Chapter 9.
Visualising Multilingual Writers' Bursts and Profiles in the Initial Writing Phase

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Introduction

The aims of this chapter are to show how different types of bursts can be used to study the writing process, to offer a new type of burst based on visualisations, and to provide examples of how bursts and visualisations can help identify writers' profiles in the initial phase of writing. This chapter combines theory with term definition to present an empirical study that uses a visualisation tool in a data-driven way.

Writing process research seeks to understand the cognitive processes that underlie final output by examining the actions that take place during the writing process. Such studies may focus on different elements and have specific purposes. For instance, fluency features, including automatically processed linguistic elements (e.g., multiword sequences; Perez-Bettan, 2015; Wray, 2002), and disfluency features, such as pauses and revisions (Baaijen & Galbraith, 2018; Cislaru & Olive, 2018; Ellis & Yuan, 2004), may be investigated. Fluency in writing is a cognitive process that can be studied through the relationships between uninterrupted text production – also known as **bursts** (i.e., an index of fluent writing) – pauses, and revisions (Cislaru & Olive, 2018). Pauses tend to be more frequent, and bursts tend to be shorter in second language (L2) compared to first

language (L1) writing (Chenoweth & Hayes, 2001). Following conventions in writing research, we adopted a pause threshold of ≥2 seconds for **cognitive pauses** when studying bursts, as this pause length is considered a mental preparation of the text from a psycholinguistic point of view (Cislaru & Olive, 2018). This was the threshold set in the visualisation tool used in the current study.[1]

Using **keystroke logging (KSL)** programmes such as ScriptLog and InputLog offers possibilities to study linear text production, but it can be difficult for someone unacquainted with the method to decipher the depicted linearity of the writing process. Therefore, it can be useful to illustrate various aspects of the writing process to examine how it progresses, how writers construct texts, and what strategies are used to transform ideas and thoughts into coherent linear texts (cf. Cislaru & Olive, 2018). To respond to the need to illustrate writing processes more clearly, the keystroke logging software GenoGraphiX-Log (GGXLog) was created using a graph theory-based visualisation tool (i.e., a progressive graph tool), allowing for **visualisation** of the writing process at various stage of the writing session (Caporossi & Leblay, 2015; Usoof et al., 2020). In this chapter, we theoretically discuss how bursts can be identified using GGXLog (Caporossi & Leblay, 2015). This tool allows for more detailed and illustrative analyses of writing processes that are accessible to different audiences, including learners, teachers, and researchers (see, e.g., Mutta & Laine, 2022). Visualisations and learning analytics are often used in education to help learners understand complex themes or phenomenon (Vieira et al., 2018), for instance, visual models representing contexts of practices and attitudes (Storto et al., 2023) or process graphs illustrating the dynamics of the writing process (Leblay et al., 2015, 2022) or displaying different sources used during the process (Kruse, 2024).

This chapter concentrates on the initial phase of writing, meaning the title and the first sentence ending with a punctuation mark. This choice was made for two reasons. First, we wanted to discuss the definition of "bursts" according to different criteria and to provide our own definition. Bursts can include the linguistic material produced between pauses (**P-bursts**) or between pauses and revisions (**R-bursts**), as well as other actions (e.g., a mouse or arrow-key movement) away from the leading edge (**I-bursts**; Baaijen & Galbraith, 2018; Cislaru & Olive, 2018; Conijn et al., 2021). Our definition is based on the visualisations made by GGXLog. Due to the nature of the GGXLog visualisation tool, it was reasonable to illustrate only the beginning of the writing process (see the next section and (Chapter 2 by Basnayake & Usoof and Chapter 3 by Caparossi et al. in this book), as visualisations based on longer productions were too complex for our analysis purposes. Second, we wanted to study how fluently writers begin a text during spontaneous sentence production with no materials (i.e., dictionaries) other than the task assignment and their mental lexicon, which reflects their implicit understanding of the topic (Baaijen & Galbraith, 2018).

The empirical case study focuses on writers' profiles in the initial writing phase and the production of bursts, which indicate fluent text production. In spontaneous text production, writers seem to make relatively short pauses and bursts (Baaijen & Galbraith, 2018). Writer profiles have been studied in relation to writing processes and certain features. For instance, some researchers have distinguished between **writing profiles** that describe structural variability and the organisation of processes and **writer profiles** that are specific to individual writers (Van Waes, 1992; see also Mutta,

[1] The GenoGraphix-Log programme uses this default threshold, but it can be modified according to study purposes.

2020; Mutta & Laine, 2022; Van Waes & Schellens, 2003).[2] These two profiles seem to intertwine on several points; therefore, in the present chapter, the term writer profile is used to describe writers' behaviours, including bursts and pauses as well as text production when writing on a computer. The empirical aspect of this chapter examines fluency in university-level, first language (L1) Finnish writers' (n = 30) writing processes in three second languages (L2s): English, French, and Swedish. All the examples were taken from this data.

