Eliani Ventura

Syntactic Priming Studies:

A Review of Methodological Procedures

Florianópolis

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SYNTACTIC PRIMING STUDIES: A REVIEW OF METHODOLOGICAL

PROCEDURES

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ABSTRACT

The syntactic priming paradigm is a well-established method of research in the psycholinguistics field (Branigan & Gibb, 2017). In the same manner, studies related to syntactic priming effects have been investigated since Bock's (1986) seminal study. Since then, they have contributed to a further understanding of the mechanisms underlying syntactic processing in both L1 and L2. The present study aims to synthesize and assess the state-of-art literature in syntactic priming by analyzing articles published between 2017 and 2020, in English or in Portuguese, with full texts available online. Given the large number of equipment and test tools available, the present systematic review has the goal to discuss some of the main features that must be taken into consideration while designing studies in syntactic priming. By including items such as structure choices, the types of fillers, the pair prime/target presentation, and the differences in task design across comprehension and production modalities it is intended to obtain a general overview of the research methods used, as well as provide a few insights for future research.

Keywords: syntactic priming, structural priming, systematic review

RESUMO

O paradigma de *priming* sintático é um método de pesquisa bem estabelecido no campo da psicolinguística (Branigan & Gibb, 2017). Da mesma forma, os efeitos de *priming* sintático são investigados desde Bock (1986) e os estudos na área contribuíram significativamente para uma melhor compreensão dos mecanismos que subjazem o processamento sintático tanto na L1 quanto em L2. O presente estudo busca reunir e avaliar o que há de mais recente na literatura sobre *priming* sintático por meio de análise de artigos publicados entre 2017 e 2020, em inglês e em português, com textos completos disponíveis online. Dado o grande número de equipamentos e ferramentas de testagem, a presente revisão sistemática tem o objetivo de discutir algumas das principais características que devem ser consideradas durante a preparação de estudos sobre priming sintático. Com a análise de itens como as estruturas sintáticas escolhidas, tipos de *fillers*, apresentação dos pares *prime*/alvo e as diferenças dos desenhos entre as modalidades de compreensão e produção busca-se obter uma visão geral dos métodos de pesquisa utilizados, bem como fornecer insumo para futuras pesquisas.

Palavras-chave: priming sintático, priming estrutural, revisão sistemática

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Introduction

Understanding mental representations and the processes related to language use are the main concerns of psycholinguistic studies (Warren, 2013). How do humans produce and comprehend language? How is language stored in the brain? These are only some of the questions raised by researchers in the field of psycholinguistics. The priming paradigm is often used in studies that address these issues since it allows researchers to observe linguistic representation (e.g. Pickering & Branigan, 1998; Schoonbaert, Hartsuiker, & Pickering, 2007; Branigan & Pickering, 2017), language storage (e.g. Hartsuiker, Pickering, & Veltkamp, 2004), language production (e.g. Bock, 1986), and language comprehension (e.g. Weber & Indefrey, 2009).

In 1951, Karl Lashley used the term *priming* for the first time to refer to a phenomenon in which a response tendency could be activated temporarily in the brain (Chartrand & Jefferis, 2004). That was the starting point for priming studies, especially in the field of psychology, in which repetition has a central role in a variety of psychological mechanisms (Pickering & Ferreira, 2008). The effects of priming in the choice of sentence structures were described for the first time later on by Schenkein (1980). He analyzed recordings obtained by the police during a bank robbery and he observed syntactic repetition in natural conversations between the thieves.

After that, Levelt and Kelter (1982) ran an experimental investigation on the effects of repetition on structure choice in Dutch. The experiment was based on asking shopkeepers "At

what time does your shop close?", starting the question with a preposition, or "What time does your shop close?", without the preposition. In the first case, Levelt and Kelter (1982) observed that responses tended to start with a preposition, such as "At five o'clock". As for the second question, the answers tended not to have the preposition at the beginning, such as "five o'clock". However, such syntactic repetition could occur for different reasons (e.g. the similarity between the question-answer pair) (Branigan, 2007), which led Bock (1986) to explore this repetition phenomenon in what is now considered a seminal work for the area.

Bock (1986) conducted a series of experiments in English in which participants had to repeat prime sentences, and then produce sentences to describe target pictures. Therefore, when describing the sentences participants tended to use the structures they had repeated before. Bock (1986) investigated passive and active transitive structures and prepositional object (PO) and double object (DO) dative structures, in both cases the structure repetition was observed — for instance, after a PO prime sentence, participants were more likely to produce a PO picture description than a DO, and the same happened with the other structures. Her findings drew the attention of several researchers to start exploring the likelihood of producing a particular structure after prior exposure/production. In her work, Bock (1986) referred to the phenomenon as syntactic persistence, but researchers in the area also use the terms structural priming (e.g. Pickering & Ferreira, 2008; Fine & Jaeger, 2016; Hardy, Wheeldon & Segaert, 2020), which comprises a wider vision of the phenomenon (not only related to syntax) and syntactic priming (e.g. Pickering & Branigan, 1998; Hartsuiker, Pickering & Veltkamp, 2004; Segaert, Kempen, Petersson & Hagoort, 2013), which also refers to more specific facilitatory effects related to syntactic and lexical processes during sentence processing (Pickering &

Ferreira, 2008). Throughout the present study we will mainly refer to the phenomenon using the term syntactic priming.

Syntactic priming can be defined as the effect that a prime exposure to a certain syntactic structure has on the processing of a subsequent similar syntactic structure presented afterwards (Branigan et al., 1995). Significant syntactic priming effects are more commonly found with less frequent syntactic structures, such as the passive voice (Jaeger & Snider, 2013). Someone who has been primed with a sentence in the passive voice is more likely to produce a sentence in the passive voice. Also, the processing of a sentence in the passive voice may also be facilitated by the prime stimulus. Additionally, syntactic priming is also a research method referred to as syntactic priming paradigm. Through this paradigm it is possible to investigate syntactic processing.

