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# Planning Processes in Speaking, Texting, and Writing:

The effect of reader's and listener's temporal and  
spatial presence on planning in language production

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## Abstract

This thesis investigates planning processes in language production, more specifically in texting as compared to speaking and writing, through pauses analyses (Goldman Eisler, 1969; Matsubashi, 1981). Texting is used to examine the role of the spatial and temporal presence of a listener/reader in language production. Texting offers an interesting context in this respect since it has spatial absence between texter and reader, just like in writing, but temporal presence just like in speaking. The main research questions are as follows: In which contexts are pauses located in texting, speaking, and writing? How long are the production bursts in speaking, texting, and writing?

This study uses the processing models *the blueprint of the speaker* (Levelt 1999) and *the individual-environmental model of written language production* (Hayes 1996) to identify the processes in texting. Part of the thesis comprises method development to capture and analyse the real-time language production in texting on smartphones. The method consists of an experimental set-up where the same participant talks and texts dialogically, and then writes monologically. In the texting and writing conditions, the pause threshold is 1 minute, and in the speaking condition all *perceived pauses* are identified. In the analyses, the pauses are categorised based on the context that precede the pause (e.g. syntactic unit or revision).

The results show that the temporal and spatial presence of the reader/listener has an effect on language production. *Clause boundaries* are important contexts for pausing and planning in all three conditions, indicating that language users make use of syntactic units when they produce language regardless of the spatial and temporal presence of the speaker/listener. In texting and writing, pauses following a *revision* are important, showing that the texters and writers review what they have written. Further, the results show that texting has shorter planning units than both speaking and writing, which can be explained by the temporal presence of the reader resulting in a faster pace of communication, while the writing tool limits the speed at which language can be produced. In speaking and texting, pauses in *phrase-final* position are more common than in writing, which can be a result of the shorter planning units.

In conclusion, texters adapt their language production to the temporal presence of a reader, through shorter planning units, while also adapting to the spatial absence of the reader through reviewing and editing their messages. The findings of this thesis are finally used to propose a model for the language processes in texting.

*keywords: language processing, spoken language production, written language production, computer mediated communication, CMC, planning processes, texting*

TILL PAPPA

*Att jag är av ditt blod, åh, jag grips av ångest fatt!*

*Hur skall jag blott mitt arv ej förspilla!*

*Jag sjunger till fiol i din stjärnglesa natt*

*för mitt hjärta, som aldrig kan bli stilla.*

”Till min far”, Dan Andersson

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## Chapter 1 : Introduction

It is safe to say that smartphone texting has become a very popular way of staying connected with people across distances, with over 90% of Swedes between the ages 16 to 35 reporting that they engage in smartphone texting on a daily basis (Davidsson et al., 2018). However, there is a lack of studies examining the language production processes in texting and how these compare to language production processes in speaking and writing. That is the focus of this thesis.

Throughout history, technological advancements have given rise to new ways of long-distance communication, from carrier pigeons to phone calls. Long distance communication is by no means a product of modern society; however, smartphones have fundamentally changed the speed at which we are able to communicate across distances. Sometimes referred to as direct messaging (DM), chatting, instant messaging (IM), computer-mediated communication (CMC) or just messaging, texting enables language users to reach other people very quickly and instantly receive a written reply<sup>1</sup>. Texting is typically text-based written communication, like writing, but at the same time it is also fast-paced and dialogic, like speaking.

When speaking and writing, we are engaging in several different language production processes<sup>2</sup>. Depending on whether the language is spoken or written, the language production processes are somewhat different, which leads to language production models in speaking and writing emphasizing different processes. For example, in writing, revisions and evaluations are important parts of models for written language production (Hayes, 1996), whereas in speaking, phonological encoding and articulation have an important role in spoken language production (Levelt, 1999). Texting combines the fast pace of speaking with the process of having to write, or transcribe, the language and as such can be compared to both spoken and written language production processes.

We are now able to have a real-time long-distance conversation with someone in a different place *in writing*. In other words, texting allows the recipient of the message to be temporally present while simultaneously being spatially absent, giving way for a new context for communication that is governed by different constraints for speaking and writing. This raises questions about the effect of these constraints on the language processes that are involved in language production.

There are several important language production processes; such as grammatical encoding, working memory, revision, lexical choice and more. Another important process in speaking and

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<sup>1</sup> It is also possible to dictate a message on a phone and send it, or record when you are speaking and send the reply as a sound file.

<sup>2</sup> Signed language production also involves language production processes, however, for this thesis the focus is on spoken and written language.

writing is planning. Planning will always be an important feature of spontaneous spoken and written language production, where speakers and writers need to plan what to say and write, that is, lexical and grammatical choices regarding words and word order, as well as the structure: in what order should the events unfold. While speakers need to plan quickly at the same time as they are speaking, writers can often plan before, during, and after writing.

Texting combines aspects of both speaking and writing, with the interlocutors being present temporally just like in speaking, while also being absent spatially, just like in writing. The simultaneous temporal and spatial presence of the receiver in speaking means that the communication is fast paced, whereas the temporal and spatial absence of the receiver in writing means that the language needs to be clear in order to avoid misunderstandings. How does this affect the planning processes in language production? On the one hand, the temporal presence of the receiver means that texting has a faster pace as compared to writing, while on the other hand the spatial absence of the receiver means that the texter needs to adapt to the fact that the other person is not spatially present when the message is being produced.

The effect of the listener's temporal and spatial presence on planning in language production can be studied by pause analysis. Pauses can provide information of the processes that are involved in language production, like the planning processes in writing and speaking (Goldman-Eisler, 1969; Matushashi, 1981; Wengelin, 2006). Planning can take place before (overt) language production, during language production, and in writing also after the initial production of the language by going back and changing the text. Further, pause analysis can show where language producers plan as well as for how long they are able to plan at a time. Examining pauses in texting as compared to speaking and writing allows us to explore how the planning processes in language production are affected by the temporal and spatial presence of a receiver, and further our understanding of how the constraints of different modalities facilitates and inhibits language production. To my knowledge, there are no previous studies that have compared planning processes in texting to those of speaking and writing.

## **1.1 Aim and Research Question**

The aim of the current study is to explore the effect of spatial and temporal concurrent presence on planning processes in language production. This is done by comparing pauses in texting to on the one hand, speaking and on the other hand, writing.

1. In which contexts are pauses located in texting, speaking, and writing?

2. Are there any differences in pause location regarding:
  - 2a) texting as compared to speaking,
  - 2b) texting as compared to writing?
3. How long are the production bursts in speaking, texting, and writing?
4. Are there any differences in length of the production bursts between:
  - 4a) texting as compared to speaking?
  - 4b) texting as compared to writing?

### 1.1.1 Limitations and Definitions

It is impossible to account for and investigate every aspect of language production. As such, the limitations of the study are presented here as well as the definitions of the key concepts that are used in the thesis. The study presents data from three different conditions: speaking, texting, and writing. **The speaking condition** refers to spoken language production between two persons, **the texting condition** refers to the real-time language production of SMS conversations on smartphones between two persons, and **the writing condition** refers to written language production by one person on a laptop.

This thesis investigates **planning processes** in the three different conditions. Planning processes in language production can encompass several different processes and can thus be investigated in different ways, such as through pauses or revisions. In order to fulfil the aim of this thesis, the focus is on identifying pauses and analysing these in relation to planning processes in language production. A **pause** is defined as a suspension of language production, e.g. when a typist stops typing. The **pause criteria** are how pauses have been identified in the collected data. For speaking, a pause is defined as a disfluency in spoken language by silence, a filled pause, or any kind of intonational or prosodic feature suggesting a pause. This is referred to as a **perceived pause**. **Production bursts** refers to the number of words produced between two pauses and is a way of measuring the length of a planning unit (Alves & Limpo, 2015).

## Chapter 2 : Background

In her seminal work on speech production in psycholinguistics, Goldman-Eisler defined speech production as an “external projection of internal processes organized and integrated in time” (Goldman-Eisler, 1968, p. 6), meaning that studying language production in real time is really to study the manifestation of the cognitive processes involved in language production. Similarly, Matsuhashi (1981) made ground-breaking work on written language production in her study on pausing and planning in writing. She writes that real-time written language production “offer[s] observable clues to the covert cognition processes which contribute to discourse production” (Matsuhashi, 1981, p. 114). Both Goldman-Eisler and Matsuhashi tapped into a research field where real-time language production could be studied in order to understand the processes that speakers and writers engage in as they speak and write.

In this chapter, the theoretical background of this thesis will be presented, starting with an outline of some of the processing models for spoken and written language production and their relation to texting. This is followed by an overview of pause behaviours in speaking and writing and their relation to planning processes, as well as production bursts and their relation to planning processes. Some differences between spoken and written language are then outlined, as well as a description of the characteristics of texting.

### 2.1 Processing Models of Writing and Speaking

There are different theories that describe the process of transferring an idea, or an *intended meaning*, to an utterance or a text. The purpose of these models is to help us understand the cognitive processes involved in spoken and written language production. In this section, a short overview of some of the different theories will be given for speaking and writing. This is then followed with a more detailed description of one model for each modality that will be used in this thesis. The chosen models will then be described in relation to the role of the listener’s or reader’s concurrent spatial and temporal presence, as well as their possible application to texting.

#### 2.1.1 Models of Speaking

The models that outline spoken language production can be divided into serial processing models and connectionist models. In serial processing models, the language production moves through more or less independent stages of production. One example of this is the serial model proposed by Fromkin (1973) which suggests that the speaker moves through different stages during the speech production: the stage of the intended meaning, the stage of the syntactic structure, the stage

of the intonational contour, the stage of word selection, and the stage of the phonemic representations and phonological rules.

In connectionist models, language production moves through different levels, and these levels are closely connected to one another and several levels are active at the same time. An example of a connectionist model is the spreading-activation model by Dell (1986) where the focus is the simultaneous activation of several processes across different levels of processing. The semantic, syntactic, phonological, and morphological levels are all active during language production, and the levels consists of nodes, for example, the phonological level contains nodes of phonemes. The activation of the phonological node /d/ may spread the activation to similar phonemes such as /t/ and /b/, and the same goes for all levels in the model. On the semantic level, this could be the meaning of *swan* spreading activation to the meaning *bird*.

Both the Fromkin (1973) and the Dell (1986) models are based on speech errors. Fromkin (1973) made use of speech errors in order to understand the structure of language production, and based on this suggested that the syntactic structure of the message is created prior to the lexical choice based on studies that showed that word switches often occur within the same syntactic unit (e.g. saying *blood of puddle* instead of *puddle of blood*). In the Dell (1986) model, speech errors are explained by the simultaneous activation of different levels and nodes, for example the phonemes /p/ and /b/ both being activated on the phonological level leading to speech errors such as saying *buddle of blood* instead of *puddle of blood*.

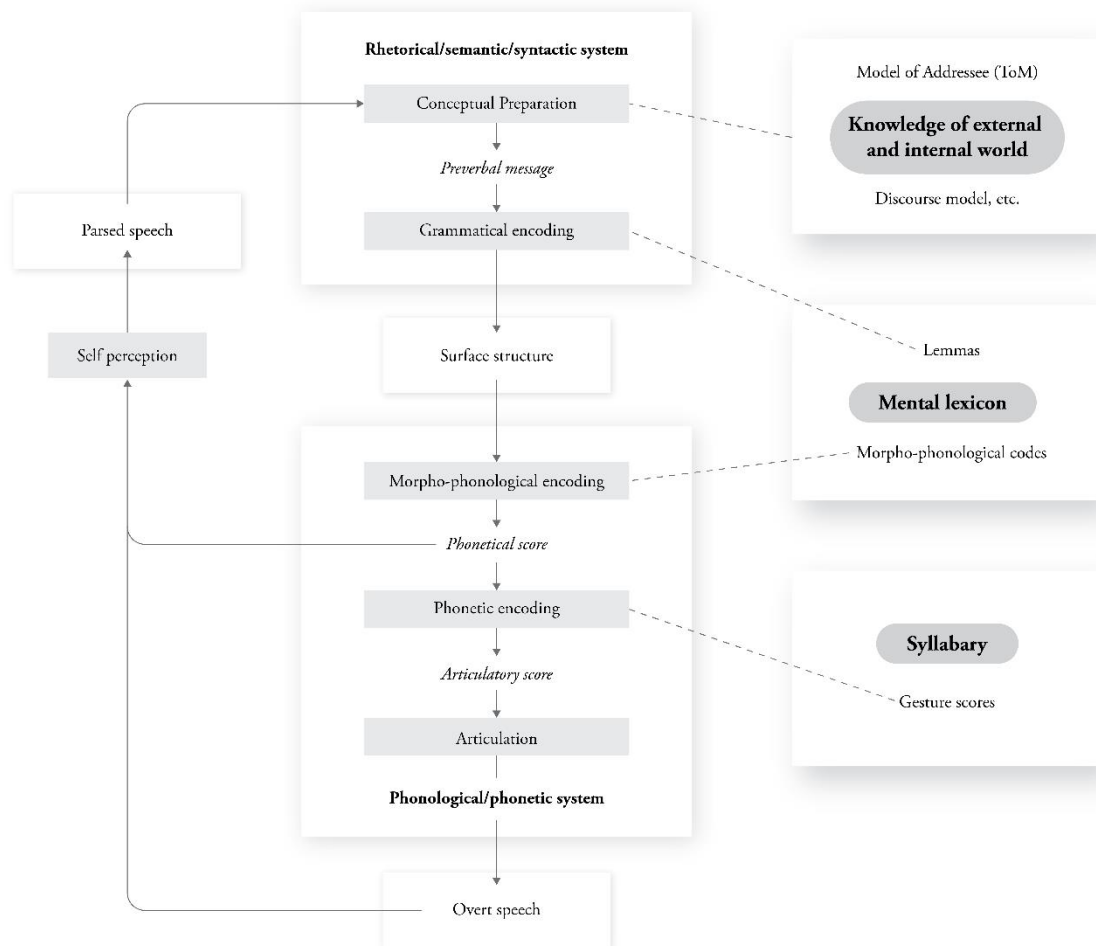
Another model is the blueprint of the speaker by Levelt (1999), an illustration of this model can be seen in Figure 1. The blueprint of the speaker is a serial processing model that has a feedback system that works as input for the speech production of the speaker. The production processes of the model are divided into two parts: the rhetorical/semantic/syntactic system and the phonological/phonemic system. According to this model, the speaking processes start in the rhetorical/semantic/syntactic system with the conceptual preparation or intended meaning. The conceptual preparation takes input both from the external world, with the addressee and the discourse model, as well as a feedback loop of self-perception. The conceptual preparation leads to a pre-verbal message that then gets grammatical encoding where words are taken from the mental lexicon and assigned to the correct grammatical position in the message.

This creates the surface structure of the speech, and after this the language production proceeds to the phonological/phonetic system. Here the message is given its morpho-phonological encoding, i.e. the words that have been chosen are assigned their morphological structures that match the grammatical encoding that preceded it. After this, the message moves to the phonological encoding before moving onto articulation where the message is articulated, resulting in overt speech. The

speaker hears their own speech, which then feeds back into the conceptual preparation where the process starts again.

**FIGURE 1**

*An Illustration of the Blueprint of the Speaker as Described by Levelt (1999)*



*The figure shows an illustration of the blueprint of the speaker as described by Levelt (1999), with the rhetorical/semantic/syntactic system at the top and the phonological/phonetic system at the bottom with the different speaking processes that are involved in spoken language production. To the right of the model the knowledge of the world, the mental lexicon and the syllabary can be seen, and on the left parsed speech and self-perception.*

Furthermore, the blueprint of the speaker is a model that shows the process of speaking with consideration to the outside world, the listener, as well as the speaker's own self-perception of their speech signal, making it a good fit for this thesis where the constraints that are investigated are tied to the social environment of the speaker. The listener in the conversation is part of the social

environment, meaning that the speaker takes the listener into consideration from the very beginning where the intended meaning is created.

All models presented here identifies some different processes that are involved in speech production, for example all models present phonological encoding of some kind as one of the processes. However, the focus of the models differ as a result of them having originated to solve different problems, e.g. the connectionist models focusing on how different levels can be active at the same time and affect language production from the perspective of speech errors, and the serial models rather focusing on the entire speech process, and how it moves through different stages. In the Fromkin model (1973) and the Dell model (1986) the focus is on the speaker and the speaker's underlying processes in speech production, and the listener is not described explicitly in the models. For this reason, the blueprint of the speaker is the model that works best for this thesis.

While planning is not a language process of its own in the blueprint of the speaker, planning can take place at any time during speech production. Of course it is present when the intended meaning is formed, but it can also be found during the grammatical encoding and word selection process of the model where the speaker has to make decisions on what to say and which words to use to do so.

### **2.1.2 Models of Writing**

While spoken language production is an instantaneous act where the speaker is unable to plan without the listener being able to access the planning process during a conversation, written language production allows the writer to go back and change their words and formulations until they are satisfied with the result. As such, the models for written language processes also account for the large role that editing plays when writing a text. Because of this, models for writing detail several processes that are not present in models for speaking, and since the writing process seldom is a linear task in the same way as speaking, models of writing do not have a specific order that language production follow.

One of the most influential processing models for writing is the cognitive writing process by Flower and Hayes (1981). The authors outline the processes of writing and divide these into three main processes: planning, translating, and reviewing. The planning process is made up of the sub-processes of organizing, goal setting, and generating, while reviewing is divided into the sub-processes evaluating and revising. Translation has no sub-processes, but it contains the low-level processes of identifying and finding letters on the keyboard and writing them down. All three of the writing processes are monitored by the writer as s/he writes, and they are also connected to the task environment.

An updated version of this model, the individual-environmental model of the writing process was presented by Hayes in 1996. In this model, the individual writer's motivation and affect have been added, as well as a clarification of the interaction between the working memory and long-term memory of the writer. The model is divided into the task environment and the individual. The task environment consists of the social environment (audience, collaborators) and the physical environment (the text so far, the composing medium). The individual consists of motivation/affect, working memory, long-term memory, and cognitive processes.

These are then divided into different sub-processes, motivation/affect contains the writer's goals, predispositions, beliefs/attitudes, and cost/benefit estimates. The long-term memory encompasses task schemas, topic knowledge, audience knowledge, linguistic knowledge, and genre knowledge whereas the working memory holds the phonological memory, visual/spatial sketchpad, and the semantic memory. Lastly, the cognitive processes consist of text interpretation, reflection, and text production. These processes account for revisions that are made during writing.

In this model, the addressee is part of the social environment together with any collaborators who may be working on the text. The model also takes the composing medium into account in the physical environment alongside the text so far, making it a good fit to compare the language processes of writing to those of texting. While there is no specific process dedicated to planning, again, planning takes place during the entire written language production and the different processes can influence the plans of the writer, for example if the goals of the writer change, the planning will also change.

