade expository, adult narrative, and adult expository texts were 15.1 (8.3), 15.6 (6.6), 30.5 (14.7), and 36.0 (17.3), respectively. A 2 (Age: 4th graders, adults) $\times$ 2 (Genre: narrative, expository) analysis of variance (ANOVA) on the mean subject text length, treating age as a between-subject variable and genre as a within-subject variable, yielded only a significant main effect of age, $F(1, 26) = 24.68$, $p < .0001$.

The mean length of the clauses (with standard deviations in parentheses), expressed as the number of words, for the fourth-grade narrative, fourth-grade expository, adult narrative, and adult expository texts were 5.75 (0.91), 5.36 (0.80), 7.12 (0.83), and 7.31 (0.94), respectively. As in the text length analysis,

the 2 (Age) × 2 (Genre) ANOVA on the mean clause length yielded only a significant main effect of age, $F(1, 26) = 43.34$, $p < .0001$.

Pause Duration Analyses

ANOVAs were carried out on the mean pause duration times, treating subjects as a random variable. Because mean pause durations are based on different numbers of observations for a given category (resulting from variations in text length), the number of observations on which the data are based are indicated in the tables. In total, the corpus consists of 5,867 and 2,018 valid pause observations in the adult and fourth-grade data, respectively. Post hoc analysis (Fisher PLSD) was used if appropriate. Alpha was set at 5%.

Genre and syntactic location. In the first analysis, we tested whether pause duration is different in narrative and expository texts, and the extent to which this pattern is qualified by age. A 2 (Age: 4th-graders, adults) × 2 (Genre: narrative, expository) ANOVA was performed on the mean subject pause durations, treating age as a between-subject variable and genre as a within-subject variable. This analysis yielded a main effect of age, $F(1, 26) = 11.547$, $p = .002$. Mean pause duration was longer for fourth graders ($M = 1.134$ s, $SD = .317$) than for adults ($M = 0.807$ s, $SD = .294$). The main effect of genre was not significant. These effects were qualified by a marginally significant interaction between age and genre, $F(1, 26) = 3.653$, $p = .067$; in the adults, pause duration was 0.175 s longer in expository than in narrative texts ($p = .10$); whereas in the children, pause duration was about the same in narrative (1.167 s) and expository (1.100 s) texts ($p = .40$).

In the next two analyses, we examined whether pause duration varies with the syntactic location of the clause. We first compared mean pause durations before the initial words of clauses and before remaining words within clauses, for the narrative and expository texts of each participant (see Table 1). If a participant's cell mean was based on fewer than three observations, this mean was replaced by the corresponding cell mean of all participants in his or her age group. This way, two cell means—of the total number of 28 (participant) × 2 (genre) × 2 (location in clause) = 112 cell means—were replaced. A 2 (Age: 4th-graders, adults) × 2 (Genre: narrative, expository) × 2 (Clausal Pause Location: clause-initial, clause-internal) ANOVA was performed on the mean subject pause durations, treating age as a between-subject variable and genre and clausal pause location as within-subject variables. The mean pause durations are presented in Table 1. The analysis showed a strong effect of clausal pause location, $F(1, 26) = 45.46$, $p < .0001$. Mean clause-initial pause duration was 1.506 s longer than mean clause-internal pause duration. The factor clausal pause location did not interact with age, $F(1, 26) = 1.885$, $p = .18$, or genre, $F < 1$. The remaining

TABLE 1
Mean Pause Durations (in Seconds) Before Clause-Initial and Clause-Internal Words in Expository and Narrative Texts Written by Children and Adults

	Expository		*Narrative*	
Age	*Clause-Initial*	*Clause-Internal*	*Clause-Initial*	*Clause-Internal*
Adults				
M	2.601	0.665	2.208	0.519
SD	2.066	0.219	1.069	0.111
No. of observations	378	2,848	319	2,322
Fourth graders				
M	2.155	0.938	2.198	1.017
SD	0.870	0.242	1.458	0.365
No. of observations	115	887	121	895

effects were not significant either. This analysis indicates that children, as well as adults, paused substantially longer before clause-initial words than before clause-internal words, in both narrative and expository texts.