Defining Bursts: Comparing Linear Text and Visualisations

In this section, we compare different ways of identifying various types of bursts (i.e., P-bursts, R-bursts, I-bursts; Baaijen & Galbraith, 2018; Cislaru & Olive, 2018; Conijn et al., 2021) and examine how a visualisation tool can help define them and reveal differences in L1 and L2 writing fluency. As explained in Chapter 5 (Cislaru et al. in this book), studies using log files record various process-related data, such as the time and occurrence of each keystroke, enabling an examination of different phases of the writing process (Spelman Miller et al., 2008). Compared to other KSL programmes, GGXLog enables a more detailed analysis of writing processes at various stages, as it combines log files and linear text analysis with a progressive graph tool. The tool represents a writing session as **nodes** (vertices) and **edges** (links); each node is a cluster of continuous events (e.g., inserted, appended, or deleted text, or a pause), and each edge represents relationships between nodes, such as chronological order, flow in the final text, or deletions (Caporossi & Leblay, 2015; Usoof et al., 2020, p. 27, 38). Comparing linear texts and visualisations provides a more comprehensive understanding of how the writing process starts and what strategies are used to construct a text.

In earlier studies in which writers created texts using pen and paper, average burst length was calculated in words – more experienced writers averaged 10–12 words, while less experienced writers averaged 5–6 words (Kaufer et al., 1986) – and the delimiting criterion was a pause of two or more seconds (Chenoweth & Hayes, 2001, p. 83). In studies examining typing on a computer, burst type is defined based on the nature of the interruption of the writing process at either end of the burst (Conijn et al., 2021). According to Baaijen and Galbraith (2018), P-bursts (*pause bursts*) begin and end with a cognitive pause (≥2 secs) and represent a text production without modifications (e.g., revisions or deletions; see also Hayes, 2009). The GGXLog programme illustrates a P-burst only when no revisions were made by the writer and when the burst starts and ends with a pause. Figure 9.1 shows a case in which the linear text and the visualisation align, as the writer's actions included only bursts (nodes 1 and 3) and pauses (node 2). It is notable that a mouse event started the process, which is illustrated with a green node (= event 0). In the GGXLog programme, when the cursor is placed on the progressive graph, it is marked with node 0 [START], indicating the starting position of the graph. In the linear text, the numbers in angle brackets indicate the length of pauses in milliseconds. In the visualisation, the green nodes represent pauses, and the red nodes represent

[2] Van Waes and Schellens (2003, pp. 836–837; see also Van Waes, 1992) proposed a typology of five writer profiles: initial planners, fragmentary first-phase writers, second-phase writers, non-stop writers, and average writers. This last category is omitted in some studies (see, e.g., Mutta, 2020).

text insertion. The final pause is not included in either the linear text or the illustration, as a punctuation mark came before the pause.

Table 9.1 - Example of GGXLog's different presentation tools (ID 2019, L2 Swedish, C1 level).

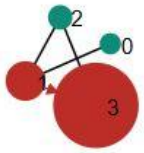
Final text	Linear text	Visualisation
Jag tycker att det är inte lika viktigt längre att ha körkort. I think it is not as important anymore to have a driving licence.	<MOUSE EVENT>Jag tycker att det är <2135>inte lika viktigt längre att ha körkort.	

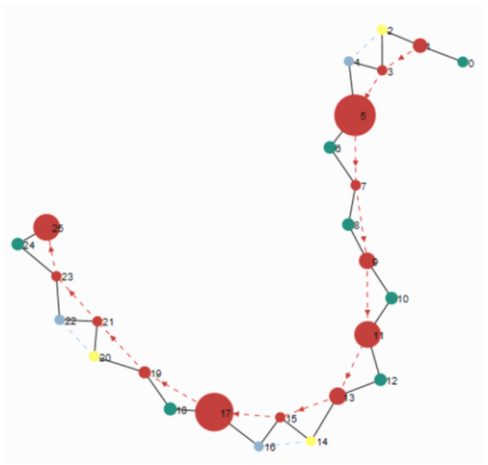
Table 9.1 illustrates a student's (ID 2019) entire initial phase (i.e., the first sentence in its final form) alongside the linear text and its visualisation; the student did not write a title at the beginning of the session. In this study, the analysis focuses on the visualisation and the linear text; thus, the final text has been excluded from all other examples provided to highlight the production of bursts during the writing process.

The orthographic correction of a few letters is considered a revision.[3] It is rare that a writing process is entirely free of orthographic or content-related corrections and there are no revisions or deletions. Some learners primarily use the strategy of pausing and then producing text, meaning they mentally plan the text before writing it down all at once. This occurs especially when a learner is reliant on the use of multiword sequences comprising words or other units stored in memory as single units and retrieved automatically (e.g., "bring to one's attention"), which can enhance the flow of writing (Tavakoli & Uchihara, 2020; see also Mutta et al., to appear). Table 9.2 illustrates a case in which P-bursts consist of a compound word and a multiword sequence ("Student exchange" and "was brought to my attention", respectively), which alternate with pauses from nodes 6–12. These words are bolded. The blue and yellow nodes represent deletion by backspace or other methods (see Usoof et al., 2020, p. 25; see also Chapter 3 by Caparossi et al. in this book). It is important to note that revisions by backspace occurred in other places in the linear text.

Table 9.2 - Example of P-bursts alternating with pauses (ID 2013, L2 English, B2 level, time 01:32).

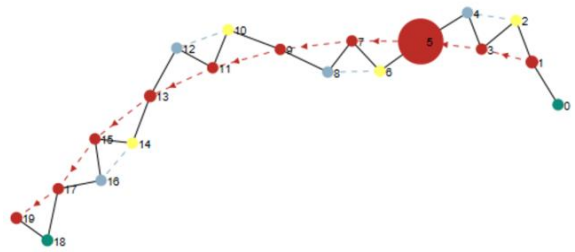
Visualisation	Linear Text

[3] When writing by hand, P-bursts are likelier to contain more complete words due to the use of a pen or pencil (i.e., there are usually fewer mistakes; Kaufer et al., 1986).