### **2.1.3 The Role of Concurrent Spatial and Temporal Presence in the Processing Models**

In Levelt's (1999) blueprint of the speaker, the listener is part of the external knowledge section of the processing model. It feeds into the rhetorical/semantic/syntactic system where the conceptual preparation and grammatical encoding takes place, meaning that the context is the premise for the speech act itself. The speaker needs to be aware of the context, the type of discourse as well as who they are talking to and what their common ground is before they begin to form the utterance. Levelt explicitly states that "the speaker will monitor whether the interlocutor is following the speech act" (Levelt, 1999, p. 90), meaning that the presence of the speaker not only forms the base for what to say and how to say it, but their reactions and replies to the speech acts that are produced further feeds into the context of the language processes.

In Hayes' (1996) individual-environmental model of writing, the interaction between the task environment and the individual writing process is one of the essential parts of the written language production. The task environment consists of on the one hand, the physical environment encompassing the text written so far as well as the composing medium with which it is produced,



and on the other hand, the social environment which consists of any collaborators as well as the audience of the text. Since the audience is absent during the production of the text, the writer needs to consider the knowledge of the audience. Of course, the writer cannot (generally) ask the reader beforehand what they know, but instead the “audience knowledge” as it is called by Hayes is part of the long-term memory of the writer.

In both models, the social environment is an important aspect for language production, however, one key difference is that in the blueprint of the speaker (Levelt, 1999), the speaker continuously updates and changes their knowledge of the listener because they are there to reply and react whereas in the Hayes model, the audience, or imagined reader, is absent and cannot change the social environment during the written language production (unless the writer changes who the audience is).

#### **2.1.4 The Processing Models and Texting**

There are no proposed processing models for texting yet but based on the models described above as well as the characteristics of texting that are also outlined above, some presumptions about the processes involved in texting can be made. The temporal presence that texting allows for means that texters need to adapt their typing to a faster pace as compared to writing, while still being constrained by the spatial absence of the reader. This may result in texters spending less time on editing and revising in order to be able to send messages quicker.

An important distinction between writing and texting is that the reader is present to a greater extent and messages sent from the interlocutors can change the social environment of the conversation, something that the Hayes model cannot account for. At the same time, the blueprint of the speaker relies on the spatial presence of the listener to allow the speaker to see their real-time reactions to what is being said, but it does not account for the delay in receiving feedback from the interlocutor in texting.

### **2.2 Pausing and Planning**

Planning in speaking and writing is only one of several cognitive processes involved in language production, and while there are other interesting processes to study, examining planning in texting as compared to speaking and writing is a way of looking at how language users adapt to the constraints posed by the social and the physical environment. One way of looking at planning is through pause analysis. Pause analysis is a way to uncover the cognitive processes in speaking (Goldman-Eisler, 1968) and writing (Matsuhashi, 1981) as they offer insight into the underlying structures of language processes.

However, it is important to remember that it is impossible to know exactly why a person is pausing while speaking or writing, the person may be scratching their head instead of writing, they may be reading their text, they may be suspending their speech production because they got distracted by something they saw. Nonetheless, pauses can be analysed, and they can, to some extent, imply what the speaker or writer is doing based on the context in which it occurs.

In order to be able to study pauses, what constitutes a pause in language production must be established. A pause is a suspension of production, in speaking this can be either a filled or an unfilled pause and in writing, this is usually a predefined time-limit for how long a transition between keys can be before it is considered a pause (Wengelin, 2006).

Language production consists of a series of production bursts and pauses, or fluencies and disfluencies. Pauses are the moments between bursts of production, and it helps both speakers and writers to produce language. When speaking, pauses can be both physiological, with the speaker interrupting their stream of words to grab some air, but they can also serve other purposes such as pacing, to add emphasis, to facilitate understanding, as well as to help with word retrieval and planning as well as being a result of disfluencies in the speech production (Wengelin, 2006).

However, not all pauses in speech are silent. Filled pauses, with the speaker repeating utterances such as “um” or repeating their last word (*I have a a bad a boat*) are pauses in the flow of speech that conveys that the speaker is not done talking, it is a way for the speaker to keep the floor when they are speaking (Clark, 1996). Pauses can also be a way for the speaker to signal that they are having trouble with searching for a word, and sometimes the listener is able to help out by suggesting a word. Pauses can also help the listener process what is being said, as suggested by Clark (1996).

Although pausing in speech can indeed be communicative, it also serves the purpose of planning ahead. Goldman-Eisler (1968) presented important findings about pause behaviour in speech and the relation between pause length and cognitive load, showing that task complexity affected the pause length of the participants, resulting in longer pauses. Similarly, in a study by Matsuhashi (1981) she had four students write four different text in four different discourse types: expressing, reporting, generalizing, and persuading. The results showed that the participants produced longer pauses when they were faced with a more complex writing task as compared to a simplex writing task.

Previous studies have suggested that pause location interacts with grammatical units and used either the grammatical unit preceding or following the pause to categorise pauses (Milton Cowan & Bloch, 1948; Maclay & Osgood, 1959; Hawkins, 1971; Matsuhashi, 1981; Spelman Miller, 2006; Wengelin, 2006). Pause location can be used to discern different levels of planning that speakers and writers engage in depending on the syntactic location of the pause. Most pauses occur at clause

boundaries, suggesting that the planning taking place is concerned with larger units of production, or macroplanning (Spelman Miller, 2006). Smaller units of planning, or microplanning, can be assumed to take place when a pause occurs within a syntactic unit such as a phrase (Spelman Miller, 2006). Categorising pauses based on the syntactical unit that precedes them can help in understanding what kind of planning processes that are taking place during the pause (Wengelin, 2006).

In speaking, both filled and unfilled pauses are more likely to occur before a content word as opposed to a function word (Maclay & Osgood, 1959). Hesitations such as false starts (i.e. the speaker starting over) are more common before a content word as compared to a function word, whereas repetitions are more commonly done with function words as opposed to content words (Maclay & Osgood, 1959).

## **2.3 Production bursts and Planning**

A production burst is an unbroken stream of language production, delimited by a pause at either end. It can show how long a planning unit of the speaker or writer is, i.e. how much they plan at a time. Pauses, or disfluencies, in language production can indicate that the speaker/writer needs to decide what to put in the next planning unit, meaning that the length of a burst corresponds to the length of the planning unit. Linguists have been interested in burst lengths analyses because it offers insights into the length of a planning unit, as well as which syntactic units that are planned together.

Depending on the pause definition, or threshold, the average length of a production burst will vary, a longer pause threshold will result in longer burst and a shorter pause threshold will result in shorter bursts. Kaufer, Hayes and Flower (1986) found that adult writers produce about 9 words between pauses, whereas for speaking, Goldman-Eisler (1968) found that speakers generally produce six words or less at a time.

For writing, transcription skills can have an effect on burst length. In a study by Alves (2013), they wanted to test this by increasing the cognitive strain on the working memory by changing the layout of the keyboard to make transcription more difficult Alves (as cited in Limpo and Alves, 2017) found that the number of words that writers produce in each burst was lower as compared to the burst length with the original keyboard layout. Similarly, Limpo and Alves (2017) and Alves and Limpo (2015) found that writers with lower transcription skills also produced shorter bursts, whereas writers with higher transcription skills were found to produce longer bursts.

Olive and Cislaru (2015) analysed the syntactic contents of bursts with a pause threshold of 2 seconds and found that depending on the burst length, the syntactic units within the burst was different. They found that shorter bursts often contained incomplete syntactic units, whereas

longer burst contained complete syntactic units and the longest bursts contained both complete phrases and complete clauses.

*Working Memory* The working memory is, so to speak, the sketchpad of the brain where cognitive processes take place (McCutchen, 2000). As such, it makes up an important aspect of production bursts, it is the number of units that the speaker or writer is able to process at the same time while writing or speaking (McCutchen, 2000). The different cognitive processes involved in language production, such as planning and revising, all compete for the same working memory space (Kellogg, 2001). Depending on the skill level of the writer, e.g. the automatization of transcription skills, level of experience regarding for example genre and topic knowledge or general linguistic knowledge, the working memory may be occupied with low-level processes such as typing, which leaves less room for processes such as planning (Johansson et al., 2010).

## 2.4 Differences Between Speaking and Writing

One main difference between speaking and writing is the way in which they are produced – speaking is produced with the vocal organs whereas writing is produced with a writing tool (e.g. pen and paper, keyboard). Speaking and writing also belong to different sensory modalities – speaking is primarily auditory while writing is visual. This means that speaking is more often ephemeral (granted that it is not being recorded), whereas writing is more often preserved, ready to be read repeatedly.

Furthermore, speaking is the primary means of expression, meaning that it is the first form of language that babies encounter<sup>3</sup>, and it is also the modality on which writing is based. As such, speaking is in a way the natural state of language, while written language is an extension of this and something that requires years of schooling in order to learn, making it exclusively available to those who have access to schools or other means of learning to write. It is also important to note that not all spoken languages have a written counterpart, and not all language users have access to schooling to learn to write.

Despite spoken language being the primary form of language as opposed to writing, written language has come to reach a certain status and is often seen as a purer form of language than writing (Johansson, 2009). Written language is often refined and edited to perfection, and historically, written language was reserved for a select few of the elite, making reading and writing a symbol of status (Linell, 2005).

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<sup>3</sup> For people with hearing disabilities, the primary language is sign language which is visual rather than auditory.

Another reason why written language is seen as superior to spoken language could be that written language is edited while spoken language is produced at the same time as it is being interpreted with no time to edit. As Johansson (2009) stated in her doctoral thesis, students are taught that they need to edit and perfect their writing before showing it to anyone. In written language, the result is shown when it has been edited to the best ability of the writer, and the time and effort that has been put into the text is nowhere to be seen. Writing is the finished product, and the reader is not aware of how the language production has unfolded in real-time, whereas speaking is the process of producing speech as it unfolds in real time.

## **2.5 Constraints of Language Production in Speaking and Writing**

Different modalities have different constraints that affect language production. These differences have been outlined before, and in this section the differences between speaking and writing are presented based on the overview that was written by Chafe and Tannen (1987). Speaking is synchronous and both the speaker and the listener are typically present, whereas writing is asynchronous and lacks presence between the writer and the reader. Furthermore, when producing speech, the speech is auditory and thus disappears instantly, while written language is visual and is typically preserved for others to read.

The presence of the listener or reader is important in language production. When speaking, the speaker can see the listener and as such is able to infer the listener's understanding from reactions and monitor if they are following along whereas in writing, the writer needs to ensure that the reader has access to all the information they may need in order to follow along. When texting with someone who is temporally present but spatially absent, the texter does not see the reactions of the receiver, however the receiver will be able to respond and ask for clarifications if something is unclear. Even though the receiver is able to ask for clarification, this has to be initiated by the receiver, and the person who wrote the text will not be able to infer whether or not they have understood what they meant without the receiver explicitly stating that they need clarification.

The impact of spatial and temporal presence has been demonstrated in before. For example, in a study on gestures by Bavelas et al. (2007) they had participants describe an image to a spatially present listener, to a listener on the phone, and to a tape recorder. They found that the speakers gestured more with a present interlocutor as compared to a spatially absent interlocutor on the telephone, and they also gestured more when describing the picture on the telephone as compared to when they spoke to a tape recorder. Naturally, speakers are not expected to gesture in a setting such as texting where they are producing the language with their hands, but the study by Bavelas

et al. shows that the spatial and temporal presence of the listener seems to have an effect on language production processes.

Furthermore, under the spatial presence constraint the speaker has access to a direct context to which they can refer. Chafe and Danielwicz (1987) did a study where they compared spoken and written language and found that in face-to-face conversation, there were differences in the content of spoken language as compared to written which could indicate that speakers tend to ground their expressions in the direct context of the conversation. Further, speakers have access to the real time reaction of their listeners, and vice versa. This means that they can make use of many extralinguistic features such as facial expressions and gestures that provide cues to both what is being said but also to what is being understood.

In writing, on the other hand, the writer and the reader are typically in different places. This results in the writer needing to be explicit in order to make sure that the reader is able to understand. This means that writers need to be specific in their descriptions, and Chafe and Danielwicz (1987) found that there were more, and longer, noun phrases used to identify subjects in a sentence in written language as compared to spoken language.

The temporal presence constraint means that the speaker and listener, or texter and reader, are both present in time but not necessarily in space. An example of this is a chat room, where participants are located in different places, sometimes as far apart as different countries, and chat with each other in real time. For speakers, an instance of temporal presence but the lack of spatial presence is in phone calls or video calls, where both participants are part of the conversation as it unfolds, even though they might be miles apart. While speaking often has spatial and temporal presence, whereas writing typically lack both, these constraints are not limited to one of the modalities. Speakers can talk through a door and thus lack spatial presence, and writers can write with a co-author working on the same text in the same document, thus having the temporal presence of a reader.

## **2.6 Characteristics of Texting**

Texting, or text messaging is the act of engaging in a fast-paced, often synchronous, conversation in written form. The semi-synchronous nature of online chatting and texting has garnered attention from linguists since it started to spread more widely in the 90's (Hård af Segerstad, 2002). Today, synchronous and semi-synchronous computer mediated communication is not tied to a specific platform but can take place on smartphones, computers, or tablets. Additionally, there is a myriad of different apps and webpages that can be used for texting and chatting. In this section, some of the key features of texting and online chats will be outlined.

During texting or chatting, turns are constructed in isolation as compared to speaking where the listener is typically present during the entire turn-construction. In an early study on CMC, Garcia and Jacobs (1999) examined turn-construction in chat rooms and found that turn-construction in CMC is multidimensional, meaning that more than one turn can be constructed at the same time by different participants. In an earlier study, Garcia and Jacobs (1998) also found that “phantom adjacency pairs” are fairly common in chats, meaning that turns that were constructed simultaneously appear next to each other on the screen creating the illusion that one is a response to the other. For example, if a person is writing a reply to the question “Are you coming tonight?”, and while they are typing, the other person also sends the message “Or are you staying home?”, resulting in the answer “Yes, I am” appearing after the second question, making it seem like the person is staying home while they are in fact planning to come tonight.

In another study, Markman (2004) recorded the computer screens of six students as they engaged in a group work exercise in a virtual classroom where they used a chat programme to communicate to examine how the students constructed their turns in the chat. The study found that the main difference between turn-construction in speech as compared to CMC is that the turns are constructed in isolation. This in its turn, could lead to what Markman refers to as “false adjacency pairs” where the participants risk misunderstanding each other due to how the messages appear on the screen, just as was found by Garcia and Jacobs (1998).

Because texting lacks the spatial presence that speaking has, many of the characteristics of texting (or CMC) are ways to convey extralinguistic cues to the reader. One important characteristic of texting is how texters adapt their vocabulary, use abbreviations, and change the spelling of words when they text (Hård af Segerstad, 2002; Kemp, 2010; Darics, 2013; Haryono et al., 2018). When the SMS, or short message service, was first made popular, SMS messages had a character limit that the texter had to adapt to, one way to deal with this was the adoption of abbreviations such as *u* for *you* and *l8* for *late* (Hård af Segerstad, 2002). These abbreviations made it possible to write more without having to send several messages, however, as the technology advanced the character limit was expanded and today there are few apps that have a character limit per message. Despite this, respellings and abbreviations in texting still occur (Tagg, 2012).

Because there is no longer an upper limit on characters, the way in which texters adapt their language is not due to the character limit constraint, but it is rather a choice that texters make while constructing their message. In a study of letter repetition in instant messages, Darics (2013) found that letter repetitions were used to add paralinguistic cues to the message based on the mismatch between the spelling and the pronunciation of the word, suggesting that misspelling can be used to bring focus to a specific part of the message. Darics (2013) also suggested that letter repetition

should be considered an integral part of CMC that needs to be analysed based on the context in which it appears rather than as a reflection of how words are pronounced in order to uncover the function of these repetitions.

Another important aspect of texting is the use of punctuation marks, or rather, the lack thereof. Gunraj et al. (2015) examined how readers interpreted messages with and without punctuation marks by having participants rate the sincerity of several messages with and without punctuation marks, question marks and other kinds of punctuation marks. They found that messages that ended with a punctuation mark were interpreted as less sincere than those without. They also had the participants rate messages written on hand-written notes with and without punctuation marks and found that on hand-written notes, a punctuation mark did not affect how the reader interpreted the sincerity of the message.

In a similar study by Houghton, Upuday, and Klin (2018), students got to rate affirmative and negative responses with or without punctuation marks. The results showed that an affirmative response followed by a punctuation mark was interpreted as more negative as compared to affirmative responses without a punctuation mark. Houghton et al. (2018) suggests that the period in CMC is used to add meaning to the message through non-verbal signalling rather than to convey grammatical information. Similarly, in Gullberg (2016) five participants of varying ages discussed the interpretation of messages containing emojis. The study found that a message that had a punctuation mark at the end instead of an emoji was interpreted as more formal and serious as compared to messages with emojis.

Another way of adding information to a message while texting is through the use of non-verbal signs such as emojis and emoticons. Emojis are graphic images of smiley faces, animal, signs, and much more whereas emoticons make use of already existing keyboard characters to portray faces, such as :- ) or ;- ). In a neurolinguistic study, Weissman and Tannen (2018) had participants read different text messages with sarcasm that either used words to signal the sarcasm or a winking emoji. They found that the brain had the same reaction to a winking emoji at the end of a message as it did to sarcasm signalled verbally, suggesting that emojis can be interpreted linguistically as part of the message. In two other studies on non-verbal sarcasm, Thompson and Filik (2016) as well as Filik et al. (2016) report that emoticons can be used to signal sarcasm and clarify the intent of a written message.

Emojis and emoticons can also be used for relationship maintenance when texting (Sugiyama, 2015), however, they are also subject to misinterpretations due to different renderings depending on the platform on which they are shown (Novak et al., 2015; Miller et al., 2015).



To summarise, texting has carved its own space in communication and has different means of compensating for the lack of spatial presence, for example with letter repetitions, emojis and emoticons, and by using punctuation marks.

## **2.7 Summary of Background Theories**

In summary, there are clear differences between speaking and writing in the way that they are produced, primarily that speaking is auditory whereas writing is visual. This affects both the way in which the language is produced but also the contents of the language. Additionally, speaking is characterised by both the temporal and spatial presence of the listener, whereas writing often lacks both for the reader. The temporal and spatial presence of the listener in speaking means that the speaker has access to the reactions of the listener while speaking. At the same time, it also means that the entirety of the production process is audible to the listener.

In writing, on the other hand, the lack of both temporal and spatial presence means that the writer needs to predict how much information the reader will need in order to understand the writing. At the same time, writing can be edited and revised to ensure that the text is understandable. Texting presents a case where the language production can have temporal presence while simultaneously lacking spatial presence. The effect of this on language production processes is largely unexplored.