As stated above, priming effects emerge from repeated exposure to a stimulus. Priming can happen at different linguistic levels, such as the repetition of similar structures, meaning, and sounds. That said, priming paradigms focus on manipulating linguistic characteristics in order to build a prime stimulus that can in fact influence the processing of the target stimulus (Branigan & Gibb, 2017). Thus, syntactic priming paradigms manipulate the structure of the sentence. Most of them investigate structure choice, but there are also some syntactic priming paradigms that can investigate other linguistic features (Branigan & Gibb, 2017), such as eye movements in both sentences or pictures, response latencies, and brain activity, just to give a few examples.

The variety of syntactic priming paradigms is also reflected on the variety of tasks, test tools, and equipment that can be used in syntactic priming research. Moreover, depending on the structure and/or study modality (e.g. production or comprehension) being tested, the tasks,

the prime/target presentation, the trials, and other methodological choices will probably be different to meet the needs of each research. This variety in methods of syntactic priming can be confusing and complex to those who are initiating in the area. In order to gain an understanding of the methodological differences in the research design of studies on syntactic priming, a systematic review of literature was conducted with the main objective of describing and discussing some important methodological choices from the selected articles.

Differently from a traditional review, a systematic review follows a rigorous method of research that includes the following key stages: 1) scope and map, 2) plan and protocol, 3) document, 4) inclusion and exclusion criteria, 5) search and screen, 6) quality appraisal, 7) data collection, and 8) synthesis (Jesson, Matheson, & Lacey, 2011). These stages bring transparency to the study and allow it to be replicable in future research.

Objective and Research Questions

Based on the discussion above, this study will synthesize the last three years of research in syntactic priming in order to describe the design of each study selected and discuss some methodological aspects[1]. Studies in L1 and L2[2] will be included. In order to accomplish this general objective, the following questions were pursued:

1) Which dependent measures were investigated in the selected syntactic priming studies?

2) How are the experimental tasks designed and organized?

3) What type of fillers are used?

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[1] The present study is related to the research project "Frequência e repetição: efeitos no processamento de estruturas morfológicas e sintáticas complexas" coordinated by Prof. Dr. Mailce Borges Mota (Bolsa PQ/CNPq – Processo 310729/2016-5).

[2] As defined by Ortega (2014) the term L1 is used to refer to the language or languages that a child learns from his/her closest relatives or caretakers from the time he/she is born up to about the age of four. Therefore, L2 refers to any language learned after that.

4) Which syntactic structures are investigated?

5) What are the main differences in task design in terms of modality? (i.e.,

production and comprehension)?

Significance of the Study

Given the importance of syntactic priming, both as a natural phenomenon and as a

method of research, to the field of psycholinguistics, the significance of the present study is

justified not only because it describes the design of the studies, but also because it reviews what

has been done during the last years of research. Considering the wide range of research methods

that can be used to investigate syntactic priming, along with a variety of linguistic structures

that are usually investigated, the present study will provide a general overview and can also be

used as a guide to future researchers.

Organization of the Study

This study is organized as follows. First, I will present a review of literature in which

the following topics will be addressed: 1) experimental research in psycholinguistics; 2)

research design in syntactic priming studies; 3) research design in syntactic priming studies in

comprehension; and 4) research design in syntactic priming studies in production. Later, in the

method section, I will discuss the procedures followed while conducting the study, such as

inclusion and exclusion criteria and search strategies. Then, in the discussion and results section

I will present a short summary of all the studies included before individually addressing and

answering each of the research questions proposed. Finally, in the final remarks section I will

present the implications of my work.

Review of Literature

The present section is organized as follows. First, a brief introduction to experimental research in psycholinguistic studies will be given. Then, I will address experimental designs for syntactic priming research. Finally, I will discuss the most commonly used methods in syntactic priming studies in both language production and comprehension.

Although language can be seen as a finite computational system which allows us to produce an infinite number of unprecedented expressions (Maia, 2015), language processing is shown to be facilitated by repetition. Humans tend to repeat previously presented structures, a phenomenon that is known as syntactic priming (Branigan & Gibb, 2017). In order to investigate such implicit event, many paradigms (e.g. eye-tracking paradigm, picture-matching paradigm) have been developed to understand the conditions that may lead to this facilitation process, which can also help to answer questions about linguistic representation and language processing (Branigan & Gibb, 2017).

Psycholinguistic research can rely on a number of different methods and experimental techniques. Generally speaking, the methodologies can be divided into three major categories of study: corpus research, simulation, and experimentation (Sandra, 2009). Corpus research has been mostly used in cases in which the language topic of investigation does not require a real-time measurement or it is difficult to achieve (as it is for studies in children's language acquisition) (Sandra, 2009). Simulation is closely related to the field of computational linguistics and attempts to simulate human data; therefore, it neither measures language use nor mental processes (Sandra, 2009). Finally, the last major category is experimentation, which is the focus of the present study and will be extensively discussed throughout this work. However, before addressing specifically the methodologies related to syntactic priming as well as the syntactic priming paradigm itself, it is important to define a few general concepts.

First, the basis of experimental research: the experiment. An experiment in psycholinguistic research can be defined as "an attempt to understand a particular phenomenon by making a highly controlled design for collecting data on that phenomenon" (Sandra, 2009, p. 304). To achieve this goal, an experiment is built over dependent and independent variables. The dependent variable is directly related to the topic of the study, it is its response measure, while the independent variable is something that can be manipulated by the researcher depending on what is being investigated (Kantowitz, Roediger III, & Elmes, 2014). The dependent variable can be considered an effect of the independent variable, which is the manipulated cause. Additionally, in experimental research in psychology, as it is the case for psycholinguistic research, a control variable is vital to the study. The control variable is an independent variable controlled by the researcher, so it stands constant during the experiment (Abbuhl, Gass, & Mackey, 2014). An experiment needs at least two different conditions to be compared to each other (a control condition and an experimental condition, for instance). This is necessary to observe if the independent variable had an effect on the dependent variable (Kantowitz, Roediger III, & Elmes, 2014).