	<MOUSE EVENT>Student exchanf<BACKSPACE>ge and its advantages and disadvantages<2672> <RETURN><RETURN>**<7153>Student exchange <2017>was brought to my attention** <2545>in highschool and i<BACKSPACE>I had a few friends who would go and <14545>study for a <BACKSPACE3> <5666>about a year and come back.

R-bursts (*revision bursts*) are more typical than P-bursts during the writing process. They end with a revision at the leading edge (Baaijen & Galbraith, 2018; Conijn et al., 2021; Hayes, 2009), but existing definitions do not specify how the bursts begin. GGXLog delimits an R-burst as an activity starting with a pause and ending with a revision, starting with a revision and ending with a pause, or terminated by revisions on both sides. Table 9.3 illustrates an example that includes several R-bursts.

Table 9.3 - Example of R-bursts in text production (ID 2017, L2 English, B1 level, time 00:40).

Visualisation	Linear Text
	<MOUSE EVENT>Student exchange <RETURN><RETURN><BACKSPACE2> - is it worth it?<RETURN><RETURN>I have always been interested in global issues, multiculturalism <BACKSPACE>, <BACKSPACE2> and exchanginf <BACKSPACE2>g <3153>cultures. I

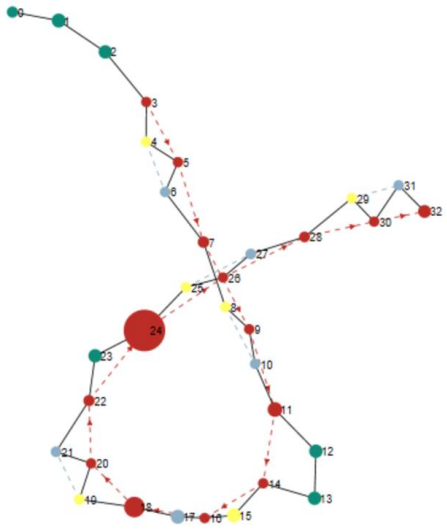
In this example, the first cognitive pause <3153> occurs just before the final word (*cultures*) of the first sentence. The learner wrote quickly, completing the sentence in only 40 seconds. The only pause was short, and the deletions were typing corrections. This writer was thus considered to have a fluent writing process (see also Table 9.10). The illustration of the R-bursts details what occurred between cognitive pauses and how the writer started the text; however, analysing only P-bursts without modifications can lead to a great deal of information about the writing process being lost.

Whether it is meaningful to study only P-bursts or to include revisions and modifications is dependent on a study's objectives (see, e.g., Cislaru & Olive, 2018).

According to Baaijen and Galbraith (2018), I-bursts (*insertion bursts*) start with a mouse or arrow-key movement followed by text production, all of which move away from the leading edge of the current writing point. It is rare to find I-bursts in the initial writing phase; the exception is writers who make an explicit plan and then insert text into this plan (for an example, see Table 9.6 in Section 4; inserted node colour, nodes 17–26).

In earlier studies relying on linear text, researchers (see, e.g., Mäntylä et al., 2020) examined P-bursts and accepted some typing corrections (e.g., one to two backspaces) when defining burst length. The challenges of such delimiting criteria include how many backspace deletions are accepted without impacting the flow of writing and at what point a text is no longer produced automatically and efficiently – that is, fluently (cf. Mutta, 2020). Table 9.4 exemplifies such a case.

Table 9.4 - Example of pauses and revisions in text production (ID 2011, B2 level, time 01:11).

Visualisation	Linear text
	<12594><MOUSE EVENT><6952>T<BACKSPACE>Studeny<BACKSPACE>t Exchange<RETURN><RETURN> <4704><3329>Start<RETURN><RETURN>I thi<BACKSPACE11>tudent exhange can be <BACKSPACE3>be a <3473>fun and insighful period in a studne'<BACKSPACE3>entä<BACKSPACE>'s life.

This writer started slowly, writing a title surrounded by pauses and followed by small typing corrections. After the title (*Student exchange*), there occurred a sequence of several backspace deletions (11 and 3). Revisions are often accompanied by pauses of different lengths (see, e.g., Cislaru & Olive, 2018; Mutta, 2020); however, in this example, the pauses were not closely related to revisions. This leads to the question of whether such corrections should be interpreted as not interrupting the flow of writing or if ending with a change of structure impacts the cognitive process. An advantage of using GGXLog is that all revision events are analysed in the same way, and visualised bursts are easy to recognise. Thus, the analysis is systematic, and the difference between

automatic typing corrections (i.e., one or two letters) and longer strategic revisions is ignored. Furthermore, the GGXLog visualisation tool does not define I-bursts (i.e., contextual insertions) separately, as all revisions and pauses are addressed in the same way.

The examples in Tables 9.2–9.4 indicate that analysing R-bursts and visualising revisions provide valuable information about how the processes reinforce each other. P-bursts reveal what learners process as an entire unit between cognitive pauses, whereas R-bursts show the problematic places where learners correct and revise a text sporadically, often, or systematically, which may also reveal a lack of keyboarding skills.