The cognitive processes involved in language production has been described by different theories through different processing models of language production. In speaking, the blueprint of the speaker by Levelt (1999) describes a serial processing model where spoken language production starts at the level of the intended meaning and moves through grammatical encoding, lexical choice, morphological encoding until it becomes overt speech which is monitored by the speaker. For writing, the individual-environmental model of written language production by Hayes (1996) shows how the writer needs to juggle many processes at the same time such as the social and physical environment, reading the text so far, setting goals etc. Both models allow for planning on different levels of the language process, for example in the writing model where planning can occur from e.g. goal setting or reading the text so far. However, neither of these models capture the nature of planning in texting where the texter is engaged in a fast-paced written conversation with little time for editing, but at the same time lacks the direct feedback from the receiver.

One way to analyse the planning processes in both speaking and writing is to analyse pause behaviours in language production. The syntactic location of a pause can indicate when a speaker or writer needs to plan and what units that have been planned together, as well as what kind of syntactic structures or units that are cognitively heavy. Additionally, production bursts can indicate

how much a speaker or writer is able plan at a time.

## 2.8 The present study

Based on previous studies in written and spoken language production, texting offers an interesting context for studying language production processes in both speaking and writing in a way that has not been done before. Furthermore, studying real-time language production in texting can allow linguists to further the understanding of to what extent different constraints facilitates and restrains language production processes, as well as providing insight into what extent that language users are able to adapt their language production based on the medium that is used to produce language.

**TABLE 1**

*The Temporal and Spatial Presence Constraints in Speaking, Texting and Writing*

	Speaking	Texting	Writing
Temporal Presence	X	X	
Spatial Presence	X		

The current study investigates the effect of spatial and temporal concurrent presence on planning processes in language production through a pausological study comparing on the one hand speaking with texting, and on the other hand, writing with texting. For the purpose of this study, the differences between the modalities have been outlined as can be seen in Table 1. The spatial presence constraint means that the interlocutors are physically in the same space and can see each other. The temporal presence constraint means that the interlocutors are present at the same moment in time. In speaking, the interlocutors are typically present both spatially and temporally, whereas in writing the interlocutors are often spatially and temporally absent. Texting typically lacks the spatial presence of speaking while allowing the interlocutors to be temporally present. This thesis uses an experimental setup where the same person talks, texts, and writes, enabling an examination of the effect of the spatial and temporal constraints on pause patterns in language production.

## Chapter 3 : Method

In this chapter, the set-up of the study is described in detail, starting with a description of the participants and the experimental design. It then proceeds to describe the materials, divided into the equipment and the stimuli that was used. This is followed by a description of the procedure of the study, where the three conditions texting, speaking, and writing are all described separately. Finally, it concludes with a section about how the data was operationalized and analysed.

To explore the differences in planning in texting on the one hand compared to speaking, and on the other hand, compared to writing, an experiment was designed to collect data in all three modalities. Since there was no established method for collecting the real-time texting process, a method for how to collect and analyse this was developed for this thesis.

In the experiment, the same language users, two and two, were asked to text, write, and speak. The experiment was conducted with dyads who knew each other and participated in all three conditions together. In the speaking condition, the dyads were placed in the same room and were given a task to solve together. In the texting condition, the dyads were placed in different rooms with a smartphone each and given a task to solve together. In the writing condition, the dyads were placed in different rooms and asked to write a text on a given subject.

### 3.1 Participants

The study consisted of 26 participants (F=14) between the ages of 20 and 36 (mean=26.7, median=25.5). The inclusion criteria were to be between the ages of 18 and 36, to own a smartphone, to have texted with each other before, to have Swedish as a native language, and having a friend with whom they could participate in the experiment (who also fulfilled the inclusion criteria). The age distribution can be seen in Table 2, and the age distribution across the dyads can be seen in Table 3.

**TABLE 2**

*Age and Gender Distribution of Individual Participants*

	Min.	Max.	Mean	Median	SD
All	20	36	26.7	25.5	4.6
Female	20	31	25.6	25.6	3.5
Male	20	36	28	29.5	5.5

Limiting the selection to a specific age group ensured that the participants belonged to the most frequent smartphone users, which according to the report *Svenskarna och Internet 2019* is the age group between 16 and 35 (Andersson, 2019). In this age group, over 90% of the respondents reported that they engage in chatting. In the report from the year before, which focuses on smartphone usage and social media, over 90% of the respondents in the same age group report that they engage in texting on their smartphone (Davidsson et al., 2018).

**TABLE 3**

*Age and Gender Distribution Across the Dyads*

Gender	Number of dyads	Min. age	Max. age	Mean age	Median age	SD
F*	4	20	29	24.4	24	2.6
F/M	6	20	36	28.9	29.5	4.4
M	3	20	32	25.2	23	5.5

*Note* \*The dyads were made up of friends who were recruited together, leading to dyads with varying gender set up, both same-sex dyads and mixed dyads.

By including only people who own a smartphone, the study was limited to people who were familiar with texting. 54% (N=14) of the participants in the study reported that they use an iPhone, whereas the remaining 46% (N=12) report that they use another brand for their smartphone. The experiment used iPhones. Exclusion criteria were self-reported reading and writing difficulties and not owning a smartphone. Recruitment of participants was done through posters, information at lectures and seminars, through social media as well as through friends and family.

### 3.2 Experimental Design

The design of the experiment is a multivariate study with the listener's temporal and spatial presence as the independent variables and pauses as the dependent variable. In order to isolate the different phenomena that are investigated in this study, the study was done in the form of an experiment. Furthermore, to control for spatial and temporal presence the experiment was divided into three conditions: the speaking condition, the texting condition, and the writing condition.

**TABLE 4***Counterbalancing: The Two Experiment Orders*

<b>Group A (dyads N=7)</b>	Speaking	Texting	Writing
<b>Group B (dyads N=6)</b>	Texting	Speaking	

In the speaking and texting conditions, the participants were given a task to solve together, and in the writing condition the participants individually wrote one blog post each on a given subject. To control for effects of speaking on texting, and texting on speaking, the experiment was counterbalanced with half of the participants starting the experiment with the speaking condition, and half of the participants starting with the texting condition. The writing experiment was always done last since previous studies have found that writing has a greater effect on speaking than vice versa (de Sousa Olivera et al., 2019). The counterbalancing is illustrated in Table 4. The texting and speaking conditions were designed as collaborations between the two participants in the dyads to simulate a natural context for texting and speaking, whereas the writing condition was done individually to simulate a natural writing context.

### 3.3 Materials

#### 3.3.1 Equipment

For the speaking condition, the speech was recorded with two *Sennheiser EW100* transmitters with *Sennheiser* lavalier microphones, connected to a *Sennheiser EW100* receiver and recorded using a *Zoom H5 handy recorder*. The lavalier microphones were chosen because they are less noticeable than a microphone put on the table, making the participant less weary of the recording equipment.

For the writing condition, two 13-inch screen MacBook Pro computers with MacOS Mojave version 10.14.4 were used. The data was collected with the keystroke logging program *ScriptLog* (Wengelin, Frid, Johansson, & Johansson, 2019). Keystroke logging records which keys that are being pressed on a keyboard and allows for a playback of the writing process. It collects a large amount of data and can measure transition times between keystrokes on the keyboard, enabling for pause analysis of the writing process.

For the texting condition, there was no established method on how to capture the writing process on a smartphone. There are no programmes such as the keystroke logging programme *ScriptLog* (Wengelin, Frid, Johansson, & Johansson, 2019) that can capture and help in the analyses of the data. Thus, the thesis work comprised method development in order to capture and analyse the texting processes. In order to capture the texting processes in the texting condition, two iPhone

6S phones with iOS 12.1.4 were used since at the time of the experiment, iPhone was reported to be the most commonly used smartphone in Sweden (Davidsson et al, 2018). Further, it was important that the two phones were of the same model to control for influence of the hard- and software on language production. The experiment was done in the Messenger app, and the data was captured in 44 frames per second with the built-in screen recorder. Both phones had autocorrect disabled and had the emoji keyboard enabled to simulate a natural texting environment. There was no autocompletion or word prediction functions on the phones.

### 3.3.2 Stimuli

In the speaking condition, the stimulus consisted of three printed images of cats. One of the images was an example of a meme showing a sour looking cat (Grumpy cat, 2018) with the text “Jag hade roligt en gång” (*I had fun once*) at the top, and “det var hemskt” (*it was awful*) at the bottom. The other two images were one picture of a cat standing on its hind legs looking at a bowl of cereal (Cats wanting fruit loops, 2018) and a toy cat sitting on a box with its hands stretched out (Persian Cat Room Guardian, 2013), both lacked a caption and the participant were asked to make up their own captions for these images. The images were chosen on the one hand to provide the participants with a talking point that would seem relaxed and easy to do, and on the other hand to provide the participants with a task on which to return to if they found themselves uncertain of what to talk about.

In the texting condition, the stimulus consisted of three printed images. One of the images was taken from a Facebook page called Lund’s Memevercity which is a page that creates and posts memes about student life. The image is depicting a video game character saying “Wait. That’s illegal” with the meme caption “När du ser en polare äta en semla innan fettisdagen” (*When you see a mate eating a semla<sup>4</sup> before Shrove Tuesday*) (Lund’s Memevercity, 2019). The other two images were one of the cartoon character Spongebob Squarepants seemingly exhausted, and without pants, catching his breath, and three consecutive images of Theresa May walking on to a stage (Tired Spongebob, 1999; Dancing Theresa May/Maybot 2018). These two pictures did not have any captions and the participants were asked to make up their own captions for them. Again, the images were chosen to provide the participants with a talking point and a task to which they could always return – creating captions for the images.

The pilot showed that constructing the talking point as a task rather than just a topic made it easier for the participants to keep the conversation going since they could always turn back to the

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<sup>4</sup> A semla is a sweet bun filled with an almond paste and whipped cream, traditionally eaten on Shrove Tuesday in Sweden, but in recent years semlor have been available for purchase from Christmas until Shrove Tuesday, breaking the tradition.

task at hand – creating memes together. The choice to use memes was also done to make sure that the conversation in both the texting and the speaking conditions would be kept informal. Using memes for both the speaking and the texting condition was also to make sure that the tasks would be comparable since the participants would then engage in similar conversations in the two conditions.

In the writing condition, the stimulus consisted of a video of a dog who is trying to catch food that is being thrown towards it (Fritz Dog, 2015). The choice to use a video instead of an image was to provide the participants with more input for the writing condition since they would be working individually and not together. The dog struggles to catch the food and the last clip shows the dog succeeding in catching a French fry, and the video worked as input for the subject that they were to write about: learning new things. There is instrumental music in the background of the video and sound effects have been added when the food hits the dog in the face.

The stimulus that was used in all three conditions are part of a genre of “spreadable media”, a kind of media that is shared and remixed (Wiggins & Bret Bowers, 2015). The memes present images that are often “remixed”, i.e. they are used to describe different relatable scenarios, and Wiggins and Bret Bowers (2015) argues that memes are an important part in what they call participatory online media, i.e. media that encourages people to remix and re-use images as part of an ongoing conversation. The video of the dog, while not a meme in the definition of Wiggins and Bret Bowers (2015), is an example of an emerging meme – it is wide spread with over 8.5 million views on Youtube (in August 2020) but it has not become part of the participatory culture where it is being altered in the way as a meme is. Using stimulus that all are part of this same online genre was a way to keep the tasks in the different modalities similar.

### **3.4 Procedure**

The experiment took place in the LARM-studio of the Lund University Humanities Lab and made use of the recording studio and a post-production room. All information and the tasks for each experiment was given in the recording studio with both participants present, after which one of the participants was brought to the post-production room in the texting and writing experiment. After the experiment, the participants filled in a questionnaire with background information and information about their phone and texting habits, as well as what phones they typically use and whether or not they used to text with the person they participated in the experiment with outside of the experiment. All instructions in the three conditions were given by the same experimental leader, the author of this thesis.

### 3.4.1 Speaking

For the speaking condition, the participants were sat opposite each other in the main recording room with a table between them. The microphones were attached to their clothing and the recording started before the instructions for the experiment were given. The task began with the participants being presented with the three stimuli pictures, one cat meme with text and two blank cat images, and they were asked to talk about their relation to these kinds of images as well as if they themselves look at cat memes online. They were also asked to come up with two or more meme-texts for the blank images and were told that they did not need to write anything down. They were given 15 minutes to complete the task from the moment the door closed.

### 3.4.2 Copy task texting

In the texting condition, the participants started with a copy task in order for them to familiarize themselves with the keyboard on the phones since the pilot showed that some participants struggled with typing on a new phone. They were shown the text “Blinka lilla stjärna där, hur jag undrar var du är ★” (*Twinkle twinkle little star, how I wonder what you are* ★) which is a well-known Swedish lullaby. They were asked to remember the text and then write it three times on the smartphone once the paper was removed (Torrance et al., 2016). The star emoji was there to ensure that they could find the emoji keyboard in case they wanted to use them<sup>5</sup>. The participants were not given any information on how to hold their phones or how to type on the phones.

### 3.4.3 Texting

After the copy task, the participants were shown the three stimuli pictures: one with a meme-text and caption, and two blank common meme images. They were informed that the pictures came from a page that posted memes about student life and were asked to text about their thoughts on student memes or other memes with a narrow audience, as well as come up with suggestions for two or more meme texts for the two blank images. One of the participants was brought to the post-production room where s/he had access to additional copies of the stimuli. They were given 20 minutes to complete the task starting from the doors of the rooms being closed.

### 3.4.4 Copy task writing

In the copy task, the participants were first shown the interface of *ScriptLog* which looks like a simple word processor. They were informed that they could copy and paste, delete text, but not

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<sup>5</sup> In the pilot, one participant was not able to find the emoji keyboard until halfway through the experiment and said that it affected their texting behaviour.



edit it to be bold, italics or change the font size. They were then told that they would be shown a text that they were to copy seven times, the text was a well-known Swedish lullaby and they were asked to remember the lines they were to write (Torrance et al., 2016). They were then shown a piece of paper with the text “Bä bä vita lamm har du någon ull, ja ja kära barn jag har säcken full.” (*Baa baa black sheep, have you any wool? Yes, sir, yes sir, three bags full.*). Once they had read the text, the paper was removed, and they were allowed to start writing. They were sat in the same room opposite each other while completing the copy task.

### **3.4.5 Writing**

In the writing condition, the participants watched a video of a dog trying to catch food. They were then asked to write a blog post about learning new things, and were told that they may, but were not required to, use the dog in the video as an example. If they asked what a blog post was, or wanted clarification of the writing task, they were told that a blog post is a think-piece about a topic based on their own ideas and experiences. They did the writing in separate rooms and were given 30 minutes to complete the task. When the time was up, they were allowed to finish their text before ending the experiment if they needed to, however, no participant needed extra time to finish their text.

### **3.4.6 Questionnaire**

After completing the task in the three conditions (as well as the copy task), the participants were asked to fill in a questionnaire with background information as well as information about their texting habits. They were allowed to ask for clarification as they filled in the questionnaire if anything was unclear. The questionnaire can be found in Appendix A.

## **3.5 Ethical Considerations**

Ethical considerations were made based on the guidelines that can be found in CODEX (2020a) about research that involves humans, as well as the guidelines from Lund University (Student projects, 2019; Informed consent, 2019; Management of personal data, 2019). No sensitive personal data was collected, and all collected data was stored locally on a computer and an external hard drive, as well as on the password protected Lund University Humanities Lab servers to ensure that no unauthorized persons would be able to access the data.

Before the experiment, the participants were informed about the aim of the study as well as the procedure of the experiments. They were told that participation was voluntary and that they could withdraw their participation at any time during the experiment. They were also informed about

how the data would be stored and that it would be anonymized in the paper as well as in presentations based on the paper. They gave their spoken consent beforehand, and after the study was completed, they signed an informed consent form with detailed information about the experiment and data handling (CODEX, 2020b; Informed consent, 2019). The consent form can be seen in Appendix B.

### 3.6 Analyses

The analyses were carried out in different programmes for the three different conditions due to the different nature of the conditions. The data that was recorded in the speaking condition was transcribed and all perceived pauses were identified. For the data in the texting condition, the screen recording videos were annotated in ELAN and all pauses that were 1 second or longer were identified. The writing data was analysed in *ScriptLog* with a pause threshold of 1 second. The analyses are described in detail below.

In all three conditions, a smaller part of the data was analysed due to the time-consuming nature of the analyses. For speaking, the first 3 minutes of every conversation were analysed, for texting the first 10 minutes of every texting conversation was analysed, and for writing the first 15 minutes of the writing process of each participant was analysed. As for the transcriptions and analyses in the speaking condition, together they took about 1.5 hour per minute of recorded material. For the texting condition, the annotations and analyses for each file took about 4 hours per participant. For the writing condition, the analyses took about 0.5 hours to analyse per participant. Ideally, the entire language production process would have been good to analyse, but in the context of this thesis there was not enough time to analyse the entirety of the collected data.

#### 3.6.1 Pause criteria

For the pause analysis, all the pauses in the data were identified and analysed according to an annotation schema which is presented in section 3.6.2 Annotation schema. In the speaking condition, the pauses were identified during the transcription based on perception, a so-called perceived pause (Norrby, 2014). A perceived pause can be either a silent pause evident in the speech signal, or a filled pause as in a disfluency in the speech signal.

For the writing and texting conditions, the pauses were identified based on a convenience pause criterium – a pause was defined as a suspension of the written production that was 1 second or longer. Using a pre-defined pause threshold for the pauses does not consider that writers and texters may type at varying speeds, however, in order to operationalise the data, a pre-defined threshold was used (Wengelin, 2016; Chenu et al., 2014). Using a convenience criterium for pauses

means that the writing speed of each participant is not considered in the analyses since faster transition times may indicate the need for a lower pause threshold, whereas longer transition times between keys may mean that the pause threshold should be longer (Wengelin, 2006).

The data collected in the speaking condition were transcribed in the transcription programme *CLAN* (MacWhinney, 2000) using conversation analysis transcription conventions as described by Norrby (2014). The pauses were identified from a listener's perspective, meaning that the pauses were identified on a purely auditive basis. Since the pause criteria was that the pause should be a perceived pause, the pauses were not measured nor was a waveform used to identify pauses in the data. Apart from the pauses, overlaps were also marked in the transcription file. The analyses were cut off at the end of the last turn after 3 minutes.

For the data collected in the texting condition, the video files were annotated in the multimodal analysis programme *ELAN* (Wittenburg et al., 2006; ELAN, 2020) and all pauses that were 1 second or longer were identified. The analysis ended at ten minutes, and if a turn was being constructed at the ten-minute mark in the file, the entire turn was analysed. The participants' videos were analysed in isolation from each other, i.e. one screen recording was analysed at the time. This meant that the analyses cannot account for real-time overlaps between the files, instead overlaps were marked from the perspective of the writer – whenever the three dots indicating that the other person was writing appeared, this was marked as an overlap. This was due to the elicitation of the data where the recording on the two smartphones were started one at a time, meaning that there would be delays in the exact start of the recording. Currently, there is no other way to record the data than on two separate smartphones.