We added the sentence level in the second analysis, and compared pause duration before sentence-initial, clause-initial, and internal words (see Table 2). It appeared that in 9 of the 14 fourth graders, too few (<3) valid observations of pause duration before sentence-initial words were present in their narrative, expository, or in both texts (see also Foulin, 1998). Often, fourth graders started a new sentence on a new line, rendering the pause duration before the sentence-initial word an invalid observation. We, therefore, decided to constrain this analysis to the adult data (inspection of the 4th-graders' data showed that the pattern of pause duration before sentence-initial, clause-initial, and internal

TABLE 2
Mean Pause Durations (in Seconds) Before Sentence-Initial, Clause-Initial, and Clause-Internal Words of Adults' Expository and Narrative Texts

	Expository			*Narrative*		
Age	*Sentence-Initial*	*Clause-Initial*[a]	*Clause-Internal*	*Sentence-Initial*	*Clause-Initial*[a]	*Clause-Internal*
Adults						
M	4.745	1.163	0.665	3.593	1.119	0.519
SD	3.783	0.834	0.219	1.929	0.646	0.111
No. of observations	133	245	2,848	132	186	2,322

[a]In this table (unlike Table 1), pause durations of clause-initial pauses that are also sentence-initial clauses are excluded.

words was similar to that of the adults). As in the previous analysis, cell means based on fewer than three observations were replaced by the corresponding cell mean of all participants, resulting in the replacement of two cell means. Because sentence-initial and clause-initial words are hierarchically embedded, some clause-initial pauses are also sentence-initial pauses. To discern sentence-initial from clause-initial functions, we followed Foulin's procedure and coded initial pauses according to the highest level. Therefore, a clause-initial pause that was also a sentence-initial pause was coded as a sentence-initial pause. The 2 (Genre: narrative, expository) × 3 (Pause Location: sentence-initial, clause-initial, clause-internal) ANOVA was performed on the mean subject pause durations of the adult texts, treating genre and pause location as within-subject variables. Mean pause durations are given in Table 2. The main effect of pause location was significant, $F(2, 26) = 27.44$, $p < .0001$. Sentence-initial pauses were 3.03 s longer than clause-initial pauses and 3.58 s longer than pauses before clause-internal pauses (both ps $< .0001$). Clause-initial pauses were nearly twice as long as clause-internal pauses; however, the difference failed to reach significance in the post hoc analysis ($p = .30$). The effect of genre and the interaction between pause location and genre were not significant. This analysis substantiates the conclusion that writers pause longer as the syntactic level increases, both in narrative and in expository texts alike.

Clause linkage. In the second series of analyses, we examined temporal characteristics of connecting clauses in writing. In the analyses comparing clause-initial and clause-internal pause durations reported earlier, we found that adults and children pause substantially longer before the beginning of the clause. In speaking, Holmes has observed that adult speakers also hesitate longer (Holmes, 1988) and more often (Holmes, 1995) after clause-linking words (like conjunctions and relative pronouns) compared to other locations within a clause. To test whether this also pertains to the other production mode, writing, and in both children and adults, we compared pause duration after conjunctions and relative pronouns with pause duration at other locations within the clause (see Table 3). As in previous analyses, we replaced pause durations based on fewer than three observations, resulting in the replacement of six cells. A 2 (Age: 4th grade, adult) × 2 (Genre: narrative, expository) × 2 (Pause Location: after clause-linkage word, clause-internal) ANOVA was performed on the mean subject pause durations, treating age as a between-subject variable and genre and pause location as within-subject variables. The resulting means are presented in Table 3. The effect of pause location was not significant, but location did interact with age, $F(1, 26) = 6.134$, $p = .02$. Adults paused a little longer (0.073 s; $p = .10$) after a clause-linking word than after a clause-internal word, but the fourth graders showed the opposite pattern and paused 0.179 s shorter after a clause-linking word ($p = .08$). As in previous analyses, the main effect of

TABLE 3
Mean Pause Durations (in Seconds) After Clause-Linking Words and Before Clause-Internal Words in Expository and Narrative Texts Written by Children and Adults

	Expository		*Narrative*	
Age	*After Clause-Linking Word*	*Clause-Internal*	*After Clause-Linking Word*	*Clause-Internal*
Adults				
M	0.795	0.660	0.531	0.520
SD	0.405	0.224	0.241	0.113
No. of observations	210	2,638	154	2,168
Fourth graders				
M	0.805	0.965	0.872	1.071
SD	0.261	0.279	0.435	0.408
No. of observations	71	816	74	821

Note. The mean clause-internal pause durations in Table 3 differ from those reported in Tables 1 and 2 because, unlike Table 3, clause-internal pause durations in Tables 1 and 2 also include pause durations after the clause-linking word.

age, $F(1, 26) = 16.170$, $p = .0004$, and the interaction between age and genre, $F(1, 26) = 6.003$, $p = .02$, were significant. None of the remaining effects reached significance. In sum, adult writers, unlike fourth-grade writers, paused somewhat longer after clause-linking words than after clause-internal words, but the difference was considerably smaller than the effect observed in adult speakers.