The earlier definitions of the different types of bursts are partly in line with our definition. However, the criteria of the earlier definitions, including where and how bursts start and end, are not always clear. GGXLog enables bursts to be defined precisely by consistently using the same criteria. In the present study, a new type of burst based on the GGXLog analysis is introduced: ***visualisation bursts*** **(V-bursts).** These are defined according to the visualisations produced by the GGXLog tool, and the graphical representation includes seven possible types of nodes: append, insert, removed, deletion, displaced, copy and pause. Figure 9.1 shows the criteria settings; for instance, uncategorizable pauses are listed as "unknown" (see Usoof et al., 2020, pp. 27, 32, 42; see also Chapter 2 by Basnayake & Usoof in this book).

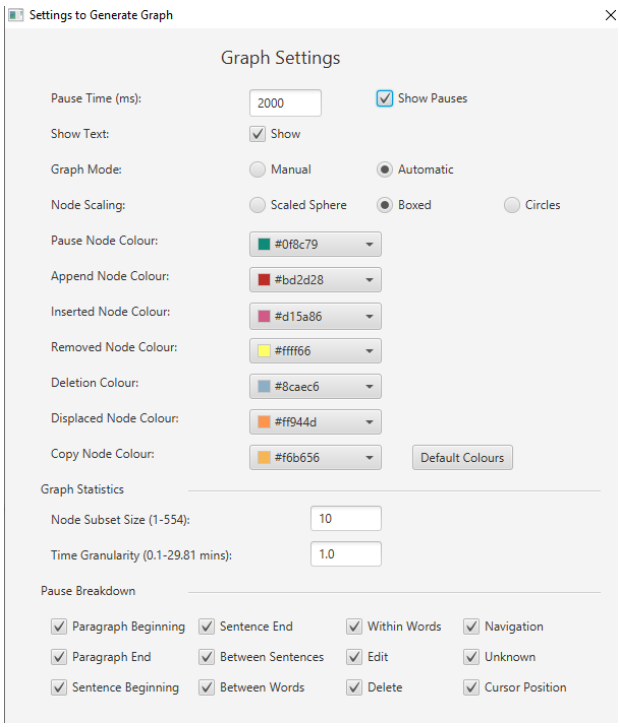


Figure 9.1 - Criteria for V-bursts in GGXLog.

As mentioned, studying bursts according to previous definitions is appropriate in different contexts. The following demonstrates how V-bursts can be used to study writer profiles. With the help of V-bursts and visualisations (see Section 4), we were able to identify various writer profiles in the initial

phase – in other words, how the writers started a text during spontaneous text production. Before presenting these profiles, we present the empirical data.

University Students' L1 and L2 Writing Processes – A Case Study in Finland

The empirical data were collected at a university in Southern Finland in 2021 and 2022 following the EU's General Data Protection Regulation (GDPR) and with consideration for the anonymity of the students, all of whom participated voluntarily. The data are a part of the KISUVI project[4], a larger body of research on writing fluency and the use of multiword sequences. For the current study, 30 students were recruited from various degree-programme courses in English, French, and the Scandinavian languages. Prior to data collection, the students completed a questionnaire addressing background information and language repertoire, and they gave their informed consent to participate in the study. The students were considered multilingual, as their language repertoires included one to three L2s in addition to their L1 (Finnish). They all studied L2s as their major or minor at the university level.

The students wrote two argumentative texts on a QWERTY keyboard with Finnish layout. There were three possible language combinations: Finnish–English, Finnish–French, and Finnish–Swedish. Thus, the students wrote one text in Finnish (n = 30) and the other in English (n = 10), French (n = 10), or Swedish (n = 10). Each writing task consisted of a 30-minute spontaneously written text with no extra tools (e.g., dictionaries). The students were asked to provide a title for their text; however, it is important to note that some of the students may have added their title later and not during the initial phase of the writing process. The students first wrote a text in one language; after a short pause, they wrote a text in their other language. The order of the languages of writing was counterbalanced, that is, some students wrote first in L1, some others in L2. Topics were chosen based on the writers' familiarity with the topic in their everyday lives in the Finnish context (cf. Baaijen & Galbraith, 2018). The task assignments were short and always the same: "Write

[4] The KISUVI project is funded by the Kone Foundation (2022–2026) and focuses on multilingual writers' writing processes, especially formulaic sequences and fluency patterns in writing (https://sites.utu.fi/kisuvi/en/).

a short argumentative text in your L1/L2. Title your topic." However, due to the study design of the KISUVI project[5], the topics varied as follows:

L1 Finnish: Mitä mieltä olet töiden tekemisestä opiskelun ohessa? Mitä hyviä ja huonoja puolia siinä on? (*What do you think about working while studying? What are the advantages and disadvantages?*)
L2 English and L2 French (*same topic*)*: Qu'est-ce que vous pensez des études en échange? Quels sont les avantages? Quels sont les inconvénients?* (*What is your opinion on student exchange? What are the advantages? What are the disadvantages?*)
L2 Swedish: Tycker du att det är viktigt att ha körkort? Vilka för- och nackdelar finns det med att ha bil? (*Do you think it is important to have a driver's licence? What are the advantages and disadvantages of having a car?*)

The L2 texts were evaluated by two project researchers; a third evaluator was invited in case of disagreement. For comparability, we excluded the lowest (A1–A2 in L2 French) and highest (C2 in L2 English) levels (for a comparison of the role of proficiency level in the initial phase, see Mutta et al., to appear). Only productions written by students at the intermediate or advanced levels (B1–B2–C1) according to the Common European Framework of Reference for Languages (CEFR; Council of Europe, 2001) were included to ensure adequate proficiency levels for our purposes (see Table 9.5).