For the data collected in the writing condition, the analyses were done using *ScriptLog* (Wengelin, Frid, Johansson, & Johansson, 2019). The pause threshold in *ScriptLog* was set to 1 second and all analyses in *ScriptLog* were cut off at the 15-minute mark regardless of it being in the middle of a production burst or not.

### 3.6.2 Annotation schema

All pauses were analysed based on the grammatical unit or event that preceded them. Categorising the pauses based on what preceded them can help in understanding which constructions that are cognitively heavy to produce, and to see what it is that requires planning (Spelman Miller, 2006). Furthermore, a benefit of looking at the unit that precedes the pause as compared to what happens after the pause, e.g. as in Goldman-Eisler (1969), is that we can see what has been produced before the pause as compared to the numerous possibilities of what may come after the pause. Table 5 shows the pause categories and their definitions.

**TABLE 5***Definitions and Examples of the Pause Categories*

Category	Application	Example
Clause boundary	Pauses preceded by a grammatical unit that can be considered a clause. For the unit to be considered a clause, it needs a subject (implied or stated) and a predicate.	det är bra <pause> <i>it is good</i>
Phrase final	Pauses preceded by a grammatical unit without a predicate are categorized as phrase-boundary. E.g. pausing after saying only “you” constitutes a phrase-boundary.	ja precis <pause> <i>yes exactly</i>
Phrase-internal	Pauses preceded by a unit that is not a complete phrase, e.g. pauses after a determiner or transitive verb.	jag tänker att <pause> <i>i think that</i>
Word-internal	Pauses preceded by a non-complete word (such as typing “wou” and pausing).	om vi sk<pause> <i>if we wo</i>
Clause initial	Pauses preceded by a clause initial word, often a subordinate or dependent clause.	och <pause> <i>and</i>
Revision	Pauses preceded by any kind of revision or editing. In speaking, this can be the replacement of a word as well as false starts.	eller när <backspace4> <pause> <i>or when &lt;backspace4&gt;</i>
Overlap/Message (speaking/texting only)	Pause preceded by the other person talking (speaking) or sending a message (texting). For texting, this category has pauses that are preceded by the other person “reacting” to a message, i.e. they press a message and select a reaction that appears on screen.	-
Start (writing only)	Pause before the person starts writing.	-
Other	Pauses that do not fit any of the other categories	In texting pauses preceded by a keyboard change.

*The table shows all the pause categories used in the analyses. The left column shows the name of the category, the middle column describes how the category was applied to the data and the right column shows an example.*

When defining the categories, it was important to find categories that would be comparable across the three conditions. Because of the differences between written and spoken language production, with written language production often involving revisions and longer bursts, whereas spoken language production lacks the kind of revisions that can be found in writing and having shorter burst, the syntactic units to use for the categories have a broader definition than they might have when looking at the modalities in isolation.

The different grammatical categories were *clause-boundary*, *phrase final*, *phrase-internal*, *word internal*, *clause initial*, *revision*, *receiving a message/overlap* (only applicable to speaking and texting), *other*, and *start* (for writing only). The different pause categories present different syntactic units, however, some of these categories represent similar syntactic units but on different levels. For example, the categories *clause boundary*, *clause initial*, and *phrase final* all represent a syntactic boundary to some extent. The *clause initial* category consists of pauses that occur after a clause initial word and the *phrase final* category can be seen as a syntactic boundary at a lower level as compared to a “full clause” as defined in Table 5. In a sense, these three categories all present complete syntactic units.

The category *other* contains all the pauses where the preceding unit does not correspond to any of the predefined categories. One example of this in texting is pauses that are preceded by the participant changing the keyboard. In speaking, an example of a unit preceding a pause that was categorised as *other* was when it was not possible to discern what the participant was saying before the pause. In writing, an example was pauses preceded by a line change in the beginning of the file.

### 3.6.3 Production bursts

A production burst was defined as any string of production consisting of at least one word delimited on either end by a pause (Alves & Limpo, 2015). A word was defined as any complete uttered or typed word, an incomplete word that was completed in the next pause was counted as part of the production burst where the word was completed. A single typed and deleted character was not counted as a word, neither was any emoji or emoticon that was typed. The length of a burst was counted as the number of words that were produced between two pauses, including any complete words that were later deleted (in writing and texting). Abbreviations and acronyms were counted as one word. In Table 6 some examples of what the bursts looked like in the different conditions can be seen.

Table 6 also shows how the words have been counted in some of the bursts from the data. Revision of one word of the data in the texting and writing condition does not result in an additional word, however, in cases where the revision deletes one or more completed words with new ones, the total number of typed words were counted.

In the table, Speaking 1 shows a burst that contains six words, each counted word is delimited by a |. The speaker repeated the words “dom” (*the*) and “bästa” (*best*) but because the words were uttered as complete words two times, they are counted both times. Speaking 2 shows a burst that is 12 words long, and right before the pause the speaker says /t/, this /t/ is not counted since it does not constitute a word in Swedish.

**TABLE 6**

*Examples of Production Bursts in Speaking, Texting, and Writing*

Condition	Burst example	Word	
		count	Translation
Speaking 1	(.)   asså   dom   bästa   [dom]   bästa   djurmensen   (.)	6	<i>like the best [the] best animal memes</i>
Speaking 2	(.)   så   bruka   ja   känna   så   hä   när   mina   kollegor   har   sitt   årliga   t (.)	12	<i>then I usually feel like this my colleagues have their yearly t</i>
Texting 1	När   mN<backspace>An<backspace>an   går   från   jobbey <backspace>t   ovh <backspace>ch   har   semester	8	<i>When yo&lt;backspace&gt;On&lt;backspace&gt;on leave work and go on vacation</i>
Texting 2	Kom   på   en <backspace>   Jag   har   ek   tilln <backspace>yill<backspace>till   på   tjejen   som   gpr<backspace>år	11	<i>Came up with&lt;backspace&gt;I have one form&lt;backspace&gt;yor &lt;backspace&gt;for the girl who is ngr&lt;backspace&gt;walking</i>
Writing 1	<1.603><ENTER1>   Jag   be<BACKSPACE6>Efter   detta   video klipp   å<BACKSPACE1>på   knappt   1   minut   <1.217>*	8	<i>&lt;ENTER&gt;I be&lt;BACKSPACE6&gt;After this video clip f&lt;BACKSPACE1&gt;on barely 1 minute</i>
Writing 2	<7.673>Nyfiken <BACKSPACE1>het   är   en   intressa<BACKSPACE14><2.948>	3	<i>Curious &lt;BACKSPACE1&gt;ity is an interes&lt;BACKSPACE14&gt;</i>

*Square brackets in the speaking condition indicate an overlap with the other speaker and (.) indicates the pauses delimiting the burst. Each counted word is delimited by a | in the table.*

*Note* \*When one word was written with a space in between, as in *video klipp* instead of the correct form *videoklipp*, this was counted as one word

In Texting 1, the participant writes “När” (*When*), followed by the word “man” which is misspelled and edited two times before being completed, this is counted as two words. The participant also has a typo when writing “jobbet” (*work*) and changes this, again, this is counted as one word. The

same goes for the word “och” (*and*) which is also misspelled and corrected in the same burst. Texting 2 is a burst with 12 words, and the participants starts with writing “Kom på en” (*Came up with*) which is then deleted, these three words are counted towards the burst length.

In Writing 1, the participant starts with “Jag be” (*I be*), the “be” after the space is not counted towards the burst length since it is not a possible word in the context. Further, the word “video klipp” (*video clip*) is written as two words in the data but the correct spelling is “videoklipp”, instances like these when one word was written as two were always counted as one word. The last example, Writing 2, ends with the incomplete word “intress” (*interes*), which in the following turn is completed as the word “intressant” (*intresting*). In these cases, the word was counted as part of the burst in which it was completed, i.e. the next burst.

### **3.6.4 Statistical analyses**

The statistical analyses were done in R (R Core Team, 2019), and the data were analysed with a repeated measures ANOVA. The data that were used for the statistical analyses of pause locations can be found in Appendix C, and the data that were used for the statistical analyses of the burst lengths can be found in Appendix D.

## Chapter 4 : Results

In this chapter, the results are presented. First the results of the pause location analyses are presented individually for each condition, followed by a comparison between on the one hand speaking and texting, and on the other hand, writing and texting. After this, the results of the production burst analyses are presented individually for each condition. The production bursts of speaking are then compared to the production bursts of texting, and the production bursts in writing are then compared with the production bursts in texting. Lastly, the results are summarised.

### 4.1 Pause Location

#### 4.1.1 Pause Location in Speaking

For speaking, the analysed material consisted of a total of 27 064 transcribed characters and a total of 820 analysed pauses. An overview of the analysed data can be seen in Table 7. The table shows the number of transcribed characters in the analysed speaking data, i.e. the first three minutes of the recorded data, as well as the number of pauses that were identified during the transcription of the first three minutes of the recording. The transcribed characters were counted for each individual participant and added together. The number of characters does not include annotations that were used to indicate pauses and overlaps (e.g. square brackets etc.). The minimum and maximum number of characters and pauses shows the participant with the least or the largest number of characters or pauses.

**TABLE 7**

*Overview of the Analysed Data in the Speaking Condition*

	Mean	Median	SD	Min	Max	Total
Number of transcribed characters	1040.92	1074.00	269.86	508.00	1430.00	27 064.00
Number of analysed pauses	31.54	30.50	10.71	13.00	53.00	820.00

On average, each participant had 1040.92 transcribed characters, ranging from 508.00 to 1430.00 characters (SD=269.86). All pauses were categorized according to the syntactic unit that preceded them, and the results of the analyses can be seen in Table 8. The table shows how the pauses in the speaking condition were located in different syntactic units. The second column shows the total number of pauses that were analysed in each context. The mean shows the mean number of pauses



that were located in e.g. clause boundary or phrase internal context etc. The median shows the median number of pauses that were located in e.g. clause boundary or phrase internal context, and the SD shows the standard deviation in the data sample. Min shows the lowest number of pauses in the category by a participant, and max shows the highest number of pauses in the category by a participant.

Participants produced around 31 pauses each (Mean=31.54, Median= 30.50, SD=10.71), and the number of pauses ranged from 13 to 53 pauses. In speaking, the largest pause category was pauses that occurred after a clause, making up just a bit over half of the categorized pauses in the data: 53.29% (N=437). The participants made between 3 and 16 pauses in clause boundary contexts. The percentage of all pauses was calculated by dividing the number of pauses in each syntactic context (e.g. clause boundary, phrase internal etc.) with the total number of analysed pauses for the condition.

**TABLE 8***Distribution of Pauses in the Speaking Condition*

	Total number of pauses	Mean	Median	SD	Min	Max	Percentage of all pauses
Clause boundary	437.00	16.81	16.00	5.85	3.00	26.00	53.29%
Clause initial	77.00	2.69	3.00	2.39	0.00	9.00	9.39%
Phrase final	72.00	2.77	3.00	2.45	0.00	10.00	8.78%
Phrase-internal	173.00	6.65	6.00	5.35	0.00	19.00	21.10%
Word-internal	19.00	0.73	0.00	0.92	0.00	3.00	2.32%
Revision	23.00	0.88	0.50	1.28	0.00	5.00	2.80%
Message/Overlap	6.00	0.23	0.00	0.51	0.00	2.00	0.73%
Other	13.00	0.50	0.00	0.76	0.00	3.00	1.59%
All pauses	820.00						100.00%

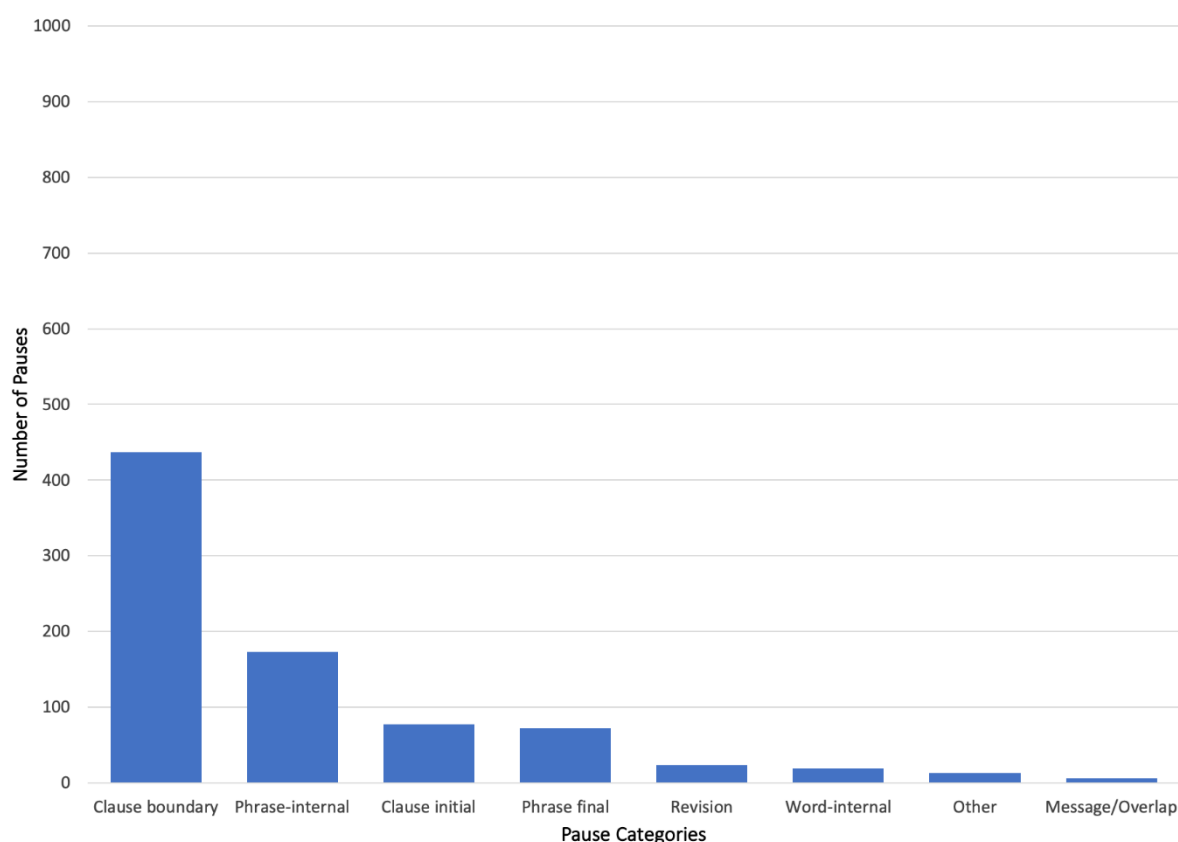
Pauses that occurred phrase internally were the second largest group, accounting for 21.10% (N=173) of all pauses in the analysed data, and the number of pauses that occurred in a phrase-internal context varied from 0 to 19 pauses. Pauses following a clause initial word such as “but” made up 9.39% (N=77) of all analysed pauses. The difference between the *clause boundary* category

and the *clause initial* category is that pauses categorised as *clause initial* all occur after a clause initial word whereas the pauses in the *clause boundary* category are preceded by the end of a clause. The two categories comprise two kinds of clause boundaries. The category *phrase final* contains the pauses that occur after a complete phrase that is not a clause, for example a noun phrase such as “the big bird”. The *phrase final* category, together with *clause boundary* and *clause initial* categories, all represent boundaries between different syntactic units, as compared to the categories *phrase internal* and *word internal* which represent pauses that occur in the middle of a syntactic unit.

When combining the categories that correspond to different syntactic boundaries, *clause boundary*, *clause initial* and *phrase boundary*, they amount to 71,46% (N=586) of all pauses in the speaking data. Pauses following a revision made up 2.80% of all analysed pauses (N=23), pauses occurring word-internally made up 2.32% of all analysed pauses (N=19). Pauses that did not fit into any other category made up 1.59% (N=13) of the analysed pauses, and lastly, pauses following immediately after an overlap accounted for 0.73% of the pauses (N=6). A visual representation of the pause distribution in the speaking condition can be seen in Figure 2.

**FIGURE 2**

*Pause Distribution in Speaking*



*This bar plot shows the total number of pauses for each category in the speaking condition. The y axis shows the number of pauses, and the x axis shows the pause categories.*

#### 4.1.2 Pause Location in Writing

In the writing condition, the analysis consisted of data totalling 56 358 written characters, including 11 454 deleted characters. Table 9 shows an overview of the analysed data in the writing condition. The table gives an overview of the number of characters that were written and deleted in the data by all participants, as well as the number of characters in the final text, i.e. the number of characters that the participants “kept” in their text. Only characters from the data that was analysed (i.e. from the selected material) is included in this table. All characters were counted using *ScriptLog*. The participants wrote between 1153 and 3967 characters (Mean=2167.62, Median=1991.50, SD=595.55), and deleted between 80 and 1029 characters (Mean=440.54, Median=383.50, SD=246.59) in the data that was analysed.

**TABLE 9**

*Overview of the Analysed Data in the Writing Condition*

	Total number of written characters: analysed data	Deleted characters: analysed data	Final text: analysed data
Mean	2167.62	440.54	1727.08
Median	1991.50	383.50	1726.50
Min	1153.00	80.00	823.00
Max	3967.00	1029.00	3364.00
SD	569.55	246.59	587.90
Total	56 358	11 454	44 904

The pause distribution in the writing condition can be seen in Table 10. The table shows how the pauses in the writing condition were located in different syntactic units. The second column shows the total number of pauses analysed for each context. The mean shows the mean number of pauses that were located in e.g. revision or clause boundary context etc. The median shows the median number of pauses that were located in e.g. clause boundary or phrase internal context, and the SD shows the standard deviation in the data sample. Min shows the lowest number of pauses in the category by a participant, and max shows the highest number of pauses in the category by a participant.

The analysed data consisted of 2 664 pauses and the participants produced between 69 and 141 pauses (Mean=102.46, Median= 98.50, SD=20.41). In writing, the most common pause category

was pauses that were preceded by a revision, making up 36.06% (N=934) of the analysed pauses. The participants made between 10 and 73 pauses after revisions (Mean=35.92, Median=33.50, SD=15.11), meaning that there is a large variety in the data. The participants made between 22 and 55 pauses after completing a clause (Mean=33.27, Median=33.00, SD=8.06), and the total number of pauses at a clause boundary made up 32.47% (N=865) of the analysed pauses.