In the final series of analyses, we examined whether pause duration varies with clause type. In these analyses, clause type rather than subject was treated as the unit of analysis because, for some specific clause types, the number of observations was not sufficiently high to reliably use subject-based scores. The average number of observations for a certain clause type for adults and fourth graders is indicated in Table 4.

A first Clause Type × Genre × Age ANOVA revealed no significant main effect of genre, nor any significant interactions with the factor genre. Therefore, we collapsed across genre in the following analysis. A Clause Type (main, coordinate, adverbial, nonfinite subordinate, relative, and nonconjunction connected) × Age (4th grader, adult) ANOVA revealed a main effect of clause type, $F(5, 898) = 8.769$, $p < .0001$. Mean pause durations are presented in Table 4. Post-hoc analyses showed that mean pause duration before main clauses was 1.317 s, 2.213 s, 2.598 s, 2.707 s, and 2.612 s longer than before coordinate clauses, adverbial clauses, nonfinite subordinate clauses, relative clauses, and nonconjunction connected clauses, respectively (all ps $< .0005$ or better). Furthermore, mean pause duration before coordinate clauses was 0.896 s,

TABLE 4
Mean Pause Durations (in Seconds) Before the First Word of Different Clause Types in Texts Written by Fourth Graders and Adults

	Clause Type					
Age	*Main*	*Coordinate*	*Adverbial*	*Subordinate Nonfinite*	*Relative*	*Nonconjunction Connected*
Adults						
M	3.606	1.880	1.288	0.715	0.721	0.794
SD	5.100	3.791	2.234	1.272	1.083	0.923
No. of observations	272	95	180	31	81	23
Fourth graders						
M	3.394	2.740	1.611	1.614	1.439	1.179
SD	4.330	4.506	2.454	2.084	1.467	1.131
No. of observations	66	71	44	12	19	16

1.282 s, 1.391 s, and 1.296 s longer than pause durations before adverbial clauses ($p = .019$), nonfinite subordinate clauses ($p = .045$), relative clauses ($p = .003$), and nonconjunction connected clauses ($p = .051$), respectively. No differences in pause duration were observed among adverbial clauses, nonfinite subordinate clauses, relative clauses, or nonconjunction connected clauses. The main effect of age was not significant, nor was the interaction between clause type and age, indicating that the pattern of pause durations before various clause types was not different for adults and children.[1]

Holmes (1988, 1995) found that speakers paused or hesitated more often before formulating nonrestrictive relative clauses than before formulating restrictive relative clauses. To see whether this is also true for writers, two scorers independently classified relative clauses into nonrestrictive and restrictive ones (because the child data contained only 19 relative clauses, this analysis was performed on the adult data only). They agreed in 88% of the relative clauses, and agreement on classification of the remaining clauses was reached after discussion. The one-factor ANOVA revealed that mean pause duration before writing nonrestrictive relative clauses ($M = 0.822$ s, $SD = 1.388$) was not significantly longer than mean pause duration before writing restrictive relative clauses ($M = 0.643$ s, $SD = 0.784$), $F < 1$.

[1]Because we found that sentence-initial pauses are longer than clause-initial pauses, and because some specific types of clauses occur more often in the sentence-first position (particularly main clauses), we performed the same analysis of variance with sentence-initial pauses excluded. Again, pause durations before main and coordinate clauses were significantly longer than before adverbial clauses, nonfinite subordinate clauses, relative clauses, and nonconjunction connected clauses. The only difference was that pause duration before main and coordinate clauses was no longer significant.

DISCUSSION

In an attempt to extend current knowledge on written language production with some insights into the performance dynamics of writing, we explored cognitive and linguistic processes involved in writing as they unfold in real time by analyzing the location and duration of pauses in combination with linguistics aspects of written texts.