Table 9.5 - Number of writers at each CEFR level in English, French, and Swedish.

Language	B1	B2	C1
English	1	5	4
French	6	3	1
Swedish	1	5	4
Total	8	13	9

The proficiency levels of the L2 French students were generally lower than those of the other language groups. In Finland, English is studied by over 90% of learners as their first L2, while Swedish is the country's second official language and thus obligatory for Finnish-speaking students

[5] In the KISUVI project, the L1 topic was always the same, and the L2 topic was the same if two languages were used; however, for three languages, the third language had a different topic. For instance, the Finnish–Swedish group wrote texts in three languages (Finnish, English, Swedish); thus, the topic in Swedish differed from that of English and French. In the current study, the English texts written by the Finnish–Swedish group were excluded from the analysis, as only two-language combinations were examined.

at school; however, the number of pupils studying additional languages, such as French, is low (Finnish National Agency for Education, 2019).

The following section examines how the students began to write their texts, the writer profiles that were identified based on their burst behaviour, and how visualisations can help identify writers' profiles in the initial phase of writing.

Writer Profiles and Visualisations of Bursts in the Initial Phase of Writing

Often, researchers examine limited criteria for creating writer profiles as part of a larger analysis. For example, one case study relied on time spent writing, number of words, and percentage of cognitive pauses (≥2 seconds) throughout the entire writing process to study writers' fluency (Mutta & Laine, 2022). Based on these criteria, three participants' L1 (Finnish) and L2 (French) writings were compared. The analysis showed that two of the writers had the same profiles in their L1 and L2: one was a fragmentary and one was a non-stop writer (cf. Van Waes, 1992; Van Waes & Schellens, 2003). The latter was due to the writer using the 10-finger typing method and being highly proficient in their L2 (French). The third writer was a non-stop writer in their L1 and a fragmentary writer in their L2. This was related to the fact that the writer was accustomed to writing texts in their L1, but their L2 proficiency level was relatively low.

As language learners use various strategies to achieve diverse communication goals, there is a need for more thorough analyses of learner profiles, for instance, comparing language learners' own profiles in their L1 and L2 instead of comparing L2 production with production by native users (see, e.g., Lintunen et al., 2020). Furthermore, mixed-methods studies should be conducted to increase teachers' and researchers' understanding of L2 writing processes (cf. Révész et al., 2022). In a fluency study (Mutta et al., 2025), the spoken and written L1 and L2 productions of 11 university-level students were compared to create a more comprehensive picture of L2 English students' fluency profiles. The written products and processes were objectively measured based on time spent on the writing process, word count, words per minute, mean length of bursts, pause time (% of cognitive pause ≥2 seconds), deletions (percentage of characters), and product-to-process ratio. The data collection and analysis of written productions were conducted using the GGXLog programme. As there are no earlier studies that compare different modes of fluency, the researchers used a data-driven method to identify different categories. With regard to writing, four different fluency profiles (Mutta et al., 2025) were derived: fast and productive, fast, slow but productive, and slow and reflective[6] The study found that seven out of 11 writers had the same profile in their L1 and L2.

Similarly, the research of the current chapter also used a data-driven method. New criteria for analysing writer profiles were created, as the focus was on the initial writing phase instead of the entire process. Our measures, which were based on V-bursts and visualisations, included number and content of events (e.g., bursts, deletions, pauses), number of nodes, and time spent until the end of the first sentence ending with a punctuation mark. Each researcher categorised the productions separately, after which we created the final categorisations in discussion together. Using this data-driven method, six writer profiles were identified: **explicit planner, implicit planner,**

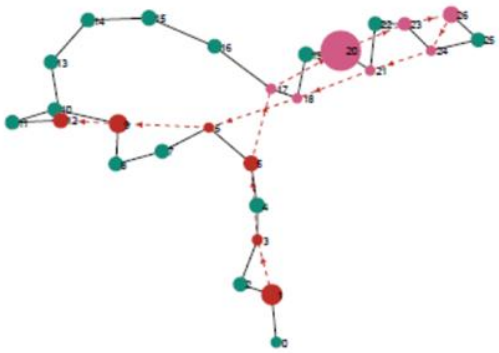
[6] The study examined fluency across modes by the same participants. For the spoken results, see Mutta et al. (2025).

slow starter, tentative starter, quick starter, and quick and productive starter. Tables 9.6–9.11 exemplify the different profiles, including illustrations and the linear texts of the data. The GGXLog analysis tool explicitly shows the number and content of bursts (see the Session Bursts and Parameters file; Usoof et al., 2020), and a progressive graph illustrates the writing process node by node (see the Representation of Progressive Graph; Usoof et al., 2020). The progressive graph cannot present the content of all the nodes at the same time, as the content only becomes visible in the programme when you place the cursor on the node. For this reason, the linear text has also been included.

Explicit planners started with (a title and) a plan. It usually took them time to complete the first sentence, and sometimes text was inserted into the middle of their plan. In Table 9.6, inserted node colour alternates with pauses, between nodes 17–26 (according to earlier studies, this would be defined as an I-burst; see Section 2). There were often many writing process events (e.g., a sequence of inserted, appended, or deleted characters, or a pause in the writing; Usoof et al., 2020, p. 27); however, some writers planned quickly and briefly.