**TABLE 10***Distribution of Pauses in the Writing Condition*

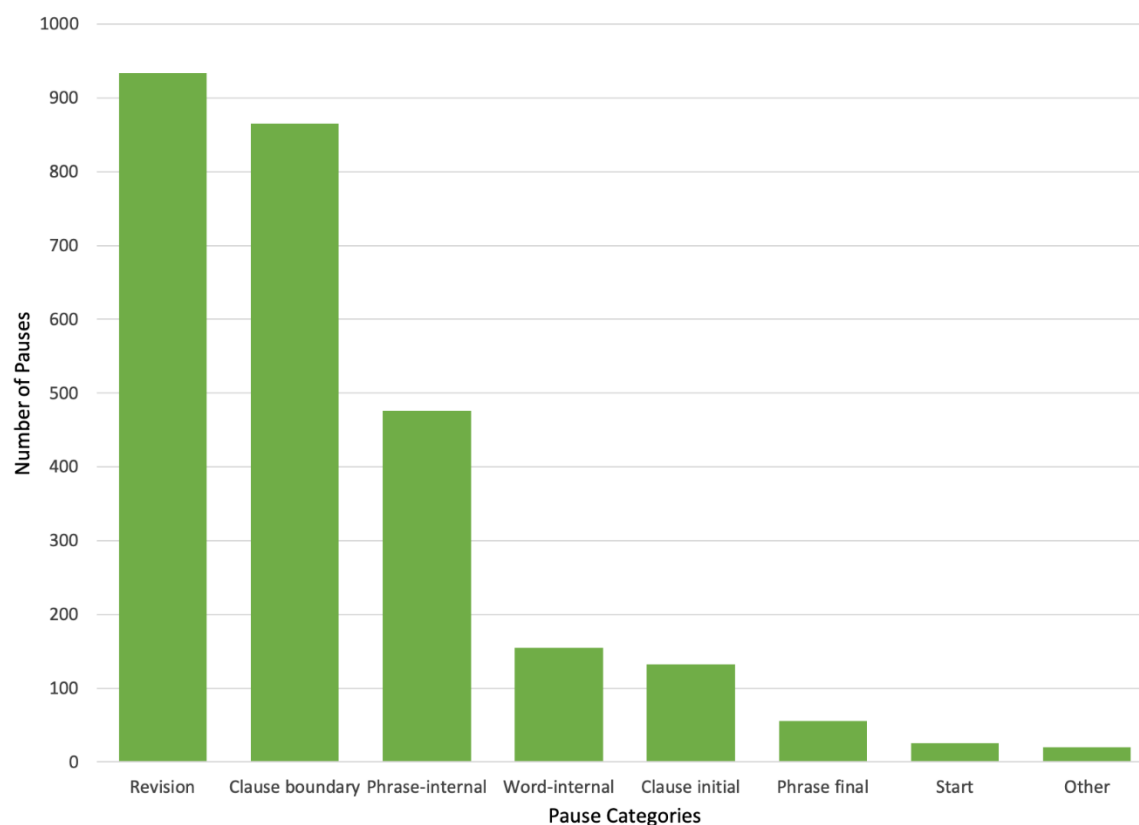
	Total number						Percentage of
	of pauses	Mean	Median	SD	Min	Max	all pauses
Clause boundary	865.00	33.27	33.00	8.06	22.00	55.00	32.47%
Clause initial	132.00	5.08	4.00	3.36	1.00	13.00	4.95%
Phrase final	56.00	2.15	2.00	2.26	0.00	10.00	2.10%
Phrase-internal	476.00	18.31	18.50	6.93	0.00	34.00	17.87%
Word-internal	155.00	5.96	5.00	4.21	2.00	23.00	5.82%
Revision	934.00	35.92	33.50	15.11	10.00	73.00	35.06%
Start	26.00	1.00	1.00	0.00	1.00	1.00	0.98%
Other	20.00	0.77	0.00	1.58	0.00	7.00	0.75%
All pauses	2664.00						100.00%

The third biggest pause category was pauses occurring phrase internally which made up 17.87% (N=476) of all analysed pauses. The participants made between 0 and 34 (Mean=18.31, Median=18.50, SD=6.93) pauses within phrases. Pauses that occurred mid-word accounted for 5.82% (N=155) of the analysed pauses, and pauses preceded by a clause initial word accounted for 4.95% (N=132) of the analysed pauses. 2.10% (N=56) of the analysed pauses occurred after a complete phrase. In the writing condition, each participant has one pause that was the initial pause, i.e. the pause after the recording started and before they started to type. These pauses accounted for 0.98% (N=26) of the total number of pauses. Less than one percent of the analysed pauses, more specifically 0.75% (N=20), were pauses that did not fit in to any other category, and these were categorised as *other*.

When combining the pauses occurring at syntactic boundaries, *clause boundary*, *clause initial*, and *phrase final*, these make up 39.53% (N=1053) of the pauses in writing. A visualisation of the pause distribution in the writing condition can be seen in Figure 3, with the largest category on the left-hand side of the figure and the smallest category on the right-hand side of the figure.

**FIGURE 3**

*Pause Distribution in Writing*



*The bar plot shows the distribution of the pauses in writing. The x axis shows the pause categories and the y axis shows the total number of pauses in each category, from the largest group to the smallest.*

#### 4.1.3 Pause Location in Texting

In the texting condition, the analysed data consisted of 20 282 written characters, including 4011 deleted characters. Table 11 shows an overview of the analysed data in the texting condition. The total number of written characters includes written and deleted characters. The deleted characters are all characters that the participants deleted in the analysed data, and the sent characters are the characters that the participant sent in their messages. One emoji was counted as one character, two as two characters, etc.

The participants wrote between 336 and 1257 characters (Mean=780.08, Median=755.00, SD=340.71), and deleted between 29 and 319 characters (Mean=157.27, Median= 150.00, SD=72.53). In the analysed data, the participants sent between 285 and 1150 characters, and the total number of sent characters was 16 271. Sent characters refer to the characters that the participants sent to each other, it is the total number of written characters minus the number of deleted characters. This can be compared to the final text in the written condition, it is the characters that the participants did not delete that became the output in the texting conversation that the other person would read.

**TABLE 11**

*Overview of the Analysed Data in the Texting Condition*

	Total number of written characters: analysed data	Deleted characters: analysed data	Sent characters: analysed data
Mean	780.08	154.27	625.81
Median	755.00	150.00	561.00
Min	336.00	29.00	285.00
Max	1257.00	319.00	1150.00
SD	240.71	72.53	229.70
Total	20 282.00	4011.00	16 271.00

Table 12 shows the pause distribution in the texting condition. The second column shows the total number of pauses that were analysed in each context, e.g. all pauses occurring after a clause boundary. The mean shows the mean number of pauses for each participant that were located in e.g. clause boundary or phrase internal context etc. The median shows the median number of pauses for each participant that were located in e.g. clause boundary or phrase internal context, and the SD shows the standard deviation in the data sample. Min shows the lowest number of pauses in the category by a participant, and max shows the highest number of pauses in the category by a participant.

The largest pause category in texting was pauses that were preceded by a clause, making up 30.55% (N=216) of the analysed pauses. The second largest group was pauses preceded by a revision which made up 27.02% (N=191) of the pauses in the texting condition. Pauses that occurred within an incomplete phrase, categorised as phrase-internal, made up 13.15% (N=93) of

the analysed pauses, and pauses that were preceded by a complete phrase made up 7.78% (N=55) of the analysed pauses.

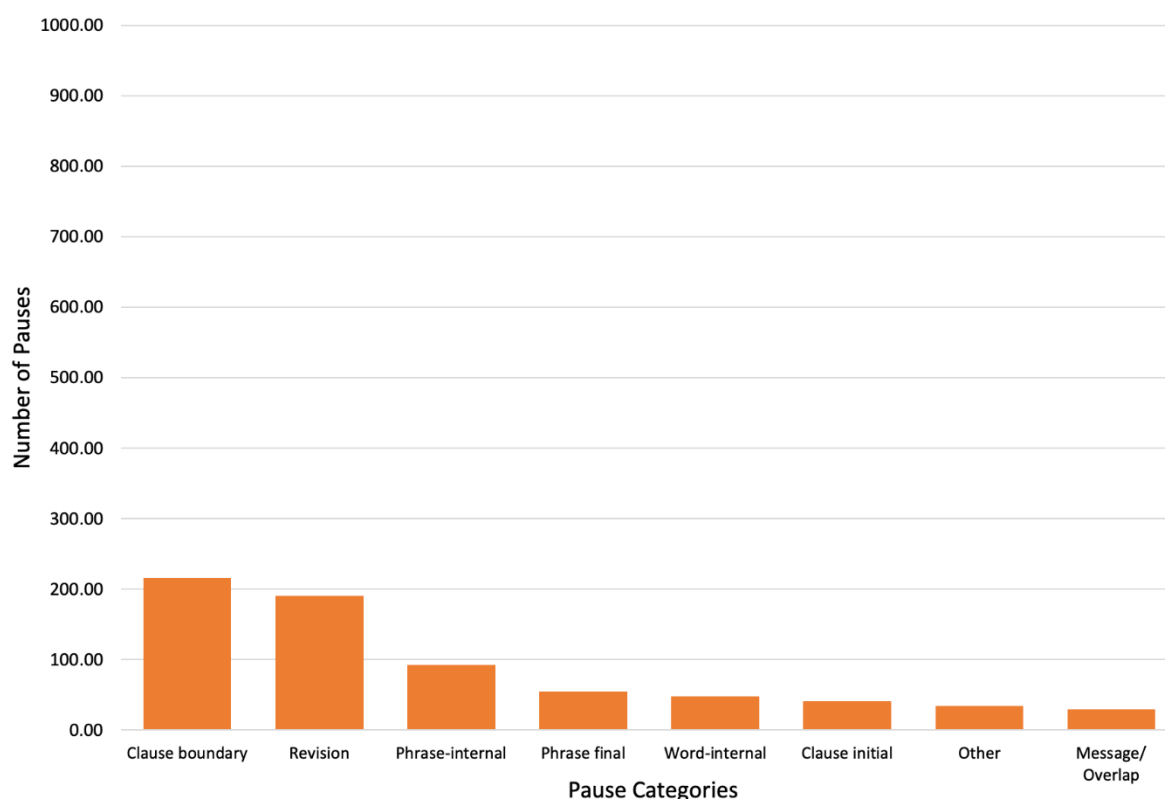
Pauses that occurred within a word, i.e. in a word internal context, made up 6.79% (N=48) of the pauses in the texting condition. Pauses that occurred in a clause initial context made up 5.80% (N=41) of the analysed pauses and pauses that were preceded by receiving a message made up 4.10% (N=29) of the analysed pauses. The category for pauses that did not fit into any of the other categories, such as pauses preceded by a keyboard change made up 4.81% (N=34) of the analysed pauses. A visual representation of the pause distribution on the texting condition can be seen in Figure 4.

**TABLE 12**

*Distribution of Pauses in the Texting Condition*

	Total number						Percentage of
	of pauses	Mean	Median	SD	Min	Max	all pauses
Clause boundary	216.00	8.31	7.50	4.51	2.00	17.00	30.55%
Clause initial	41.00	1.58	1.00	1.14	0.00	5.00	5.80%
Phrase final	55.00	2.12	2.00	1.40	0.00	5.00	7.78%
Phrase-internal	93.00	3.58	3.50	2.52	0.00	12.00	13.15%
Word-internal	48.00	1.85	1.00	2.41	0.00	9.00	6.79%
Revision	191.00	7.35	8.00	3.49	1.00	14.00	27.02%
Message/Overlap	29.00	1.12	1.00	1.21	0.00	3.00	4.10%
Other	34.00	1.31	0.00	2.04	0.00	7.00	4.81%
All pauses	707.00						100.00%

When combining the categories *clause boundary*, *clause initial*, and *phrase final*, which correspond to pauses that occur at a syntactic boundary, these make up 44.13% (N=312) of the analysed pauses.

**FIGURE 4***Pause Distribution in Texting*

*A bar plot showing the distribution of the pause categories in writing. The y axis shows the total number of pauses, and the x axis shows the pause categories, from the largest group to the smallest.*

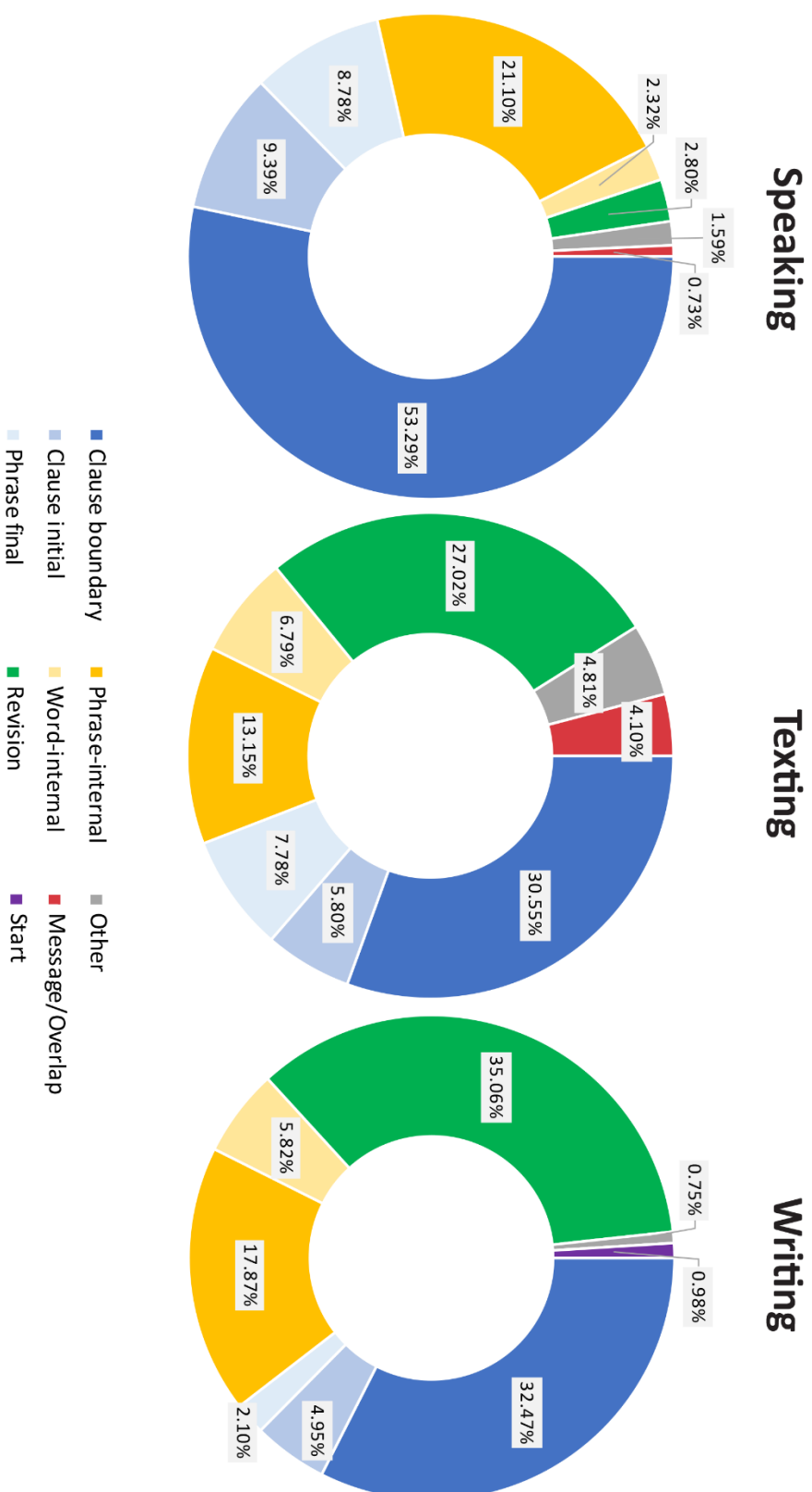
#### 4.1.4 Pause Location in Speaking as Compared to Texting

A visualisation of the pause distribution between the three conditions can be seen in Figure 5. In the speaking and the texting condition, the largest pause category was *clause boundary*. In speaking, more than half of the pauses occurred after a finished clause, more specifically 53.29% of the pauses. In texting, on the other hand, less than a third of the pauses occurred after a clause, more specifically 30.50% of the pauses. Even though it was the largest category in both conditions, the difference in the proportion of pauses occurring after a clause in the speaking condition as compared to the texting condition was significant ( $F(1,25) = 51.090$ ,  $p = 0.000$ ), meaning that there was a significantly higher proportion of pauses occurring at a clause boundary in speaking as compared to texting.



**Figure 5**

*Comparison of the Pause Distribution in Speaking, Texting, and Writing*



Three donut diagrams showing the different percentages for all pause locations in speaking, texting, and writing. The percentages show the proportion of pauses that occurred in the different syntactic contexts, e.g. clause boundary, clause initial etc.

In the speaking condition, pausing occurring in a phrase-internal context made up 21.10% of the pauses, in texting, this category held 13.15% of the analysed pauses. The statistical analyses showed that the difference between speaking and texting in regards to a phrase internal context was significant ( $F(1,25) = 4.856$ ,  $p = 0.001$ ), meaning that the proportion of pauses that occurred in phrase-internal contexts was larger in speaking than texting.

In the speaking and texting conditions, clauses following a clause initial word made up 9.39% and 5.80% of all pauses respectively. The statistical analyses showed that the difference was not significant ( $F(1,25) = 4.055$ ,  $p = 0.055$ ), meaning that there was no notable difference between speaking and texting in regards to pauses preceded by a clause initial word. The percentages of pauses occurring at a phrase boundary were similar in speaking and texting, with speaking having 8.78% of pauses in phrase boundary context, and texting 7.78% of the pauses in phrase boundary contexts. The statistical analyses showed that the difference was not significant ( $F(1,25) = 1.061$ ,  $p = 0.313$ ), meaning that there was not a significant difference in the proportion of pauses occurring in a phrase final context in speaking and texting.

There was a large difference in the percentage of pauses that occurred after a revision, in speaking 2.80% of pauses occurred after a revision where in texting 27.02% of the pauses occurred after a revision. This difference in the percentage of pauses that occurs after a revision was significant ( $F(1,25) = 84.130$ ,  $p = 0.000$ ), meaning that a significantly higher proportion of pauses were preceded by a revisions in texting.

Pauses that occurred in a word internal context made up 2.32% of the pauses in speaking, and 6.79% of the pauses in texting. The statistical analyses showed that the difference was significant ( $F(1,25) = 4.588$ ,  $p = 0.042$ ), showing that in speaking there was significantly less pauses that were word internal as compared the proportion in texting. Lastly, the pauses that were preceded by an overlap in speaking, or receiving a message in texting, made up 0.73% of the pauses in speaking and 4.10% of the pauses in texting. This difference was also significant ( $F(1,25) = 11.820$ ,  $p = 0.002$ ), meaning that there were less pauses after an overlap in speaking as compared to pauses after receiving a message in texting.

#### **4.1.5 Pause Location in Writing as Compared to Texting**

In the writing condition, the most common context in which pauses occurred was after a revision, making up 35.06% of the pauses. In texting, 27.02% of the pauses occurred after a revision. This difference was significant ( $F(1,25) = 4.868$ ,  $p = 0.037$ ), meaning that there were more pauses preceded by a revision in writing as compared to texting.