Therefore, experimentation relies on manipulating one specific aspect in a stimulus that is meant to affect or access a certain mental representation (Sandra, 2009). When referring to experimentation in the field of psycholinguistics it is also important to differ offline from online measures. An online measure refers to the register of an ongoing language process: it is a real time measure. An offline measure, on the other hand, refers to what happens after the process and it only shows the outcomes (Sandra, 2009). In sentence processing studies, as it is the case for syntactic priming in language production and comprehension, online techniques are preferable. This can be explained by the nature of such experimental tasks. Since online measures catch the participants' real time (re)action, they give the researcher a broader picture

on the ongoing language processes involved (not only the outcomes of these processes) and hinder the possibility of the participant to use conscious knowledge to perform the task (Keating & Jegerski, 2015).

Ultimately, many experimental cognitive studies related to language learning and language use employ priming paradigms (Trofimovich & McDonough, 2011). Syntactic priming research can include a variety of different tasks such as picture description, sentence recall, and sentence completion (McDonough, 2017). In the next section I will briefly address research design in syntactic priming studies, before specifying the most frequently used tasks and data collection tools in comprehension and production priming research.

Research Design in Syntactic Priming Studies

Syntactic priming is a well-established topic of research on language processing. Along with other types of priming paradigms, it is believed to be an unconscious and automatic response to a previous syntactic structure (Branigan & Gibb, 2017). That said, for a certain stimulus to prime a target stimulus it needs to be cognitively related at some level (semantically, structurally, phonologically, or morphologically) (Branigan & Gibb, 2017). In this sense, for a study to investigate priming effects it is necessary to manipulate the prime and target stimuli in a manner that gives the conditions for the facilitation process to occur (Branigan & Gibb, 2017). As stated by Branigan and Gibb (2017), this same idea is applied to investigate syntactic priming since "by manipulating the structural characteristics of the prime and target stimulus, and the modality of processing, we can determine the nature of structural representations and how they are implicated in language use" (p. 131).

The nature of primes and targets differ depending on the study and on the task, but before moving on to types of stimuli it is essential to understand some other basic concepts. A

prime stimulus needs to use or elicit one or another sentence structure, while the target stimulus may allow a syntactic structure choice, even though it is still limited to the types of prime/target stimuli included in the study (Branigan & Gibb, 2017). Prime-target expressions, for instance, will maintain the same structure of interest but will diverge in other linguistic aspects — e.g. lexical content —, except in a baseline condition — which should not facilitate the processing any of the experimental items — (Branigan & Gibb, 2017).

The organization of the task is directly related to how the prime-target pair is built and for that there are different modalities of primes to be used: they can be either an auditory prime (including both recordings and spoken primes by a live interlocutor), a visual prime (such as pictures or written sentences) or even a mixture such as a written prime that is also read aloud by the participant. Just as primes, the targets can also be exposed to participants in different ways, when prime and targets belong to different modalities — the prime is auditory and the target is visual, for instance — the technique is classified as cross-modal priming (Sandra, 2009). However, there may be some issues to be considered when choosing a cross-modal study. One of them is that the use of different prime/target modalities may keep the researcher to know what exactly caused the priming effect (Branigan & Gibb, 2017).

In addition to the prime-target stimuli there are also filler stimuli presented throughout the experiment to function as distractors and to decrease the chance of carryover effects. Carryover effects, which are also known as order effects, consist of practice and fatigue effects (Branigan & Gibb, 2017; Abbuhl, Gass, & Mackey, 2014). Practice effects refer to the experience that the participant has during the experiment, which can affect the participant's completion of the tasks because he/she can learn the pattern and use it unconsciously. While

fatigue effects are related to the effects from tiredness or boredom that can affect participants' performance (Abbuhl, Gass, & Mackey, 2014).

A syntactic priming task is designed by manipulating stimuli to test syntactic priming effects, and this task can be conducted using a number of equipment and test tools. Syntactic priming studies in comprehension usually rely on spoken or text stimuli presented to the participants on a computer screen (Branigan & Gibb, 2017). Online measures such as response time (RT), brain imaging, eye-movements, and event-related potentials are some of the most frequently used techniques in comprehension studies (Branigan & Gibb, 2017). On the other hand, even though the tasks used in studies investigating syntactic priming effects in production are similar to the ones used in comprehension studies, the tasks in production tend to be more varied than the ones in comprehension. In addition, many production studies also consist of comprehension elements (e.g. comprehension questions) and the materials studies may include picture cards or printed booklets, especially concerning studies with children (Branigan & Gibb, 2017). The next subsections will be dedicated to discuss these tasks briefly and the overt responses obtained by research methods in both language comprehension and language production studies.

Research Methods: Syntactic Priming in Language Comprehension

Temporal measures, structure choice, and non-behavioral responses are some of the most frequently used methods to observe and analyze syntactic priming effects (Branigan & Gibb, 2017). As already discussed, research in the area relies on a wide range of paradigms that allow researchers to access online and offline responses to certain stimuli (Branigan & Gibb, 2017).

Concerning temporal measures, the eye-tracking paradigm has been one of the most extensively explored methods in syntactic priming in language comprehension (Branigan & Gibb, 2017). Prime and target sentences are presented entirely and subsequently to the participants in a computer screen. These sentences can have the same or different structures, and there is generally a region of interest to be analyzed (Branigan & Gibb, 2017). Branigan and Gibb (2017) state that "measures typically used include *first pass processing* (the sum of fixations in a region until the reader fixates outside it) and *total time* (the sum of all fixations in a region)" (p. 136). There is evidence for syntactic priming if the reading times for the target sentences were reduced in a prime/target pair sharing the same structure in comparison to reading times when prime and target sentences do not share the same structure (Branigan & Gibb, 2017).