Table 9.6 - Explicit planner.

Example: ID 2031 (L2 Swedish, B2, time 02:35)



<MOUSE EVENT><RETURN>Är det viktigt <2267>att <23466><MOUSE EVENT>ha körkort?

<RETURN> <RETURN><2342><6144><MOUSE EVENT>Förnackdelar <2988> <2089><MOUSE EVENT>att ha bil?<5032><4877><MOUSE EVENT><12055><MOUSE EVENT><MOUSE EVENT> <2335><MOUSE EVENT> <RETURN><RETURN><51183>Jag tycker att trafik är nä<3520>stan som <4075>grupparbet. <11190>

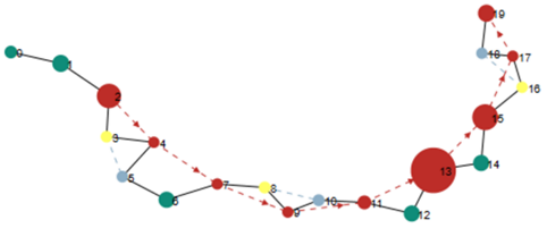
Translation

<MOUSE EVENT><RETURN>Is it important <2267>to <23466><MOUSE EVENT>have a driver's licence?<RETURN> <RETURN><2342><6144><MOUSE EVENT>Benefits <2988> <2089><MOUSE EVENT>of having a car? <5032><4877><MOUSE EVENT><12055><MOUSE EVENT><MOUSE EVENT> <2335><MOUSE EVENT> <RETURN><RETURN><51183>I think traffic is the cl<3520>osest thing to <4075>group work. <11190>

Implicit planners started slowly (with long pauses), which suggests that they created a mental plan. Their first sentence was completed quickly, and there were few corrections in the output after the

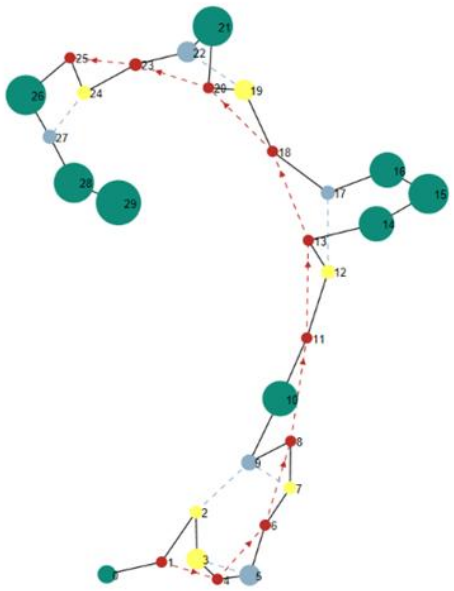
start. Long bursts distinguished these writers from slow starters. In Table 9.7, R- and P-bursts are differentiated in the linear text, while all V-bursts are illustrated as red nodes.

Table 9.7 - Implicit planner.

Example: ID 2012 (L2 English, B2, time 00:48)	
	<MOUSE EVENT><11961>Student exchange gi<BACKSPACE2><3553>is <BACKSPACE3>can be <3361>viewed as a richness in the <4657>highger education v<BACKSPACE>community.

Slow starters began slowly and took a long time (more than five minutes) to complete the first sentence. There were a considerable number of pauses and few long bursts in these writers' process. Lengthy revisions were common; therefore, output was scarce, although a lot of time was spent on the initial writing phase. The visualisation in Table 9.8 highlights the role of pauses (green nodes) during the initial phase compared to the linear text presentation.

Table 9.8 - Slow starter.

Example: ID 2005 (L1 Finnish, time 05:07)	
	<MOUSE EVENT>jbhhhhhh<BACKSPACE6>r<BACKSPACE4><2675> h<3534><15642><MOUSE EVENT><2024><BACKSPACE5>mmmmmm<33707><BACKSPACE13> mmn<27233><BACKSPACE3><13221> <MOUSE EVENT><148334><MOUSE EVENT><BACKSPACE3>y<DOWN><5632><MOUSE EVENT><BACKSPACE><DOWN><8174> <RETURN> m<BACKSPACE> <22457>Ennen opintojen alkamista mietin, että muutama vuoro vaikkapa lähiaku<BACKSPACE3>kaupassa <MOUSE EVENT>viikossa, <MOUSE EVENT>, onnistuisi mainiosti<2060> ja <2946><BACKSPACE4>. Sen myötä olisi myös

Translation

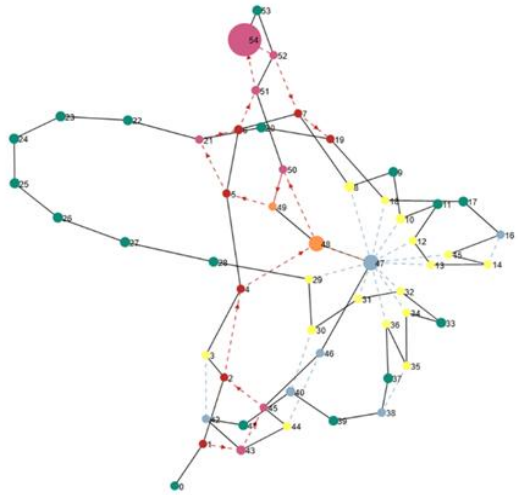
<MOUSE EVENT>jbhhhhh<BACKSPACE6> r<BACKSPACE4><2675> h<3534><15642><MOUSE EVENT><2024><BACKSPACE5>mmmmmm<33707><BACKSPACE13> mmn<27233><BACKSPACE3>