The percentage of pauses that occurred in a clause boundary context was 32.47% for writing and 30.55% for texting and this difference was not significant ( $F(1,25) = 1.001$ ,  $p = 0.327$ ), meaning that there was no significant difference between the proportion of pauses in clause boundary contexts between the writing and texting conditions. Pauses that occurred in a phrase internal context made up 17.87% of the pauses in writing, and 13.15% of the pauses in texting. This difference was significant ( $F(1,25) = 5.927$ ,  $p = 0.022$ ), meaning that there was a larger proportion of pauses that occurred phrase internally in writing as compared to texting.

The pauses that occurred in a word internal context made up 5.82% of the pauses in writing compared to 6.79% of the pauses in texting. This difference was not significant ( $F(1,25) = 0.188$ ,  $p = 0.668$ ), meaning that there was no significant difference between word internal pauses in writing as compared to texting. Pauses following a clause initial word made up 4.95% of the pauses in writing and 5.80% of the pauses in texting. This difference was not significant ( $F(1,25) = 1.961$ ,  $p = 0.174$ ), meaning that there was no significant difference between the proportion of pauses that occurred after a clause initial word in writing as compared to texting.

Pauses that occurred in a phrase final position made up 2.10% of the pauses in writing, and 7.78% of the pauses in texting. This difference was significant ( $F(1,25) = 22.330$ ,  $p = 0.000$ ), meaning that there was a smaller proportion of pauses in phrase final position in writing as compared to texting.

## **4.2 Production Bursts**

The length of the production bursts was calculated based on the number of completed words between two pauses. In the texting and writing conditions, words that were deleted were counted towards the burst length. In the speaking condition, words that were repeated were counted towards the burst length if both the initial vocalisation and the repetition of the word were completed. Below the results of the production burst analyses are presented.

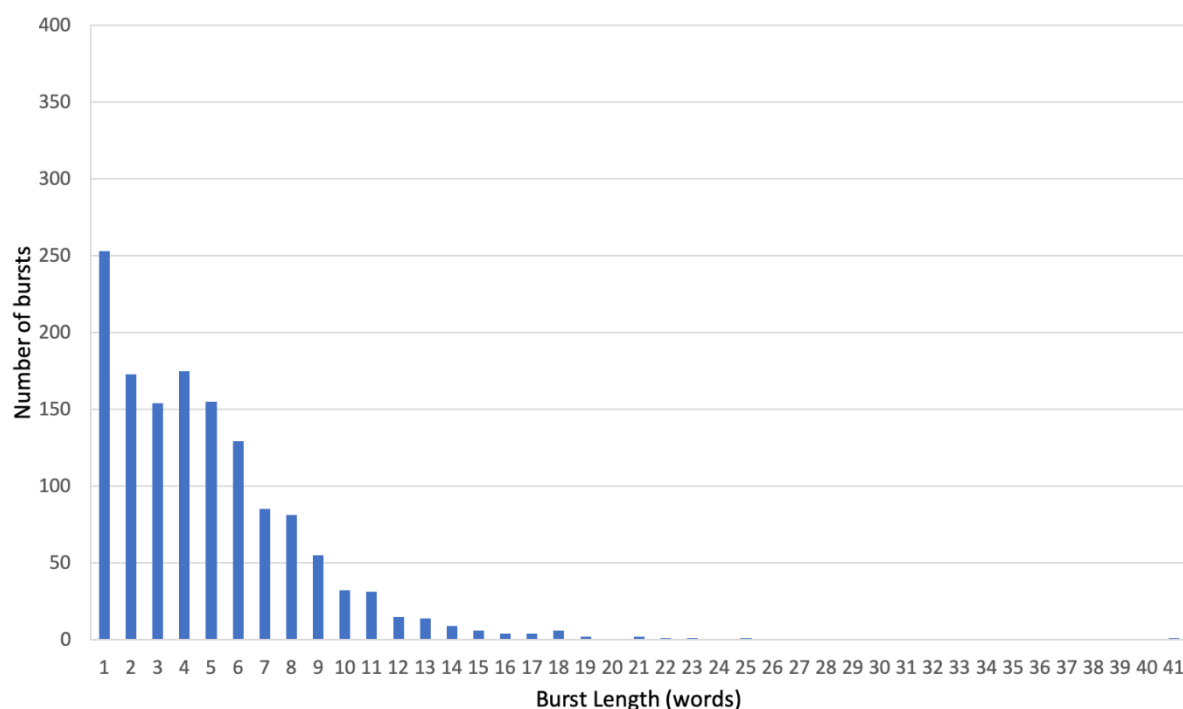
### **4.2.1 Speaking**

In the speaking condition, the participants made between 33 and 73 total bursts (Mean=53.69, Median=52.00, SD=11.56), and the total number of bursts in the analysed data was 1396 bursts. Participants who had many pauses also had more bursts. The length of the bursts ranged from 1 to 41 words, and the participants had a mean burst length of between 3.13 and 6.84 words, meaning that on average the participants produced between 3 and 7 words between pauses. Bursts that were between 3 and 7 words made up 50.00% (N=698) of all bursts in the speaking condition. The mean

burst length for all burst in the speaking condition was 4.86 words. Figure 6 shows all bursts in the speaking condition.

**FIGURE 6**

*Burst Lengths in Speaking*



*The figure shows the length of all burst produced in the speaking condition. The x axis shows the burst length in words and the y axis shows the total number of bursts in the analysed data for each of the burst lengths.*

The burst lengths of two, three, four, five, and six words are all around 150 bursts each in the entirety of the analysed data, and from the length seven and up, there is a steady decrease in the number of bursts for each burst length. Based on the findings of Goldman-Eisler (1968) that the majority of bursts in speaking are six words or shorter, dividing the bursts into six words or shorter, and seven words and above shows that 74.43% (N=1039) of the bursts are six words or shorter.

#### 4.2.2 Writing

In the writing condition, the participants made between 50 and 95 bursts (Mean=67.69, Median=64, SD=11.90), and the total number of bursts in the analysed data was 1760 bursts. One burst in the writing condition was defined as an outlier, with a burst length of 71 words. This occurrence was checked properly and mistakes during the analysis could be ruled out. The outlier was removed from the calculations. Texts that had many pauses above the pause criteria also had many bursts.

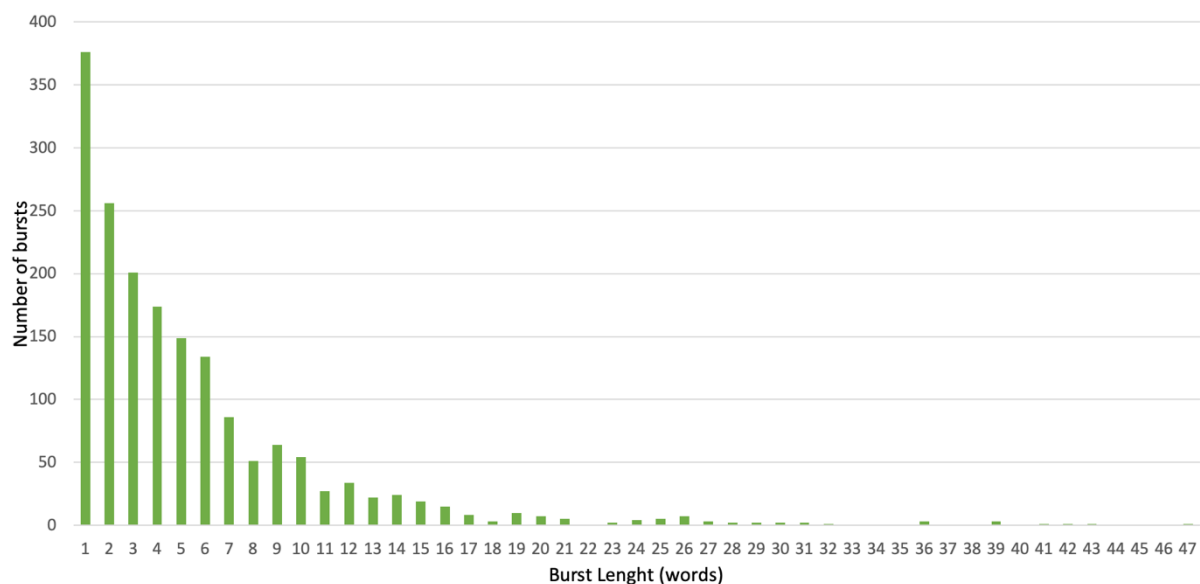
The length of the bursts varied between 1 and 47 words, and the mean burst length varied between 3.35 and 11.98 words, meaning that on average the participants produced between 3 and

12 words between pauses. Bursts that were between 3 and 12 words long comprised 55.37% (N=974) of the bursts in the writing condition.

The mean burst length of all bursts in the writing condition was 5.42 words. Figure 7 shows all bursts in the writing condition. For each of the burst length two, three, and four words there is 150 or more bursts for each length in the analysed data.

**FIGURE 7**

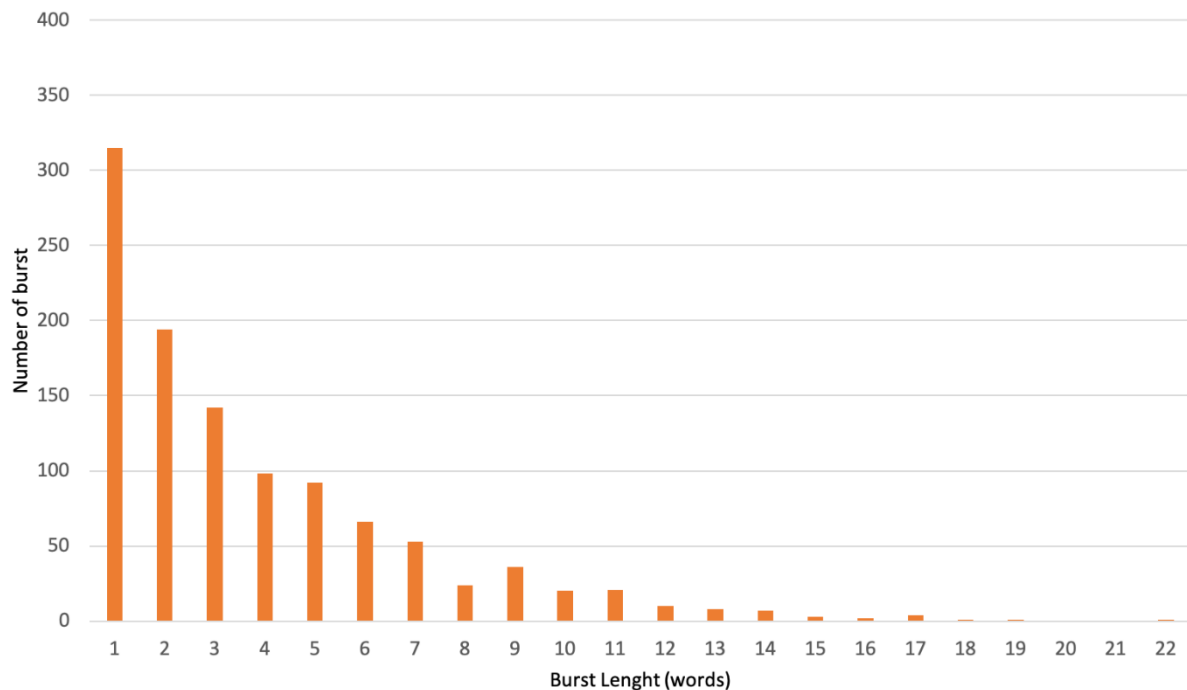
*Burst Length in Writing*



*The figure shows the length of all burst produced in the writing condition. The x axis shows the burst length in words and the y axis shows the total number of bursts in in the analysed data for each of the burst lengths.*

#### 4.2.3 Texting

In the texting condition, the participants made between 17 and 62 total bursts (Mean=42.23, Median=44.50, SD=11.78), and the total number of bursts in the analysed data was 1098 bursts. The length of the bursts varied between 1 and 22 words, and the mean burst length varied from 2.49 to 5.93 words per bursts. This means that, on average, the participants produced between 2 and 6 words between each pause. The bursts that were between 2 and 6 words long made up 53.92% (N=592) of the bursts in the texting condition. The mean burst length for all bursts in the texting conditions was 3.84 words. Figure 8 shows all bursts in the texting condition.

**FIGURE 8***Burst Lengths in Texting*

*The figure shows the length of all burst produced in the texting condition. The x axis shows the burst length in words and the y axis shows the total number of bursts in the analysed data for each of the burst lengths.*

#### 4.2.4 Production Bursts in Texting as Compared to Speaking and to Writing

In Figure 9, the percentage of the different burst lengths for each condition can be seen. In the figure, it is visible that texting has the largest percentage of bursts that were one, two, or three words long, speaking has the largest percentage of burst that were four, five, six, seven, eight and nine word long, and for bursts that were longer than nine words writing is the condition where the largest proportions of these bursts occurred.

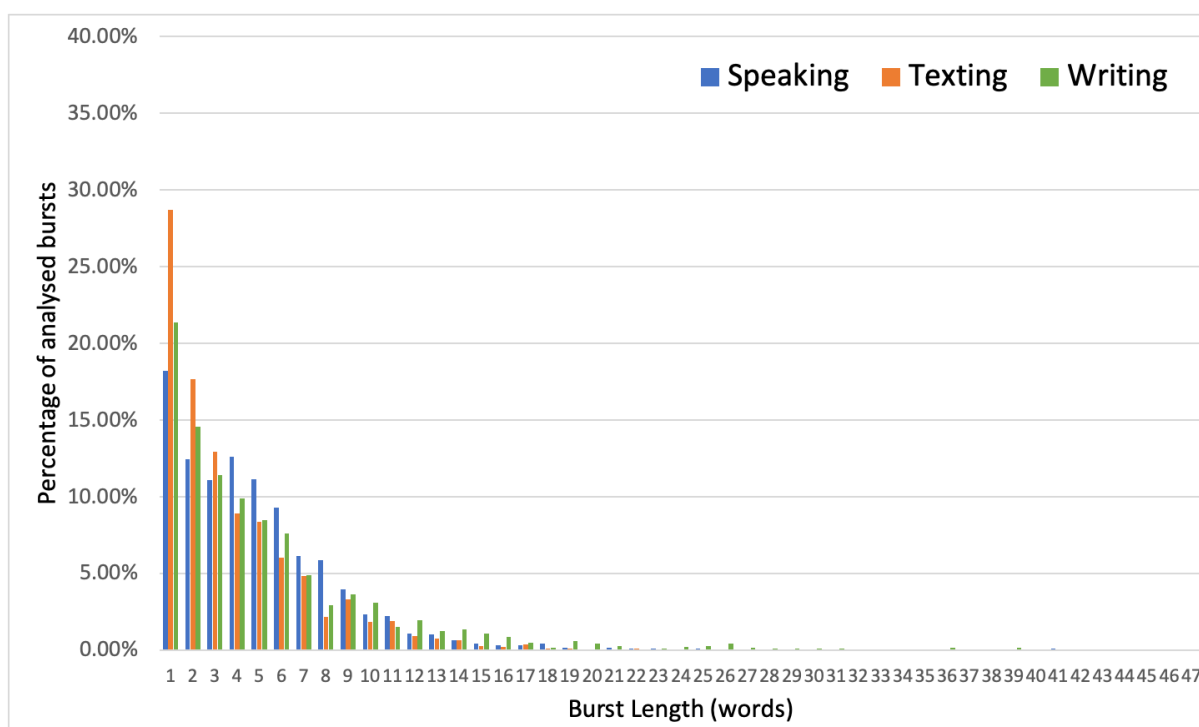
In the speaking condition, the average burst length varied from 3.13 to 6.84 words per burst as compared to the texting condition where the average burst length varied between 2.49 and 5.93 words. A repeated measures ANOVA analysis where the mean burst length for each participant was compared showed that the difference between burst lengths in speaking and texting was significant ( $F(1,25) = 30.560$ ,  $p = 0.000$ ), meaning that the bursts in speaking were significantly longer than the bursts in texting.

In the writing condition, the mean burst length varied between 3.35 to 11.98 words per burst, as compared to the texting condition where the mean burst length varied between 2.49 and 5.93 words per burst. A repeated measure ANOVA showed that this difference was significant ( $F(1,25)$

= 19.510,  $p = 0.000$ ), meaning that the bursts in writing were significantly longer in writing as compared to texting.

**FIGURE 9**

*Comparison of the Production Bursts in Speaking, Writing, and Texting*



*The figure shows the proportion of different burst lengths in speaking, texting and writing. The x axis shows the burst length in words, and the y axis shows the percentage of bursts for each length. The blue bars show the bursts in speaking, the orange bars show the bursts in texting, and the green bars show the bursts in writing.*

### 4.3 Summary of the Results

In the speaking condition, the most common pause location was at clause boundaries. This was also true for the texting condition, but the proportion of pauses at clause boundary was significantly lower in texting as compared to speaking. In writing, pauses occurring in a clause boundary context was the second largest group and there was no significant difference between writing and texting in the proportion of pauses found in clause boundary contexts.

Pauses that occurred in a clause initial context could be found in all three conditions but was most common in the speaking condition. The texting conditions had a lower proportion of clause initial pauses, but this difference was not statistically significant, neither was the difference between texting and writing. The proportion of pauses occurring in a phrase final context was largest in speaking, and texting had just around 1% less pauses in this context. This difference was not

significant, the difference between texting and writing, on the other hand, was significant with writing having less pauses in this context as compared to texting.

Some pauses occurred within an incomplete syntactic unit, such as within a phrase. Speaking had the largest proportion of these pauses, and texting had significantly less pauses in phrase internal context as compared to both speaking and writing. Pauses that occurred mid-word were least common in speaking, and texting had significantly larger proportion of pauses in a mid-word context as compared to speaking. The writing condition had the largest proportion of pauses occurring mid-word, but the proportion was not significantly larger than in texting.

The speaking condition had the lowest proportion of pauses that occurred after a revision, and texting had a significantly larger proportion of pauses preceded by a revision as compared to speaking. The writing condition had the largest proportion of pauses preceded by a revision, and texting had significantly less pauses in a revision context as compared to writing. Pauses that were preceded by an overlap in speaking or receiving a message in texting were significantly more common in texting than in speaking.

As for the productions burst, the mean burst length in speaking was between 3 and 7 words, in texting it was between 2 and 6 words, and lastly, in writing it was between 3 and 12 words. The difference between mean burst length between speaking and texting was significant, as was the difference between writing and texting, with texting having significantly shorter bursts as compared to both speaking and writing.



## Chapter 5 : Discussion

In this chapter, the results will be discussed along with possible explanations for any differences and similarities between on the one hand, texting and speaking, and on the other hand, texting and writing. The discussion starts with the pause locations in the different conditions, followed by a comparison of speaking and texting, and then writing and texting along with possible explanations for the results. This is then followed by a discussion of the results from the production burst analyses, with possible explanations for the differences between the conditions. Finally, the results are used for a proposed model of the language production processes in texting.