In a first analysis, we examined whether writers' pause duration patterns are different in expository and narrative texts. We argued that the logical argumentative structure of an expository text demands more complex and effortful cognitive operations than the structure of narrative texts, and that writers will thus need more time to plan and decide on what to write next in an expository than in a narrative text. The comparison of overall pause duration in expository and narrative texts revealed that adult writers indeed pause somewhat longer when writing expository texts than when writing narrative texts. In the beginning writers, however, no differences in pause duration in expository and narrative texts were observed. It is interesting to note that linguistic analyses of the final written products in related studies reveal that both children and adults distinguish between genre in their use of genre-specific linguistic forms in expository and narrative texts, although children tend to do so in rhetorically less-sophisticated ways (e.g., Jisa et al., 2002; Ragnarsdóttir et al., 2002; Ravid et al., 2002; Reilly et al., 2005; van Hell et al., 2005). For example, in a parallel linguistic analysis on clause packaging, we found that children used more subordinate clauses in expository than in narrative text and more coordinate clauses in narrative than in expository text, just like the adults did (see Verhoeven & van Hell, 2008). It thus seems that in adult writers, genre appears to affect both the process and product of writing. In beginning writers, genre effects emerge in the product but not (yet) in the process of writing.

This finding corroborates the observations of Chanquoy et al. (1990), who in their youngest writers also observed no differences between descriptive and narrative text endings as measured by prewriting times and pause duration before propositions. They ascribed the absence of a genre effect to the short and oversimplified sentences they had presented for the children to end. However, in our study, children wrote full texts, and we also did not observe a genre effect. An alternative explanation for the absence of genre effects in children's pause time patterns is that the lower level transcription process is highly demanding in children because their handwriting is not yet automatic (Graham & Harris, 2000; McCutchen, 1996; Olive & Kellogg, 2002). As a result, juggling the higher level process of formulation and the lower process of transcribing may be highly challenging to children, and may deplete all cognitive resources (thereby precluding any difference in pause time patterning related to higher level processes to emerge). Although our study cannot rule out this explanation,

we did observe that pause duration varies as a function of grammatical features of the utterance (e.g., longer pause duration before coordinating than before subordinating clauses), in the children and adults alike.

The finding that pause time patterning reflects a sensitivity to grammatical characteristics suggests that lower level motor transcription is not so demanding in the fourth-grade children of our study that it consumes all available resources and precludes any higher level planning and formulation during writing. In all, our data suggest that, for adults, writing a narrative is cognitively less effortful than writing an expository text. Although children use different and genre-specific linguistic forms in narrative and in expository texts, the overall time children need for planning and deciding on the formulation in expository and narrative texts is not (yet) different in beginning writers. In fact, the younger writers' approach to both narrative and expository text writing may more often follow the knowledge-telling model. Skilled writers, on the other hand, have flexible access to both the knowledge-telling model and to the more complex knowledge-transforming model. They can use whichever model is appropriate to the writing task they are facing (Bereiter et al., 1988), and can follow a knowledge-telling strategy when writing a narrative and a knowledge-transforming strategy when writing an expository text.

Both narrative and expository text writing entails planning and formulating what to write next. Our study showed that, in narrative and expository texts alike, pause duration varies as a function of the syntactic pause location: Fourth-grade and adult writers paused longer before sentence-initial than before clause-initial words, and longer before clause-initial words than before clause-internal words. Hence, although overall pause duration was longer in children's than in adults' texts, children, as well as adults, took more time to plan and decide as the syntactic level of the unit increased. These findings parallel Foulin's (1998) findings on writers finishing a report of a personal tour, and those of van Waes and Schellens (2003) on writers writing highly formal texts on banking systems and company regulations. These, and our findings combined, indicate that across various text genres, both beginning and adult writers take more time to plan and decide at higher syntactic levels. This accords with the complexity hypothesis put forward by Clark and Wasow (1998), predicting that the more complex a constituent, the more time language users need to plan it. Indeed, in speaking, Clark and Wasow observed that pause duration and the number of self-repairs increases with the grammatical weight of the hierarchy of constituents of the first word before an utterance. The observed functional hierarchy in pause time patterning in writing indicates that the hierarchy of grammatical units is also an organizing principle in writing, and the writing of fourth graders already reflects an awareness of this principle.