<13221><MOUSE EVENT><148334><MOUSE EVENT><BACKSPACE3>y<DOWN><5632><MOUSE EVENT><BACKSPACE><DOWN><8174><RETURN> m<BACKSPACE> <22457>Before starting my studies I was wondering, that a few shifts in, say, a convenience store<BACKSPACE3>in <MOUSE EVENT>week, <MOUSE EVENT>, would be fine<2060> and <2946><BACKSPACE4>. It would also

Tentative starters typed and revised the beginning of the text multiple times; therefore, there were many events involved in writing the first sentence. The writers started fairly quickly and planned during text production rather than prior to beginning. These writers did not spend much time writing the first sentence. The visualisation in Table 9.9 illustrates the fragmentary nature of text production. It is worth noting that if only P- or R-bursts were studied, a lot of process-related information would be overlooked.

Table 9.9 - Tentative starter.

Example: ID 1003 (L2 French, B1, time 03:05)



<MOUSE EVENT>Porraient les études <2289>en échange<2769> - P<BACKSPACE3>

<7488><RETURN><RETURN><18457><MOUSE EVENT>u<3379><14865><15003><11060><15001><15000><7966><MOUSE EVENT>aggraver <4354>les <3554><3217><BACKSPACE13><4377>

<MOUSE EVENT><BACKSPACE>Comment le<BACKSPACE2><RIGHT10><MOUSE EVENT><CUT><MOUSE EVENT><PASTE>p<MOUSE EVENT> être <2705>une mauvaise chose.<RETURN><RETURN>C'est commun que les é

Translation

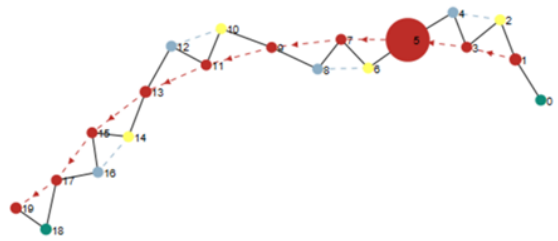
<MOUSE EVENT>Would studies <2289>in exchange<2769> -. P<BACKSPACE3><7488>

<RETURN><RETURN><18457><MOUSE EVENT>u<3379><14865><15003><11060><15001><15000>

<7966><MOUSE EVENT>aggraver <4354>les <3554><3217><BACKSPACE13><4377><MOUSE EVENT><BACKSPACE>How the<BACKSPACE2><RIGHT10><MOUSE EVENT><CUT><MOUSE EVENT><PASTE>p<MOUSE EVENT>be <2705>a bad thing. <RETURN><RETURN>It's common for e

Quick starters began quickly (a pause of under two seconds or no pause at all), and the first sentence was short. Writing time was less than a minute, and there were few events and corrections. The visualisation in Table 9.10 shows a number of short V-bursts, one larger V-burst, and no pauses. All corrections made were backspaces and are clearly visible in the illustration. In earlier studies, this kind of production would have been considered a single P-burst with some typos (Mäntylä et al., 2020).

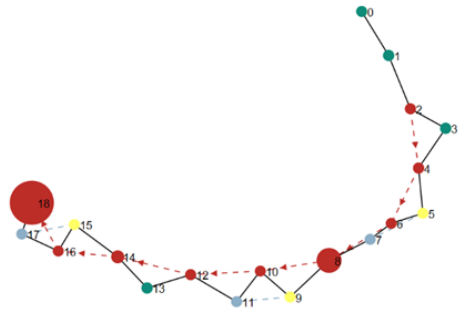
Table 9.10 - Quick starter.

Example: ID 2017 (L2 English, B1, time 00:40)	
	<MOUSE EVENT>Student exchange <RETURN><RETURN><BACKSPACE2> - is it worth it?<RETURN><RETURN>I have always been interested in global issues, multiculturalism <BACKSPACE>, <BACKSPACE2> and exchanginf <BACKSPACE2>g <3153>cultures. I

Quick and productive starters began quickly and produced a lot of text with few corrections or pauses. With regard to the number of characters, these writers were productive in a fairly short time. The visualisation in Table 9.11 shows V-bursts starting and ending with pauses or revisions.

Table 9.11 - Quick and productive starter.

Example: ID 2019 (L1 Finnish, 00:54)



<MOUSE EVENT><3609>Töiden<3114> tekeminne<BACKSPACE2>en opintojen ohella<RETURN><RETURN><RETURN>Töiden tekeminen opintojen ohella on aihe, jotai<BACKSPACE> olen <2405>pohtinut viime aikoina todl<BACKSPACE>ella paljon. Aluksi tein töitä, sillä olin ollut kaupassa jo aiemminkin, ja minun oli loogista tienata hima

Translation

<MOUSE EVENT><3609>Working<3114> alongside your<BACKSPACE2> studies<RETURN><RETURN><RETURN>Working alongside your studies is a topic that<BACKSPACE> I've been <2405>thinking about a lot lat<BACKSPACE>ely. At first I worked because I had been in the shop before, and it was logical for me to earn some money.