### 5.1 Pause Location in Speaking, Writing and Texting

In this section, the pause locations in speaking, writing, and texting will be discussed one by one. In the speaking condition, more than half of the pauses occurred in clause boundary contexts, confirming previous studies that have found that clause boundaries are an important context for pauses (Goldman Eisler, 1968; Matsushashi, 1981; Spelman Miller, 2006). One explanation for this in speaking is that because the listener is temporally and spatially present, speech needs to come in comprehensible chunks of language. Clause boundaries represent complete syntactic units that are not cut-off, and one explanation for the importance of clause boundaries in speaking is that the pauses are also used by the listener to process what is being said, as proposed by Clark (1996).

As can be seen above, pauses in phrase internal contexts also make up a large proportion of the pauses in speaking. One explanation for this is that these pauses are when the speaker is pre-occupied by micro-planning, as described by Spelman Miller (2006). That is, that the speaker produces a determiner and after this, pauses to retrieve the right word or phrase to follow. These pauses can also be filled pauses where the speaker is repeating the determiner before producing a content word (Maclay & Osgood, 1959). As a contrast to this, only a very small proportion of the pauses occur in a word-internal context, which may be a result of how speakers need to adapt their production to the spatial and temporal presence of the listener. For example, speakers might rather pause after a determiner, phrase-internally, than mid-word because the listener is present. The spatial presence of the listener means that it is important for the speaker to pause in a way that does not disrupt the understanding for the listener, while simultaneously indicating that they are not done talking and intend to keep the floor (Clark, 1996).

In the writing condition, pauses after revisions was the most common context for pauses, confirming previous studies that have found that written language is edited and refined during the writing process (Linell, 2005; Johansson, 2009). Further, reviewing and working with the text so

far is one of the processes involved in the writing process as described by Hayes (1996), so pausing after a revision can indicate that the writer is preoccupied with reviewing processes. Another important context for pauses in writing is at clause boundaries, again, confirming findings from previous studies (Goldman Eisler, 1968; Matsuhashi, 1981; Spelman Miller, 2006). While the reader is neither spatially nor temporally present during written language production, clause boundaries are still an important pause location suggesting that syntactic units are important for language producers when they write, as suggested by Spelman Miller (2006). This can also be aligned with e.g. Fromkin (1973) who suggested that language is planned in syntactic units as opposed to being planned word-by-word. As can be seen above, phrase-internal contexts are also important in written language production, suggesting that writers engage in micro-planning such as word retrieval (Spelman Miller, 2006). Pauses in a phrase final context only make up a small proportion of the pauses, perhaps due to the asynchronous nature of writing where there is no need for short answers to questions.

In the texting condition, as can be seen above, clause boundaries were an important context for pauses, confirming what has been found in previous studies that clause boundaries are important in language production (Goldman Eisler, 1968; Matsuhashi, 1981; Spelman Miller, 2006). The results also showed that revisions make up an important context in texting, suggesting that texters edit what they are typing before sending it. One reason for this may be that they need to ensure that the person who will receive the message will be able to understand it, as written language needs to be explicit (Chafe & Danielwicz, 1987). Phrase-internal context was an important location for pauses in texting, suggesting that micro-planning is taking place there as well (Spelman Miller, 2006). Pauses occurring in a phrase final context were also common in the texting condition which can be a result of the turn-construction in texting, where the texters need to type and send their messages quickly to avoid *false adjacency pairs* as suggested by Garcia and Jacobs (1998) and Markman (2005).

To summarise, clause boundaries are important in all three conditions, indicating that clauses are an important planning unit in all conditions. Clause boundaries seem to be a natural context for pausing, and it could be used to review what has been said or written, and if it corresponds to what was intended as well as to plan forwards. Further, revisions were important context for pausing in texting and writing, suggesting that language users are engaged in reviewing after a revision. Phrase-internal contexts were important in all three conditions, suggesting that micro-planning is an important aspect in language production across the modalities. Word-internal contexts, on the other hand, were more important in writing and texting as compared to speaking,

indicating that the spatial presence constraint have an effect on speakers resulting in them pausing in locations that work well in the presence of the listener.

## 5.2 Comparison of Pause Location in Speaking and Texting

In this section, the differences and similarities in pause location in speaking as compared to texting will be discussed along with the possible explanations for these differences and similarities. There were several significant differences between speaking and texting, perhaps a result of the two conditions belonging to different sensory modalities. Speaking had a significantly larger proportion of pauses in clause boundary contexts, this may be a result of speakers adapting their spoken language production to the spatial presence of the listener, whereas in texting, the reader is not present and will not see how the language production unfolds in time. However, clause boundary context still made up a large proportion of the pauses in texting.

Similarly, the larger proportion of phrase-internal contexts for pauses in speaking may also be because of the spatial presence constraint. Speakers can utilise filled pauses to keep their turn (Clark, 1996; Norrby, 2014), whereas texters construct their turn in isolation (Markman, 2005), and as such pausing does not affect the turn-taking in texting.

As mentioned above, speakers had a significantly lower proportion of word-internal pauses as compared to texting, again, this can be because the spatial presence constraint means that speakers generally try to produce language in comprehensible chunks as opposed to pausing mid-word to change what they are saying. In regard to the proportion of pauses preceded by a revision being significantly lower in speaking as compared to texting, texting is visual, and it lacks the spatial presence of the reader. This means that texters can revise and edit their text in order for the reader to be able to understand it. Speakers, on the other hand, are faced with the spatial presence of the listener who has access to the language production process as it unfolds in real-time, and as such, speakers adapt their planning so that the language production can be interpreted at the same time as it is produced.

The difference that was found between pauses preceded by overlaps/messages can be a result of the physical environment in which the texters produce language. The physical environment, in this case a smartphone texting app, is part of the individual-environmental model of written language production by Hayes (1996). In this case, the physical environment, and more specifically, the writing tool, enables texters to receive messages at the same time as they are constructing a turn. This can then result in a pause where they either read, re-plan what they are typing, or both.

The lack of any significant difference between pauses in phrase final position can be explained by the temporal presence of the listener/reader resulting in shorter turns. Because the speaking and

texting conditions were synchronous, the language production was done in turns. However, it is important to note that while speakers produce their turn in the presence of the listener, texters produce their turn in isolation. As such, texters need to type fast in order to avoid misunderstandings in the form of *false adjacency pairs* as described by Garcia and Jacobs (1998) as well as Markman (2005). To summarise, the results of the texting conditions as compared to the speaking condition shows that texting is similar to speaking in that texters need to adapt to the temporal presence of the reader, e.g. by shortening their turns to engage in a fast synchronous conversation.

### 5.3 Comparison of Pause Location in Writing and Texting

In this section, the differences and similarities in pause location in writing as compared to texting will be discussed along with the possible explanations for these differences and similarities. As can be seen above, there was a difference in the proportion of pauses in a revision context with writing having a significantly larger proportion of pauses after a revision as compared to texting. This can be explained by the lack of spatial and temporal presence in writing, where the writers can edit the text to ensure that the reader understands everything (Linell 2005; Johansson, 2009). Furthermore, writers are able to take their time while writing whereas texters need to send the message quickly to the temporally present reader to avoid *false adjacency pairs* (Garcia & Jacobs, 1998; Markman, 2005).

There was no notable difference in the proportion of pauses in clause boundary context between writing and texting, indicating that the two conditions are similar in regard to clause boundaries as important contexts for pausing. As mentioned above, writing had a significantly higher proportion of phrase-internal pauses as compared to texting, something that can be related to micro-planning (Spelman Miller, 2006). It can also be the result of turn-taking in texting, where the texters have shorter bursts and thus shorter planning units as compared to writing. Similarly, the difference in phrase-final contexts were that writing had a significantly lower proportion of pauses. This can also be a result of the shorter planning unit – texters sometimes write just “yes” as a reply, whereas this is very uncommon in the monologic writing condition.

There was no notable difference in clause initial or word-internal contexts for pauses in writing as compared to texting, meaning that the two conditions are similar in this regard. To summarise, the results for the texting condition as compared to the writing condition shows that texters are similar to writers in that they do not adapt their planning to the immediate presence of a reader, and they can engage in revisions to ensure that the text they are writing will be understood by the reader.

## **5.4 Differences in Production Bursts in Texting as Compared to Speaking and Writing**

In this section, the mean production bursts in texting will be compared to the mean production bursts in speaking and writing, together with a discussion about possible explanations for the differences. The section starts with a comparison of texting and speaking, and then a comparison between texting and writing follows.

In the speaking condition, the finding of Goldman Eisler (1968) that most bursts in speaking are 6 words or shorter was corroborated. As described above, speaking had significantly longer bursts as compared to texting. This can be explained by the temporal presence of the reader in the texting condition resulting in a need to send messages quickly, combined with the slowness of having to type the message. The physical environment as described by Hayes (1996), and the need to transcribe the language, means that language production is slower when texting as compared to speaking.

Additionally, Limpo and Alves (2017) and Alves and Limpo (2015) found that transcription skills may influence language production, with lower transcription skills resulting in shorter bursts. As 46% the participants in the study did not use an iPhone as their regular phone, the shorter bursts in the texting condition may be a result of the participants not being used to the interface of the phone they were using in the experiment. Furthermore, different screen sizes of the smartphones used in the experiment as compared to the participants' own phones may also effect the difficulty of typing and affecting the burst length in texting.

In writing, Kaufer, Hayes and Flower (1986) found that adult writers produce about 9 words between pauses, however these results are not confirmed here where the average burst length is around 5 words per burst. As described above, writing had significantly longer bursts as compared to texting. One reason for this is the temporal presence of the reader, or the social environment as described by Hayes (1996) resulting in the need to send messages quickly in order to keep up with the conversation. This results in shorter planning units as compared to writing.

Furthermore, texting has its origins in a time when SMS messages had a limited number of characters that the texters could use in their messages, leading to abbreviations to shorten messages, as described by Hård af Segerstad (2002). One explanation for the shorter bursts in texting as compared to both speaking and writing could be that messages are expected to be short, meaning that the genre – which is a part of the task environment in the Hayes (1996) model of writing – may be characterized by short messages in general.

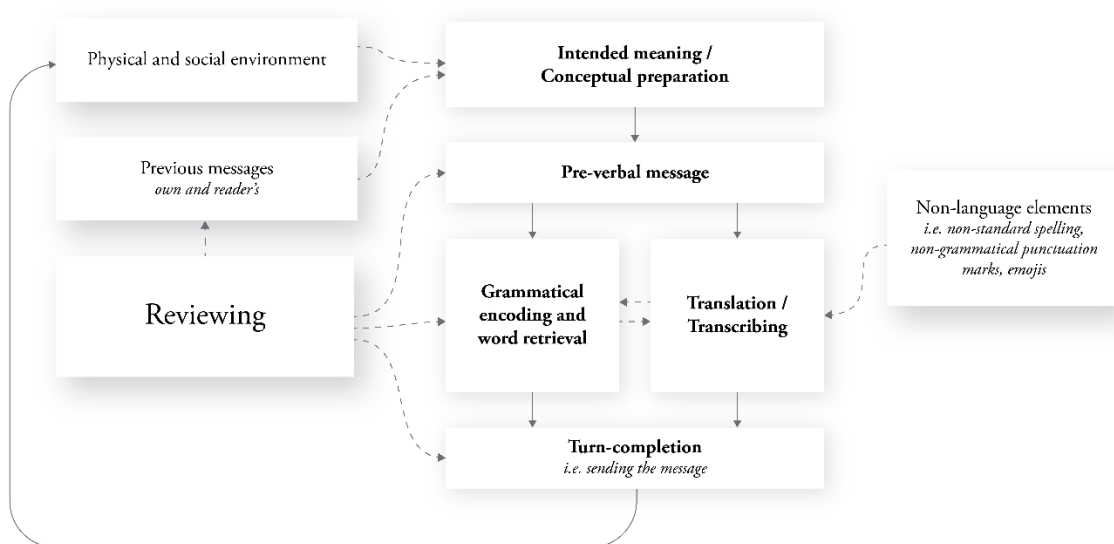
## 5.5 Implications for the Processing Models and Texting

In this section, the results will be compared to the blueprint of the speaker by Levelt (1999) as well as the environmental-individual model of written language production by Hayes (1996), in the order of a presumed production process in texting. The terms used to describe this process are taken from the blueprint of the speaker (Levelt, 1999) and the environmental-individual model of written language production (Hayes, 1996). An illustration of the texting processes can be seen in Figure 10.

Just as in the blueprint of the speaker (Levelt, 1999), texters start at the stage of an intended meaning or conceptual preparation. The intended meaning uses input from the physical and social environment as well as the previous messages in the chat. The first part of the creation of the intended meaning may very well be very similar to the conceptual preparation and pre-verbal message as described in the blueprint of the speaker (Levelt, 1999), however, texters also need to take the physical environment into account, as described in the individual-environmental model (Hayes, 1996), in this case typing on a smartphone.

**FIGURE 10**

*Language Processes in Texting*



*The figure shows a visualisation of the language processes in texting, using terminology from Levelt (1999) and Hayes (1996).*

Once the pre-verbal message has been formed, the message receives its grammatical encoding and words are retrieved from the mental lexicon, similar to the processes in the blueprint of the speaker (Levelt, 1999). At the same time, the translation/transcription of the message needs to take place and the texter starts to type the words for the message, like in the environmental-individual model (Hayes, 1996). The translation/transcription process also need to consider any non-language elements that will be part of the message, such as non-standard spelling, emojis, non-grammatical punctuation marks etc. Once the message has been typed out and the person presses send, the turn is complete and the sent message now becomes part of the physical and social environment.

During this process, texters can review the message they are writing, as well as the previous messages that have been sent. This means that if a new message is received while the texter is engaged in translation/transcription, they can review the message and adapt their own message based on the new information they have received.

The figure combines aspects of spoken language production such as the pre-verbal message, with aspects of written language production such as revising and transcribing. While the models for spoken language production often has a focus on the fundamental aspects of language, e.g. word retrieval, the written language production models often focus on higher levels of processing due to the complex nature of writing. As discussed in the background, written language is based on spoken language and as such, the fundamental aspects of language production are present in both speaking and writing.

Texting offers a combination of these two, where the texter produces fast and short messages and needs to be attentive to the potentially ever-changing environment in the form of receiving messages while simultaneously needing to transcribe and sometimes edit the text that they have produced. The reader of the messages is part of the physical and social environment in the model, as well as being part of the previous messages, and texters adapt their language production to the temporal presence of the reader.

## **5.6 Method Discussion**

Part of this thesis was to develop a method to record real-time language production data on smartphones as well as how to compare the three conditions speaking, writing, and texting. This came with a number of challenges, for example the question of how to compare pauses across the three conditions. Deciding what constitutes a pause in the data is a known issue in the field (e.g. Wengelin, 2006), and having a set pause threshold for writing and texting meant that the analyses did not account for the writing speed of the participants. Furthermore, speakers can produce language faster than writers, and one minute of conversation results in a larger amount of produced

language as compared to the amount of language produced during one minute of writing. Since the analysed data was a selection of the data, this was partially considered with the data selection in writing and texting being longer than the selection in speaking.

Furthermore, when analysing pauses, presumptions about what these pauses mean are taken, and with this method it is impossible to know exactly why a person is pausing. This is the case in all three conditions, and as such, the data is comparable due to them all having pauses that may be caused by external elements such as a participant scratching their head or yawning.

When conducting an experiment, it is important to consider the ecological validity of the collected data. In the case of this experiment, it may not have been entirely natural to talk, text, and write in a lab setting, however, having the participants take part in the experiment as friends may have made the speaking and texting conditions more natural since they were already used to speaking and texting with each other.

One important note about the experiment is that not all participants were used to typing on an iPhone 6S which was used in the texting condition. Smartphone interfaces can be different depending on the make and version of the phone, and as such this can have an impact on the language production. The copy task in the texting condition was one way to compensate for this, allowing the participants to familiarise themselves with the phones.

## **5.7 Further Research**

While this thesis has graced the surface of the planning processes in texting as compared to speaking and writing, there is still unexplored areas within the field based on these results. For example, the effect of spatial and temporal presence can be further examined within the conditions, e.g. comparing phone calls with face-to-face conversations, or texting while sat in the same room as compared to different rooms, and having a temporally present reader while writing.

Furthermore, planning processes in other kinds of computer mediated communication, such as chatting on a computer or writing an email, can further our understanding of the role of the physical environment in written language production.

This study also raises questions about the language processes involved in texting. What happens when a person receives a message? How do texters revise? Do they primarily revise content or typos? What syntactic units are produced during a production burst in texting? This shows that there is still very much to explore regarding the language production processes in texting.



## Chapter 6 : Conclusions

This thesis has examined the planning processes in texting as compared to speaking and writing. In all three conditions, clause boundaries are an important context in which language users pause and plan, indicating that macro-planning is important in all three conditions. In texting and writing, another important context in which language users pause is after a revision. It has also been shown that micro-planning, e.g. pausing within a syntactic unit, is common in the three conditions. However, in speaking micro-planning seems to be more common in phrase-internal contexts than in word-internal contexts, whereas in texting and writing both phrase-internal and word-internal micro-planning occur. Phrase final context for pauses was important in texting and speaking, perhaps owing to the nature of a dialogic exchange with shorter bursts and turns that were sometimes only a phrase. Further, the study showed that in texting, language users may adapt to the changing social context of the chat, with receiving a message resulting in pauses and possible re-planning of their own message.

The study also showed that texting has significantly shorter bursts as compared to both speaking and writing, meaning that the planning units in texting are shorter than those in speaking and writing. The slow pace of typing in combination with the fast pace of texting with a temporally present reader may cause texters to prefer shorter turns that can keep up with the fast pace of texting.

The method that was developed in this thesis to examine real-time language production in texting as compared to speaking has also been shown to be fruitful, and the three conditions are possible to compare. Future studies may need to modify the analyses to fit other research questions, but overall, this thesis presents a successful method to study and compare language processes across different modalities.

The results that were found in this thesis were used to propose a processing model of texting based on the blueprint of the speaker by Levelt (1999) and the environmental-individual model of written language production by Hayes (1996). The model shows that there are many processes that the modalities have in common, however, texting differs from speaking in the possibility for the texter to review what they are typing, and it differs from speaking in that the social context of what they are typing may change due to the reader sending a message.

In conclusion, the results for the texting condition shows that texters are similar to writers in that they do not adapt their planning to the immediate presence of a reader, however, texters have shorter planning units, suggesting that the temporal presence of the reader may indeed have an effect on the language production in texting.