Another common paradigm in syntactic priming research that uses temporal measures is the visual world (VW) paradigm. However, differently from the previous one, this method is used for spoken comprehension (Branigan & Gibb, 2017). A common task involves the participant first reading an unambiguous prime sentence, and then listening to a temporarily ambiguous target sentence while looking at pictures that contain potentially relevant objects. The objective is to observe participants' anticipatory fixations on objects. *First-gaze duration* and *log gaze probability ratio* are some of the most common measures to be considered (Branigan & Gibb, 2017).

In structure choice, common tasks involve the picture-matching paradigm which usually primes the participant with an ambiguous sentence (the stimuli can be read or heard) and then he/she has to choose between two images, one compatible with one structure, for instance high-attachment (HA), and one unrelated. In this case, the participant is forced to

choose the HA structure interpretation. Later, the participant is again exposed to an ambiguous sentence and then he/she has to choose between two images in which both are compatible with the sentence (high attachment versus low attachment). Syntactic priming is observed based on the picture choice since participants tend to choose the picture based on the structures they were primed with, but other measures such as response latencies can also be taken into consideration to analyze the syntactic priming effects (Branigan & Gibb, 2017).

Following the same idea, the Truth-Value Judgment task is more adequate to use with children. Children will listen while the researcher tells or acts out a story, and a puppet describes the events; the children need to decide if the description is true or false. In the prime trial the actions or the description will disambiguate the structure, while in the target trial the structure will be ambiguous. By deciding if the descriptions are true or false, children show how they have interpreted the sentence (Branigan & Gibb, 2017).

Finally, non-behavioral responses have been widely used as means to obtain online measures for language comprehension. These methods can use techniques such as event-related potentials (ERP), using electroencephalography (EEG), and brain imaging, using functional magnetic resonance imaging (fMRI) (Branigan & Gibb, 2017). The EEG is a method used to measure the electrical brain activity on the participant's scalp, while the ERPs are specific information extracted from the electroencephalogram. For the extraction to be possible, the ERPs are marked by *triggers* synchronized with periods of time (Mota et al., 2019). Typical studies usually involve reading tasks using rapid serial visual presentation (RSVP) in which the participants read one word at a time on the screen (Branigan & Gibb, 2017).

In fMRI paradigms, the Blood Level Oxygenation-Dependent signal (BOLD) responses are measured in language-relevant brain areas. The stimuli can vary from visual to auditory.

Depending on the type of study participants can read a prime sentence followed by a target sentence, sentences can be presented word-by-word for a certain period of time, or participants can see a verb followed by a picture of a transitive event, and a sentence description in audio form (Branigan & Gibb, 2017). There are also other neuroimaging techniques that can be used in language studies, such as the magnetoencephalography (MEG) or the positron emission tomography (PET), but that will not be discussed here.

Research Methods: Syntactic Priming in Language Production

Differently from syntactic priming in comprehension, research on syntactic priming in language production tends not to focus on restrained outcomes, and it usually focuses on participants' choice of structure (Branigan & Gibb, 2017). Nevertheless, the overt responses can be obtained by the same methods as for the language comprehension studies: temporal measures, structure choice, and non-behavioral responses. The latter two methods are not as common as for language comprehension research, so most studies in production rely on structure choice paradigms.

Starting with the less frequent, temporal measure paradigms are usually more limited in terms of participants' language production. Participants are often instructed to use certain language structures, and the tasks used can involve event description or language repetition. Temporal measures, as already discussed, reflect online processing, thus the use of computerized stimulus facilitates precise recordings, which are important to provide evidence of the syntactic priming effects (Branigan & Gibb, 2017). In non-behavioral responses, paradigms using fMRI have been developed. The stimulus from the tasks can be, for instance, a verb that the participant must use to describe a subsequent stimulus. BOLD responses are

also analyzed comparing data from participants' production after being exposed to both stimuli from a specific structure and stimuli from an alternative structure (Branigan & Gibb, 2017).

Structure choice paradigms, as previously mentioned, are the most common to be used in studies on syntactic priming in language production. There is a large number of different tasks that can involve picture-description, picture-matching, or linguistic stimuli. Additionally, structure choice paradigms are easily adapted to different populations such as children, people with restricted language abilities, and people with clinical issues (Branigan & Gibb, 2017).

The picture description paradigms can be as simple as participants hearing or reading a prime sentence and describing target pictures or videos, or more complex when the picture description task is combined with other tasks such as the picture-matching. In this case, participants not only read or hear a prime stimulus and decide if the description matches a prime picture, but also are presented to a target image in which they have to produce their own description (Branigan & Gibb, 2017).

As can be seen, designing a syntactic priming study demands attention to a wide number of factors. To ensure the most basic values in any quantitative research, such as validity, reliability, and replicability (Abbuhl, Gass, & Mackey, 2014), the process of designing a priming study involves thinking about the modality of the study, the task, the equipment for data collection, the number of trials, the participants, the syntactic structure, the prime/target construction and presentation, the fillers, to mention some of the most important factors (Branigan & Gibb, 2017). Considering the review of literature above, this systematic review will analyze the research design from the last three years of published studies in syntactic priming. The method followed will be presented in the next section.

Method

The present study consists of a systematic review of published studies in syntactic priming from 2017 to 2020. The review will focus specifically on the research design used by each study.

Objectives and research questions

The objective of the present study is to review syntactic priming studies in order to identify the main tasks used in these studies and report how the tasks were designed regarding five main aspects: 1) the dependent measures included in the data analysis of the syntactic priming studies reported; 2) the design and organization of the experimental tasks; 3) the type of fillers included, 4) the syntactic structures investigated, and 5) the main differences in task design across study modalities.

The present review included studies that report the results of controlled experiments focusing on syntactic priming in comprehension and production (both in L1 and L2), published between 2017 and 2020, in English or in Portuguese, with full texts available.