After categorisation, the writers' L1 and L2 profiles were compared. The majority (21 participants) had different profiles in their L1 and L2, while nine had the same profile in both languages. The number of each type of L1 and L2 starter profile is shown in Table 9.12.

Table 9.12 - Number of starter writer profiles in L1 and L2.

Profiles	L1 n = 30	L2 n = 30
Explicit planner	3	4
Implicit planner	2	3
Slow starter	3	0
Tentative starter	8	16
Quick starter	11	7
Quick and productive starter	3	0

Table 9.12 reveals some language-related tendencies. For example, there were more tentative starters in L2 than L1 and more quick starters in L1 than L2. Furthermore, all quick and productive starters were L1 writers, but all slow starters were also L1 writers. The visualisation tool contributes

to profiling writing processes, as it makes the different profile types easy to recognise (e.g., tentative and slow starters).

Discussion and Conclusions

This chapter defined and discussed different types of bursts, with visualisations of the data provided by the GGXLog programme. Bursts, which represent fluency in the writing process, can be defined in various ways depending on the purpose of a study. Previous studies have included three main types of bursts: P-bursts, R-bursts, and I-bursts (e.g., Baaijen & Galbraith, 2018; Cislaru & Olive, 2018; Conijn et al., 2021; Hayes, 2009). Studying P-bursts allows researchers to examine what writers are able to process with regard to whole units, specifically between cognitive pauses (≥2 seconds). P-bursts are unmodified, as corrections and revisions are ignored; however, they may contain a number of single characters (e.g., punctuation marks) when the writing is being done on a computer (see, e.g., Cislaru & Olive, 2018). Thus, depending on a writer's typing skills, there may be few multiple-word bursts (e.g., Van Waes et al., 2021).

In studying writing processes, P-bursts may be analysed alongside R-bursts. R-bursts allow researchers to study problem areas in the writing process, as they highlight corrections and revisions and reveal elements that writers miss or correct. Analysing I-bursts, which are bursts starting with a mouse event or arrow key that is not situated at the leading edge of the current writing point, helps researchers evaluate sentence linearity and distinguish between bursts that are inserted into a text and bursts that occur during forward text production (Baaijen & Galbraith, 2018, p. 208). Unless a writer makes an explicit plan and continues producing text within that plan, there are generally fewer I-bursts in the initial phase of writing.

With the GGXLog programme, these three types of bursts can be studied using the visualisation and linear text tools. However, it can be difficult to decide which elements should be included in the bursts and how many corrections might be due to typos, which do not necessarily influence the flow of writing (cf. Mäntylä et al., 2020). Indeed, a writer can be efficient and productive, even without 10-finger-typing capability and when constantly correcting typos. Thus, earlier definitions of bursts are useful but sometimes lack systematicity with regard to distinguishing criteria. This led us to create a new type of burst, V-bursts, based on visualisations provided by the GGXLog tool, in which bursts are limited by several different events (e.g., append, insert, removed, deletion, displaced, copy, and pause). The definition of these bursts always follows the same criteria, thereby enabling more precision (see Figure 9.1). However, this definition is limited, as research categories are dependent on the tools utilised and their exploitation. Every research design is limited by different measures and assumptions, and our definition of a V-burst proves that it is important to pedagogically and methodologically study all kinds of bursts. The use of other visualisation tools provided by GGXLog, such as pause graph analysis, linear text, and statistics, would be required to conduct a detailed and complex analysis of the entire writing process (cf. Usoof et al., 2020).

This chapter also analysed how Finnish writers began the writing process in their L1 and in three different L2s (English, French, and Swedish) during spontaneous sentence production without extra materials (i.e., dictionaries); thus, they could only rely on their existing understanding of the topic (Baaijen & Galbraith, 2018) and the task assignment. Writer profiles for L1 and L2 writers during the initial writing phase were created based on how fluently text production began under these

conditions. With the help of V-bursts and the visualisation tool and based on several measures (i.e., number and content of events, number of nodes, and time spent until the end of the first sentence ending with a punctuation), six writer profiles were identified: explicit planner, implicit planner, slow starter, tentative starter, quick starter, and quick and productive starter. The visualisations allowed for trends and strategies related to the ways the writers began their texts to be recognised. While many writers had different profiles in their L1 and L2, nine writers had the same profile in both of their languages (for the role of proficiency level, see, e.g., Mutta et al., to appear).

Pedagogically, it is useful to examine different kinds of bursts and various complex elements of the writing process together with learners (see, e.g., Kruse, 2024; Storto et al., 2023; Vieira et al., 2018). A visualisation of the interplay between V-bursts, pauses, and revisions can clearly demonstrate how a text is created. Examining writers' strategies and profiles in the initial phase of writing increases knowledge of writing behaviours, which may help prevent fear of a blank page. Moreover, the 10-finger typing method might help to make the writing process more fluent and include fewer typos; however, the impact of using an unfamiliar or different keyboard (e.g., QWERTY vs. AZERTY) should be highlighted. The usefulness of this method could be discussed with students to enhance their understanding of their writing processes in different languages. This chapter encapsulates the complexity of the writing process in the initial phase of text production. The knowledge provided by this study could be used in various ways, for instance, to discuss different writer profiles and help writers recognise their bursts and profiles in spontaneous writing tasks in the classroom.

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