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## Appendix A

### Post-Experiment Questionnaire for Participants

#### Deltagarbakgrund

Deltagare: \_\_\_\_\_

Ålder: \_\_\_\_\_

Kön: \_\_\_\_\_

#### Högsta utbildningsnivå

- ☐ Gymnasieexamen
- ☐ Kandidat
- ☐ Master
- ☐ Doktorand
- ☐ Annat: \_\_\_\_\_

#### Språk

##### Svenska

- ☐ Grundläggande kunskaper
- ☐ Goda kunskaper
- ☐ Mycket goda kunskaper
- ☐ Flytande/modersmål

##### Danska

- ☐ Inga kunskaper
- ☐ Grundläggande kunskaper
- ☐ Goda kunskaper
- ☐ Mycket goda kunskaper
- ☐ Flytande/modersmål

##### Engelska

- ☐ Inga kunskaper
- ☐ Grundläggande kunskaper
- ☐ Goda kunskaper
- ☐ Mycket goda kunskaper
- ☐ Flytande/modersmål

Spanska

- ☐ Inga kunskaper
- ☐ Grundläggande kunskaper
- ☐ Goda kunskaper
- ☐ Mycket goda kunskaper
- ☐ Flytande/modersmål

Tyska

- ☐ Inga kunskaper
- ☐ Grundläggande kunskaper
- ☐ Goda kunskaper
- ☐ Mycket goda kunskaper
- ☐ Flytande/modersmål

Franska

- ☐ Inga kunskaper
- ☐ Grundläggande kunskaper
- ☐ Goda kunskaper
- ☐ Mycket goda kunskaper
- ☐ Flytande/modersmål

Annat (ange även nivå): \_\_\_\_\_

Vad använder du för typ av telefon?

- ☐ Apple iPhone
- ☐ Samsung
- ☐ Huawei
- ☐ Nokia
- ☐ Sony
- ☐ Annat: \_\_\_\_\_

Ange gädda modell på telefonen (tex. iPhone 7, Samsung Galaxy 8): \_\_\_\_\_

Ungefär hur många timmar per dag använder din telefon?

- ☐ Under 1 timme
- ☐ 1 till 2 timmar
- ☐ 2 till 3 timmar
- ☐ 3 till 4 timmar
- ☐ 4 till 5 timmar
- ☐ Mer än 5 timmar

**Om du svarade under en timme på föregående fråga, hur ofta använder du din telefon varje vecka?**

- ☐ Dagligen
- ☐ 6 dagar/vecka
- ☐ 5 dagar/vecka
- ☐ 4 dagar/vecka
- ☐ 3 dagar/vecka
- ☐ 2 dagar/vecka
- ☐ 1 dag/vecka
- ☐ Mindre än 1 dag/vecka

Nu följer några frågor om SMS, och med SMS menas alla typer av meddelanden som skickas i appar eller program liknande WhatsApp, iMessage, Facebook Messenger m.m.

Hur ofta skickar du SMS?

- ☐ Flera gånger/dag
- ☐ En gång/dag
- ☐ Några gånger/vecka
- ☐ En gång/vecka
- ☐ Aldrig

Vilka personer skickar du SMS till?

- ☐ Kompisar
- ☐ Kursare
- ☐ Förälder
- ☐ Syskon
- ☐ Chef
- ☐ Lärare
- ☐ Kollegor
- ☐ Partner
- ☐ Barn (eget eller andras)
- ☐ Annat: \_\_\_\_\_

Brukar du skicka SMS till personen du gjort experimentet med?

- ☐ Ja
- ☐ Nej

Vilka meddelandefjänster använder du?

- ☐ Facebook Messenger
- ☐ WhatsApp
- ☐ Snapchat
- ☐ Telegram
- ☐ Discord
- ☐ iMessage
- ☐ Instagram
- ☐ Annat: \_\_\_\_\_

Många av de appar som används för att skicka meddelanden finns även online eller som program till datorn. Använder du något sådant program för att skicka SMS?

- ☐ Ja
- ☐ Nej

Om ja, vilket eller vilka program använder du på dator för att skicka SMS?

- ☐ Facebook Messenger
- ☐ WhatsApp
- ☐ Snapchat
- ☐ Telegram
- ☐ Discord
- ☐ iMessage
- ☐ Instagram
- ☐ Annat: \_\_\_\_\_



## Appendix B

### Informed Consent Form

- 1. Bakgrund och syfte** Syftet med den här studien är att undersöka och jämföra hur människor uttrycker sig och kommunicerar i tal, skrift och sms.

Studien undersöker hur människor producerar språk i realtid – alltså hur och vad det är vi gör när vi talar, skriver och sms:ar.
- 2. Hur går studien till?** Studien består av tre olika experiment där data spelas in: samtalsexperimentet, sms-experimentet och skrivexperimentet.

I samtalsexperimentet spelas samtalet ni har in med två mikrofoner och samtalet kommer att transkriberas, alltså att skrivas ned.

I SMS-experimentet spelas skärmen på telefonerna in när ni SMS:ar och sparas som videofiler. Videorna kommer att analyseras i detalj.

I skrivexperimentet används ett program som heter ScriptLog för att spela in när ni skriver. Programmet kan spela upp hur det sett ut när ni skriver (allt ni skrivit och suddat ut).

All data som samlas in kommer att anonymiseras i både uppsats och presentationer.
- 3. Hantering av inspelning och data** Ljudinspelningen kommer att transkriberas, alltså att skrivas ned. Insamlade data kommer att anonymiseras, likaså kommer transkriptionerna att vara anonymiserade.Handledare och examinator kan komma att få tillgång till inspelningen och eventuella rådata.

För att säkerställa att ingen obehörig får tillgång till insamlade data kommer allt att lagras lokalt på en dator samt backup på en hårddisk.
- 4. Frivillighet** Deltagande i studien är helt frivilligt, och det är när som helst möjligt att avbryta sitt deltagande under experimentet. När uppsatsen är publicerad går det inte längre att dra tillbaka sin medverkan.

**5. Ansvariga**

**Kajsa Gullberg**

*tlfnr:*

*Mail:*

Handledare: Victoria Johansson

*Mail:*

## **Informerat samtycke**

- Jag bekräftar att jag har tagit del av information kring studien.
- Jag ger mitt samtycke till deltagande i studien.
- Jag är medveten om att deltagandet i studien är helt frivilligt och att jag kan välja att avbryta mitt deltagande när som helst under studien.
- Jag tillåter att insamlad information hanteras så som specificerats i den skriftliga informationen.

---

Datum/ort

---

Namnteckning

---

Namnförtydligande

## Appendix C

### Pause Location Proportions

The table shows the proportions of pauses in each category for each participant in each condition. The proportion was calculated by dividing the number of pauses in the category with the total number of pauses that were analysed for the participant. In the speaking condition, the pause criteria were based on a perceived pause, i.e. a purely auditive analysis, and in the texting and writing conditions, the pause criteria was 1 second. The category *message/other* is only measure in the speaking and texting condition since the writing condition was monologic. The category *start* was only used in writing since it refers to the initial pause before the participants started writing, these pauses were not measured in the speaking and texting condition. The subject ID shows the subject number (G01, G03, etc.), the self-reported gender (F/M), the experimental order in which the participant did the tasks (A/B), and the number of the dyad that they were part of (P1, P1, etc.)

Subject ID	Condition	Clause boundary	Clause initial	Phrase final	Phrase-internal	Word-internal	Revision	Overlap/Message	Start	Other	Total
G01FAP1	SPEAKING	0.63	0.13	0.04	0.17	0.00	0.04	0.00	NA	0.00	1.00
G02FAP1	SPEAKING	0.23	0.23	0.00	0.46	0.00	0.00	0.00	NA	0.08	1.00
G03FBP2	SPEAKING	0.52	0.19	0.04	0.26	0.00	0.00	0.00	NA	0.00	1.00
G04MBP2	SPEAKING	0.47	0.17	0.00	0.36	0.00	0.00	0.00	NA	0.00	1.00
G05MAP3	SPEAKING	0.57	0.09	0.00	0.30	0.00	0.02	0.00	NA	0.02	1.00
G06MAP3	SPEAKING	0.71	0.09	0.00	0.17	0.00	0.00	0.00	NA	0.03	1.00
G07MBP4	SPEAKING	0.55	0.00	0.05	0.32	0.09	0.00	0.00	NA	0.00	1.00
G08MBP4	SPEAKING	0.52	0.06	0.06	0.30	0.02	0.04	0.00	NA	0.00	1.00
G09FAP5	SPEAKING	0.56	0.00	0.28	0.06	0.11	0.00	0.00	NA	0.00	1.00
G10MAP5	SPEAKING	0.53	0.00	0.22	0.20	0.02	0.00	0.00	NA	0.02	1.00

Subject ID	Condition	Clause boundary	Clause initial	Phrase final	Phrase- internal	Word- internal	Revision	Overlap/ Message	Start	Other	Total
G11MBP6	SPEAKING	0.55	0.11	0.11	0.18	0.00	0.00	0.03	NA	0.03	1.00
G12MBP6	SPEAKING	0.45	0.03	0.12	0.33	0.00	0.03	0.03	NA	0.00	1.00
G13FAP7	SPEAKING	0.42	0.04	0.08	0.40	0.04	0.02	0.00	NA	0.00	1.00
G14FAP7	SPEAKING	0.52	0.06	0.00	0.33	0.09	0.00	0.00	NA	0.00	1.00
G15FBP8	SPEAKING	0.38	0.21	0.17	0.17	0.04	0.04	0.00	NA	0.00	1.00
G16FBP8	SPEAKING	0.50	0.15	0.12	0.12	0.00	0.00	0.00	NA	0.12	1.00
G17MAP9	SPEAKING	0.63	0.10	0.20	0.07	0.00	0.00	0.00	NA	0.00	1.00
G18FAP9	SPEAKING	0.64	0.08	0.08	0.08	0.00	0.04	0.00	NA	0.08	1.00
G19FBP10	SPEAKING	0.58	0.11	0.08	0.16	0.00	0.03	0.03	NA	0.03	1.00
G20MBP10	SPEAKING	0.61	0.06	0.33	0.00	0.00	0.00	0.00	NA	0.00	1.00
G21MAP11	SPEAKING	0.56	0.04	0.19	0.07	0.07	0.04	0.04	NA	0.00	1.00
G22FAP11	SPEAKING	0.52	0.00	0.06	0.23	0.03	0.06	0.06	NA	0.03	1.00
G23FBP12	SPEAKING	0.78	0.00	0.17	0.00	0.06	0.00	0.00	NA	0.00	1.00
G24MBP12	SPEAKING	0.55	0.18	0.00	0.09	0.03	0.12	0.00	NA	0.03	1.00
G25FAP13	SPEAKING	0.51	0.21	0.10	0.13	0.00	0.05	0.00	NA	0.00	1.00
G26FAP13	SPEAKING	0.42	0.15	0.04	0.12	0.08	0.19	0.00	NA	0.00	1.00
G01FAP2	TEXTING	0.19	0.06	0.13	0.00	0.00	0.50	0.13	NA	0.00	1.00
G02FAP2	TEXTING	0.19	0.06	0.00	0.19	0.00	0.50	0.06	NA	0.00	1.00
G03FBP3	TEXTING	0.48	0.13	0.00	0.06	0.03	0.19	0.00	NA	0.10	1.00

Subject ID	Condition	Clause boundary	Clause initial	Phrase final	Phrase- internal	Word- internal	Revision	Overlap/ Message	Start	Other	Total
G04MBP3	TEXTING	0.72	0.06	0.00	0.06	0.00	0.17	0.00	NA	0.00	1.00
G05MAP4	TEXTING	0.28	0.04	0.12	0.20	0.16	0.20	0.00	NA	0.00	1.00
G06MAP4	TEXTING	0.31	0.00	0.03	0.13	0.13	0.25	0.09	NA	0.06	1.00
G07MBP5	TEXTING	0.38	0.02	0.09	0.27	0.09	0.11	0.02	NA	0.02	1.00
G08MBP5	TEXTING	0.38	0.03	0.06	0.09	0.06	0.31	0.06	NA	0.00	1.00
G09FAP6	TEXTING	0.44	0.04	0.15	0.04	0.00	0.33	0.00	NA	0.00	1.00
G10MAP6	TEXTING	0.22	0.17	0.17	0.06	0.11	0.28	0.00	NA	0.00	1.00
G11MBP7	TEXTING	0.15	0.07	0.07	0.22	0.04	0.44	0.00	NA	0.00	1.00
G12MBP7	TEXTING	0.08	0.04	0.15	0.15	0.04	0.54	0.00	NA	0.00	1.00
G13FAP8	TEXTING	0.23	0.09	0.03	0.17	0.00	0.34	0.03	NA	0.11	1.00
G14FAP8	TEXTING	0.32	0.04	0.07	0.11	0.07	0.32	0.07	NA	0.00	1.00
G15FBP9	TEXTING	0.26	0.07	0.07	0.00	0.00	0.30	0.11	NA	0.19	1.00
G16FBP9	TEXTING	0.40	0.00	0.17	0.07	0.00	0.13	0.07	NA	0.17	1.00
G17MAP10	TEXTING	0.41	0.04	0.15	0.19	0.00	0.22	0.00	NA	0.00	1.00
G18FAP10	TEXTING	0.30	0.11	0.07	0.07	0.20	0.18	0.07	NA	0.00	1.00
G19FBP11	TEXTING	0.39	0.11	0.17	0.22	0.06	0.06	0.00	NA	0.00	1.00
G20MBP11	TEXTING	0.19	0.03	0.06	0.13	0.06	0.44	0.09	NA	0.00	1.00
G21MAP12	TEXTING	0.15	0.08	0.15	0.31	0.00	0.23	0.00	NA	0.08	1.00
G22FAP12	TEXTING	0.21	0.07	0.00	0.29	0.29	0.07	0.07	NA	0.00	1.00

Subject ID	Condition	Clause boundary	Clause initial	Phrase final	Phrase- internal	Word- internal	Revision	Overlap/ Message	Start	Other	Total
G23FBP13	TEXTING	0.20	0.10	0.10	0.10	0.10	0.30	0.10	NA	0.00	1.00
G24MBP13	TEXTING	0.27	0.03	0.03	0.15	0.03	0.27	0.00	NA	0.21	1.00
G25FAP14	TEXTING	0.35	0.04	0.04	0.15	0.17	0.17	0.00	NA	0.07	1.00
G26FAP14	TEXTING	0.26	0.07	0.04	0.07	0.00	0.33	0.11	NA	0.11	1.00
G01FAP3	WRITING	0.32	0.09	0.10	0.00	0.04	0.41	NA	0.01	0.03	1.00
G02FAP3	WRITING	0.34	0.05	0.01	0.22	0.04	0.28	NA	0.01	0.06	1.00
G03FBP4	WRITING	0.24	0.10	0.04	0.19	0.03	0.36	NA	0.01	0.04	1.00
G04MBP4	WRITING	0.26	0.02	0.07	0.24	0.06	0.33	NA	0.01	0.01	1.00
G05MAP5	WRITING	0.44	0.04	0.03	0.32	0.05	0.10	NA	0.01	0.00	1.00
G06MAP5	WRITING	0.25	0.01	0.03	0.09	0.05	0.55	NA	0.01	0.01	1.00
G07MBP6	WRITING	0.40	0.04	0.01	0.17	0.06	0.29	NA	0.01	0.02	1.00
G08MBP6	WRITING	0.26	0.01	0.02	0.14	0.03	0.53	NA	0.01	0.00	1.00
G09FAP7	WRITING	0.38	0.04	0.03	0.22	0.05	0.27	NA	0.01	0.00	1.00
G10MAP7	WRITING	0.38	0.03	0.02	0.17	0.05	0.33	NA	0.01	0.00	1.00
G11MBP8	WRITING	0.34	0.02	0.02	0.26	0.09	0.27	NA	0.01	0.00	1.00
G12MBP8	WRITING	0.32	0.07	0.03	0.18	0.03	0.37	NA	0.01	0.00	1.00
G13FAP9	WRITING	0.22	0.02	0.02	0.15	0.02	0.57	NA	0.01	0.00	1.00
G14FAP9	WRITING	0.32	0.04	0.00	0.17	0.08	0.37	NA	0.01	0.01	1.00
G15FBP10	WRITING	0.42	0.07	0.00	0.17	0.08	0.24	NA	0.01	0.01	1.00

Subject ID	Condition	Clause boundary	Clause initial	Phrase final	Phrase- internal	Word- internal	Revision	Overlap/ Message	Start	Other	Total
G16FBP10	WRITING	0.42	0.03	0.00	0.19	0.04	0.31	NA	0.01	0.00	1.00
G17MAP11	WRITING	0.27	0.09	0.03	0.21	0.08	0.31	NA	0.01	0.00	1.00
G18FAP11	WRITING	0.37	0.03	0.00	0.18	0.19	0.23	NA	0.01	0.01	1.00
G19FBP12	WRITING	0.19	0.08	0.00	0.19	0.05	0.48	NA	0.01	0.00	1.00
G20MBP12	WRITING	0.33	0.01	0.01	0.25	0.08	0.30	NA	0.01	0.00	1.00
G21MAP13	WRITING	0.38	0.11	0.01	0.18	0.05	0.26	NA	0.01	0.00	1.00
G22FAP13	WRITING	0.42	0.07	0.04	0.15	0.08	0.22	NA	0.01	0.00	1.00
G23FBP14	WRITING	0.38	0.09	0.01	0.15	0.02	0.35	NA	0.01	0.00	1.00
G24MBP14	WRITING	0.24	0.07	0.01	0.21	0.03	0.41	NA	0.01	0.00	1.00
G25FAP15	WRITING	0.41	0.04	0.01	0.08	0.07	0.37	NA	0.01	0.00	1.00
G26FAP15	WRITING	0.31	0.03	0.01	0.15	0.04	0.46	NA	0.01	0.00	1.00

## Appendix D

### Mean Burst Lengths

The table shows the mean burst length for each participant in the three different conditions. The burst length shows the number of words that the participants produced between pauses. The subject ID shows the subject number (G01, G03, etc.), the self-reported gender (F/M), the experimental order in which the participant did the tasks (A/B), and the number of the dyad that they were part of (P1, P1, etc.)

Subject ID	Mean Burst Length		
	Speaking Condition	Texting Condition	Writing Condition
G01FAP1	5.34	3.58	11.98
G02FAP1	6.84	4.04	4.72
G03FBP2	3.57	3.81	4.47
G04MBP2	4.65	3.88	3.35
G05MAP3	3.66	3.98	5.56
G06MAP3	4.34	3.28	5.58
G07MBP4	4.49	2.68	7.73
G08MBP4	4.35	3.72	5.49
G09FAP5	4.93	3.82	6.54
G10MAP5	4.38	3.92	4.47
G11MBP6	5.65	4.07	3.86
G12MBP6	5.55	3.20	6.01
G13FAP7	4.61	4.28	5.19
G14FAP7	4.89	3.27	4.35
G15FBP8	5.10	5.93	5.59
G16FBP8	4.64	4.52	6.15
G17MAP9	4.61	3.77	3.68
G18FAP9	4.81	3.17	4.88
G19FBP10	5.56	3.71	5.23
G20MBP10	3.13	3.70	4.22
G21MAP11	5.60	4.33	4.72
G22FAP11	5.48	5.31	7.32
G23FBP12	5.40	4.02	7.43
G24MBP12	5.59	3.50	7.41
G25FAP13	3.89	2.49	3.73
G26FAP13	5.91	5.00	4.91