Search Criteria

The search for published articles was conducted in the Web of Science and Wiley databases. These two databases were chosen especially for three reasons: 1) free access through CAFe (Comunidade Acadêmica Federada) via CAPES portal for journals and databases, 2) access to a comprehensive number of published articles, and 3) search results available for download in various formats (e.g. excel sheet), which helped to compare the different search lists and exclude duplicates. The searches were conducted using the keywords *syntactic priming*, *structural priming*, *experiment*, *task*, and *psycholinguistics*. These keywords were combined (e.g. *syntactic priming* OR *structural priming*, *syntactic priming* AND *experiment*,

structural priming AND *psycholinguistics*). To be included in the review, articles needed to meet the following criteria:

1) The language of publication should be English or Portuguese;

2) The date of publication should be between the years 2017 and 2020;

3) The studies should investigate syntactic priming effects through the use of syntactic priming paradigms;

4) The studies should address L1 or L2 syntactic processing;

5) The articles should report controlled experiments in either comprehension or production syntactic priming;

6) All of the studies should include only healthy adults (studies investigating other populations such as children or people with aphasia were not included).

Figure 1 shows how the article search process was developed in four main steps: identification, screening, eligibility, and included (articles). These steps are related to the eight key stages of a systematic review mentioned earlier in the introduction of present work: 1) scope and map, 2) plan and protocol, 3) document, 4) inclusion and exclusion criteria, 5) search and screen, 6) quality appraisal, 7) data collection, and 8) synthesis (Jesson, Matheson, & Lacey, 2011).

Figure 1

Process of article identification, screening, eligibility and inclusion
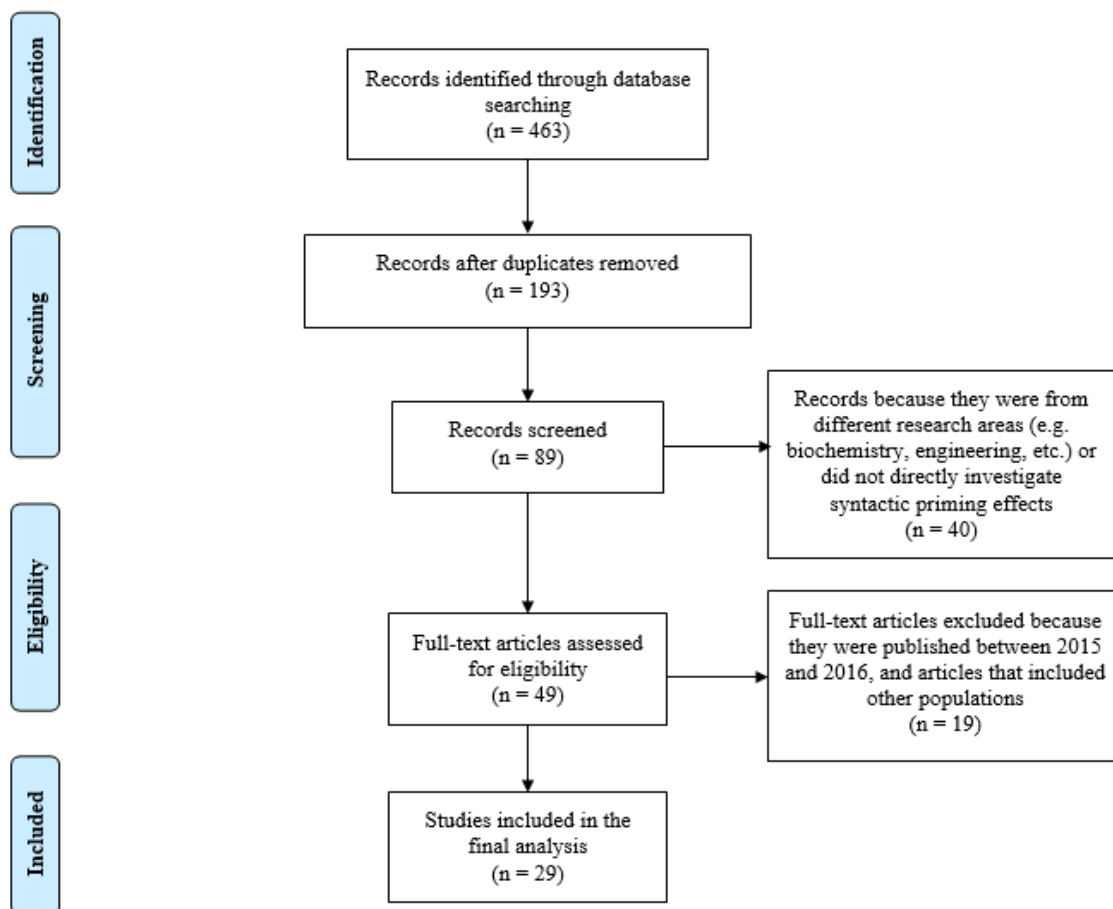
Fig. 1. The Identification stage shows the total number of articles found by crossing all keywords' searches; The Screening stage brings both the article records after removing duplicates and after reading articles titles/abstracts to have a general idea of the research topics. Full-text articles that were not excluded in the previous stages were included in the Eligibility list and went through a deep reading by the author of this review. Finally, 29 research articles were selected for the present analysis.

According to the timetable of the study, the searches were conducted throughout the first months of 2021, and after it was completed, duplicates and any other articles that did not meet all of the criteria proposed were excluded from the review. Given the time available to write an undergraduate dissertation, the initial idea was to cover published articles from 2015 to 2020; a time period of five years seemed to be adequate to understand the most recent works in syntactic priming. However, after completing the searches, the number of eligible articles was almost twice as much as the final number of articles included (29). Considering the limitations of an undergraduate dissertation and the time limit available, it was necessary to

shorten the time period. For this reason, and considering that most of the eligible articles were from 2017 to 2020, the time period of articles selected changed. Also, one extra criterion (criterion number 6, regarding population) that was not considered at the beginning of the project was also included regarding the possibility of conducting a meta-analysis of the data in the future, these two situations shortened the final list of articles included (see Appendix A to see the list of research articles excluded based on the new time cut and the sixth criterion).