Our finding that pause duration before clauses is longer than within clauses corroborates the notion that the basic clause is an important idea unit in which

writers (Chanquoy et al., 1990; Foulin, 1998) and speakers (e.g., Clark & Wasow, 1998; Hawkins, 1971; Holmes, 1995) encode their thoughts during production. Moreover, when communicating a message, speakers–writers do not express their ideas by simply listing clauses, but express connectivity between their ideas by means of clause-linking devices. To gain more insight into the temporal aspects of syntactic linking of clauses during writing, a topic that received little if any attention in the writing literature, we examined pause time patterns related to the syntactic marking of coordination and subordination. In a first analysis, we examined whether writers not only pause before writing a clause, but also take time to plan their writing *after* they had written down the clause-linking device. Studies on spoken production have indeed found that speakers hesitate longer and more often immediately after clause-linking words compared to later words in clauses (Clark & Wasow, 1998; Holmes, 1995). We found that adult writers, but not fourth-grade writers, pause a little longer immediately after clause-linkage words than at clause-internal words. The magnitude of the effect we observed in writing is, however, substantially smaller that the strong effects observed in speaking. Moreover, the time adult writers paused *after* clause-linking words ($M = 0.663$ s) was notably shorter than the time they paused *before* the same clause-linkage words ($M = 1.251$ s). This indicates that writers, unlike what has been observed in speakers, plan and decide on the contents of the clause mostly before, rather than after, producing the clause-linking device.

Further analyses relating pause duration to different types of clauses suggest that the time writers halt before writing a clause depends on its grammatical and functional (in)dependency. Coordinate and subordinate clauses are both attached to a main clause via conjunctions, but coordinate clauses are autonomous, whereas subordinate conjunctions are grammatically dependent on the main clause and often express information that is dependent on the information supplied in the main clause. We hypothesized that the formulation of ideas a writer wants to convey will take longest in the case of main clauses and will take longer in the case of coordinate clauses than in the case of subordinate clauses. The pause duration analysis showed that writers indeed paused longer before writing main clauses than before coordinate clauses, and also paused longer before writing coordinate clauses than before subordinate clauses. This pattern was observed in both narrative and expository texts. It is interesting to note that this pattern was not only present in the adult writers, but also in the fourth-grade writers. This suggests that the time both beginning and adult writers take to decide on how to express their ideas in syntactically linked clause structures varies with the grammatical and functional (in)dependency of the clause.

In a more detailed analysis, different subordinate clauses were compared, following the notion that some subordinate clauses (i.e., adverbial clauses and

nonrestrictive relative clauses) are functionally less dependent on the main clause and may express information that is as independent as the information expressed in the main clause to which they are attached. Therefore, these subordinate clauses would function as coordinate clauses in being combined with a main clause rather than being embedded within it. We indeed observed that pause duration before adverbial clauses tended to be longer than those before nonfinite subordinate clauses and restrictive relative clauses (see Table 4), thereby following the pattern of results obtained by Holmes (1995) in adults speaking in English or in French. However, the differences did not reach significance, and pause duration before adverbial clauses was still significantly longer than that before coordinate clauses in both adults and children. Furthermore, unlike Holmes's (1995) findings, pause duration before nonrestrictive relative clauses was not longer than before restrictive relative clauses. A possible explanation for these differences, which is in need of further empirical testing, can be found in differences between the spoken and written modality of language production (e.g., Jahandarie, 1999; Van de Water, Monti, Kirchner, & O'Connell, 1987). Speech is contextualized and typically involves discourse partners present at the time of speaking, whereas writing is autonomous. In expressing their ideas, speakers and writers can use the same linguistic forms to express clause linkage. Unlike writers, however, speakers can also use a wide range of prosodic features (including pauses) to indicate nuances of meaning, for example, to set new information apart from old information or to emphasize causal relations, at a more fine-grained level than via the linguistic marking of clause-linking devices alone. This may explain why variations between different types of subordinate clauses surface more clearly in speaking than in writing. Moreover, punctuation in writing may achieve some of the prosodic functions in speech, which possibly explains why we found no difference in pause durations between restrictive and nonrestrictive clauses in writing (as nonrestrictive clauses are officially marked with commas in writing), whereas Holmes (1995) found a substantial difference in pausing and hesitation before restrictive and nonrestrictive clauses in speaking.

To conclude, the study of writing as it unfolds in real time, linked to a coding of linguistic characteristics of the written text, provides new ways to gain insight into developmental patterns in writing. Analyses of the temporal patterning of writers' planning and decision activities indicate that both fourth-grade children and adults take more time to plan and decide at higher syntactic levels, in expository as well as in narrative texts. Although fourth graders use different, and less elaborate, clause-packaging devices to mark coherence relations in narrative and expository texts (Verhoeven & van Hell, 2008), the temporal indices associated with the syntactic marking of clause linkage show that, for fourth graders and adults alike, the time writers take to decide on how to express their ideas varies with grammatical and functional aspects of the utterance.

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