Results and Discussion

In total, considering the first time period (2015-2020) selected in the Web of Science and Wiley databases search, 463 studies were found. Priming is a phenomenon based on repetition and, even though it was not broadly debated in the present paper, it is not a phenomenon restricted to linguistic events (e.g. Nie, Li, & Ye, 2016; Ni,Liu & Yu, 2019) which meant that papers from different areas were shown in the search and had to be filtered. In addition, probably due to the word *structural*, it was observed that when searching for the term *structural priming* alone in the databases a large number of studies from various different areas were shown (e.g. agronomy, microbiology, cognitive neuroscience, psychology). For this reason, the term *structural priming* was always paired with another keyword (either *syntactic priming* or *psycholinguistics*) as a way to narrow the search. The keyword *syntactic priming* was used both alone and paired with the keyword *experiment* and *task* in two different searches. After each search, the list of articles found were exported to an excel sheet along with the main information from each article (authors, name of the article, year of publication, and abstract, to name the most important). These lists were used to remove duplicates. Then, the articles were downloaded and by applying all the criteria mentioned before, 29 research articles published from 2017-2020 were included in the final list.

The present section will report the results from the systematic review of studies on L1 or L2 syntactic priming during production or during comprehension published between 2017-2020 that were selected according to the criteria previously presented. First, I will address the articles by showing the list of studies included. Then, each research question will be addressed. Finally, I will discuss the implications of my findings and present the limitations of the review.

Selected Articles

The objective of the present research is to describe and discuss the design of published articles from 2017-2020 in syntactic priming research. For this means, the research questions were proposed with the aim to elucidate some of the main aspects to be considered while designing a syntactic priming study. Therefore, the results of these studies are not relevant for this analysis and will not be discussed.

Table 1

Overview of articles included in the review (published between 2017-2020)

Article's number	Study	Participants	Language	Modality of the Study	Task Type	Structure of Interest	Filler Type	Dependent Measures
1	Chia, K., Hetzel-Ebben, H., Adolph, M., Amaral, M., Arriaga, M., Booth, H., ... & Kaschak, M. P. G (2020)	921 native English speakers	English (L1)	Production L1-L1	Levelt and Kelter's (1982) paradigm	Prepositional phrases (PP)	No filler	Structure choice
2	Zhang, C., Bernolet, S., & Hartsuiker, R. J. (2020)	(1) 40 native Dutch speakers; (2) 48 native Dutch speakers	Dutch (L1)	Production L1-L1	Picture matching combined with picture description	Dutch genitives (of-genitive vs. s-genitive)	Pictures containing two figures but no objects	Structure choice
3	Tooley, K. M. (2020)	54 native English speakers	English (L1)	Comprehension L1-L1	Eye-tracking reading task	Relative Reduces clauses	Main clauses or locatives with a by-phrase	Eye-fixation (first-pass time regression-path time, total time, and regressions out)
4	Son, M. (2020)	46 Korean EFL learners of English	Korean (L1) English (L2)	Production L1-L2	Picture-description task	PO/DO dative structures	Sentences in various structures (e.g.passive sentences and sentences with intransitive verbs and pictures accompanied by sentences fragments	Structure choice

5	Hardy, S. M., Wheeldon, L., & Segaert, K. (2020)	(1) 40 young adults aged 18-22 from and 40 older adults aged 62-85, all native English speakers (2) 40 young adults and 40 older adults	English (L1)	Production L1-L1	Picture-description Task	Passive-active transitive sentences	Greyscale pictures depicting intransitive verb events and involving three nouns of different types	Structure choice
6	Ivanova, I., Horton, W. S., Swets, B., Kleinman, D., & Ferreira, V. S. (2020)	(1) 64 native English speakers (32 in each of the conditions); (2) 32 native English speakers; (3) 47 native English speakers; (4) 48 native English speakers	English (L1)	Production L1-L1	Picture-matching Task combined with a picture-description task	PO/DO dative structures	Pictures with either intransitive actions or simple transitive actions involving only an agent and a patient	Structure choice
7	Carminati, M. N., van Gompel, R. P., & Wakeford, L. J. (2019)	(1) 32 native English speakers; (2) 28 native English speakers; (3) 36 native English speakers; (4) 54 native English speakers; (5) 54 native	English (L1)	Production L1-L1	(1), (2) and (4) Picture description via the oral completion of a sentence fragment; (3) Oral completion of a sentence fragment with no visual context; (5) Oral production of a sentence from a given array of	PO/DO dative structures	Filler sentences (passives, intransitives and copula-verb construction) paired with filler pictures accompanied by sentence fragments	Structure choice

		English speakers				words and no visual context		
8	Wei, H., Boland, J. E., Cai, Z. G., Yuan, F., & Wang, M. (2019)	(1) 36 native Chinese speakers with English and L2; (2) 48 new participants from the same population	Chinese (L1) English (L2)	Comprehension L1-L2	Self-paced reading	(1) Relative clauses; (2) Both main-clause and reduced relative clause	Sentences of unrelated structures	Reaction time
9	Ziegler, J., Bencini, G., Goldberg, A., & Snedeker, J (2019)	300 native English speakers	English (L1)	Production L1-L1	Picture Description Task	Passive-active transitive sentences	Sentences with various constructions (e.g.clefts, existentials, resultatives, datives, generics, intransitive, and clausal complement). No filler sentences were passive structures. Filler pictures typically described with intransitive sentences	Structure choice
10	Ziegler, J., & Snedeker, J. (2019)	(1) 72 native English speakers; (2) 72 additional native English speakers	English (L1)	Comprehension L1-L1	Visual-world eye-tracking	PO/DO dative structures	Transitive sentences	Animate preference (Animate referents vs. Inanimate referents during a given time window)
11	Xiang, M., Grove, J., & Merchant, J. (2019)	(1) native English speakers; (2)	English (L1)	Production L1-L1	Picture Description Task	Verb phrase ellipsis and null	Bi-clausal sentences (none of them had ditransitive	Structure choice

		93 native English speakers					complement anaphora	verbs) and each filler item was paired with a picture	
12	Weber, K., Christiansen, M. H., Indefrey, P., & Hagoort, P. (2019)	27 native Dutch speakers	Dutch (L1) Artificial Language (L2)	Comprehension L1-L2	Picture-Choice Task	Passive-active transitive sentences	Intransitive SV word order sentence also present in the L1	Picture choices and reaction time
13	Tooley, K. M., Pickering, M. J., & Traxler, M. J. (2019)	(1) 37 participants native English speakers (2) 51 participants from the same population; (3) 69 further participants; (4) 50 further participants	English (L1)	Comprehension L1-L1	Eye-tracking reading task	Reduced relative clauses	Sentences with various constructions	Eye-fixation (first-pass time regression-path time, total time, and first-pass regressions)
14	Schoot, L., Hagoort, P., & Segaert, K. (2019)	Total of 117 participants native Dutch speakers (60 in the interlocutor conditions and 57 in the no interlocutor conditions)	Dutch (L1)	Comprehension-to-Production L1-L1	Picture Description Game	Passive-active transitive sentences	Pictures depicting intransitive, locative, and transitive actions	Structure choice
15	Jacobs, C. L., Cho, S. J., & Watson, D. G. (2019)	(1) 600 native English speakers; (2) 333 participants	English (L1)	Comprehension-to- production Self-priming	Written picture-description combined with	PO/DO dative structures	Images depicted non-ditransitive events and the corresponding descriptions of these filler images	Structure choice

		from the same population; (3)		L1-L1	truthful-rating image descriptions			
16	Hwang, H., & Shin, J. A. (2019)	(1) 40 Chinese (Mandarin) speakers of English (2) 32 monolingual native Chinese speakers	Chinese (L1) English (L2)	Production (1) L1-L2 (2) L1-L1	Picture description combined with sentence completion	Passive-active transitive sentences and DO/PO datives	Images depicting intransitive events accompanied by a verb and a noun to be used in the description	Structure choice
17	Fukuta, J., Goto, A., Kawaguchi, Y., Kurita, A., & Murota, D. (2018)	Non specified number of highly proficient Japanese learners and native English speakers	English (L1) Japanese (L2)	Comprehension L1-L1 L2-L2	Self-Paced Reading Task	PP–attachment ambiguity	PO/DO sentences	Structure choice and reaction time
18	dos Santos, M. P., & Mota, M. B. (2018)	15 native Brazilian Portuguese speakers that had French as L2	Brazilian Portuguese (L1) French (L2)	Comprehension L2-L2 L1-L2	Self-Paced Reading Task	Passive-active transitive sentences	Active sentences with intransitive verbs	Reaction time
19	Giavazzi, M., Sambin, S., de Diego-Balaguer, R., Le Stanc, L., Bachoud-Lévi, A. C., & Jacquemot, C. (2018)	48 native French speakers	French (L1)	Comprehension L1-L1	Picture Matching Task	Passive-active transitive sentences	No filler	Accuracy and reaction times
20	Ziegler, J., & Snedeker, J. (2018)	2914 native English speakers were recruited via Amazon	English (L1)	Production L1-L1	Picture-description Task	Dative and locative sentences	Filler trials from all experiments were the same and had direct objects with	Structure choice

		Mechanical Turk and participated on 11 different experiments					either one or two noun phrases	
21	Kootstra, G. J., & Şahin, H. (2018)	(1) 46 speakers of Papiamento (19 residing in Aruba and 27 residing in the Netherlands); (2) 62 new participants from the same population as in experiment 1 (25 were Aruba participants and 37 were Netherlands' participants).	Papiamento (L1) Dutch (L2)	Production L1-L1 L2-L1	Movie-clip Description Task	PO/DO dative structures	Movie clips representing transitive and intransitive events along with transitive and intransitive verb	Structure choice
22	Song, Y., & Do, Y. (2018)	27 self-reported balanced Korean-English bilinguals	Korean English	Production	Sentence completion	SUBJECT-TO-OBJECT RAISING (STOR) construction	English and Korean sentence fragments, neither of which employed STOR verbs	Structure choice
23	Hsieh, Y. (2017)	54 native speakers of Mandarin Chinese that	Chinese (L1) English (L2)	Comprehension L1-L2	Self-Paced Reading Task	Passive-active ambiguous sentences	Sentences of various types and lengths	Reaction time and grammaticality judgments of the target sentences

			had English as L2						

24	Scheepers, C., Raffray, C. N., & Myachykov, A. (2017)	(1) 60 native English speakers; (2) 60 new participants native English speakers; (3) 80 new participants native English speakers	English (L1)	Comprehension-to- production	Reading aloud Task and Sentence Generation Task	PO/DO dative structures	Whole sentences different in content and structure from the critical ditransitive sentences and four-word arrays that encouraged the generation of structures that were different from the critical PO/DO sentences	Structure choice
25	Jacob, G., Katsika, K., Family, N., & Allen, S. E. (2017)	(1) 32 native German speakers who had acquired English as L2; (2) 32 new participants from the same population	German (L1) English (L2)	Production L1-L2	Sentence Completion Task	PO/DO dative structures	Complete German pseudo-prime sentence followed by an English pseudo-target sentence fragment. Fillers were of a similar length as the experimental items, but consisted of a variety of different syntactic structures	Structure choice
26	Jackson, C. N., & Ruf, H. T. (2017)	(1) 19 participants native English speakers that had German as L2; (2) 19 participants from the same population	English (L1) German (L2)	comprehension-to-production L1-L2	Picture-matching combined with picture-description	(1) fronted temporal phrases (TPs); (2) fronted locative phrases (LPs)	Sentences and corresponding pictures depicting a variety of different structures (e.g. sentences with intransitive verbs, one or two object, sentences, etc.)	Structure choice

27	Ivanova, I., Wardlow, L., Warker, J., & Ferreira, V. S. (2017)	(1) 48 native English speakers; (2) 48 native English speakers	English (L1)	Production	Picture matching combined with picture-description	PO/DO dative structures	The fillers used both novel and known verbs. The filler primes were intransitive and their targets similarly elicited intransitive descriptions	Structure choice
28	Ivanova, I., Branigan, H. P., McLean, J. F., Costa, A., & Pickering, M. J. (2017)	(1) 36 native English speakers; (2) 42 participants from the same population	English (L1)	Production	Picture matching combined with picture-description	PO/DO dative structures	Filles sentences in the same structure as experimental items but with monotransitive verbs corresponding to monotransitive event, and filler images (half of them in the same type as the experimental pictures)	Structure choice
29	Heyselaar, E., Hagoort, P., & Segaert, K. (2017)	(1) 53 native Dutch speakers (2) 55 native Dutch speakers	Dutch (L1)	Production L1-L1	Picture Description Task	Passive-active transitive sentences	Pictures eliciting intransitive sentences	Structure choice

Note: a) Studies containing numbers (e.g. (1), (2), (3), etc.) reported more than one experiment, the numbers refer to each of the experiments.

Table 1 presents the studies included in the present systematic review by bringing some of the main information to be discussed further on. The table shows, for each article, the number of participants in the experiment(s), the language (s) investigated and whether the priming effects were analyzed within (L1-L1 or L2-L2) or across (L1-L2 or L2-L1) the languages, the study modality of the article (e.g. production or comprehension), the type of task used in the study, the syntactic structure of interest, the filler type, and the dependent measures of each study. The articles were enumerated from 1 to 29 to facilitate reference during the discussion.

Based on the information provided in Table 1, I will now address each research question this review aims to answer.

RQ1: Which dependent measures were investigated in the selected syntactic priming studies?

The dependent variable, as previously discussed, is directly related to the subject of the study and its choice relies on the proximity of the mental process intended to be observed (Sandra, 2009). Depending on the study, researchers can include more than one dependent variable to analyze. This explains why the total number of dependent measures reported in Figure 2 is higher than the total number of articles included in the present analysis. Table 1 shows that four[3] articles included two different types of dependent measures — combining, for instance, accuracy and reaction times, or reading times and grammaticality judgments of the target sentences — that were separately considered in in the figure below. In total, twenty-one[4] studies included structure choice as at least one of the dependent measures, six[5] studies

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[3] Studies 12, 17, 19, and 23
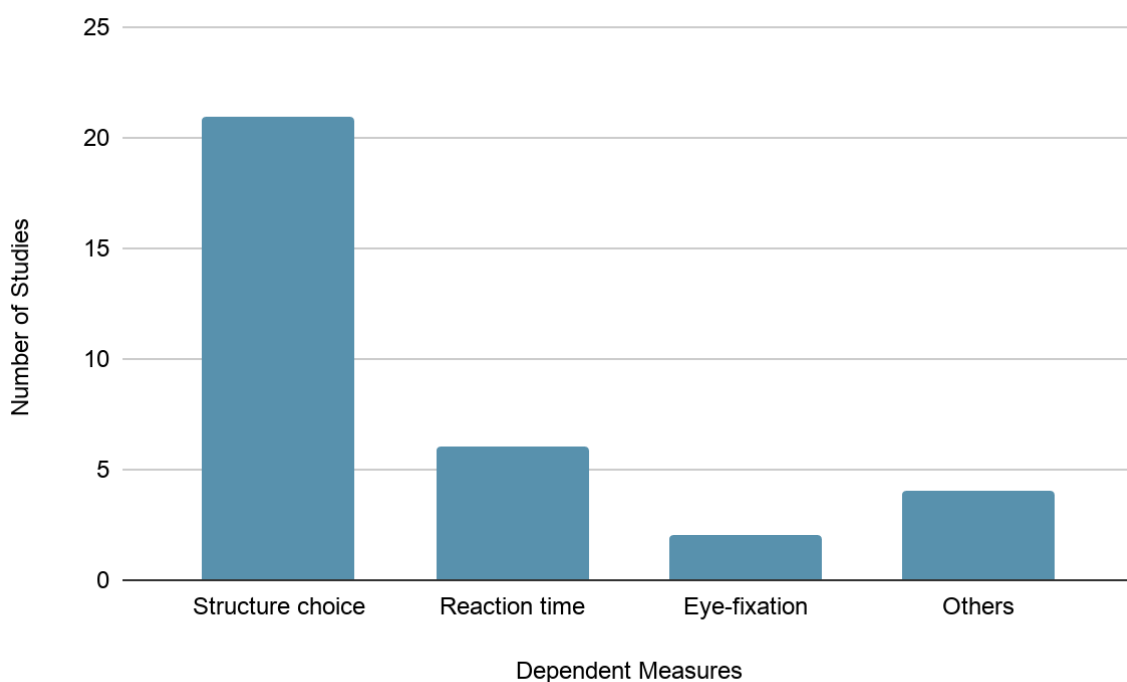[4] Studies 1, 2, 4, 5, 6, 7, 9, 11, 14, 15, 16, 17, 20 , 21, 22, 24, 25, 26, 27, 28, and 29
[5] Studies 8, 12, 17, 18, 19, and 23

included reaction time (RT) measures, two[6] studies included eye-fixation, and four[7] studies

used different dependent variables and were labeled as Others in Figure 2.

Figure 2

Dependent measures of the studies

In studies considering structure choice, participants' responses were recorded,

transcribed and then coded according to the structure of interest — PO (prepositional-object),

DO (double-object), and Other (in case any participant used a different syntactic structure), for

instance. The studies that included RT measures varied across the research articles. As defined

by Jiang (2013) a RT study is any empirical study that involves analyzing the time an individual

takes to respond to a type of stimulus or to perform a task. All four[8] self-paced reading studies

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[6] Studies 3, and 13
[7] Studies 10, 12, 19, and 23
[8] Studies 8, 17, 18, and 23

measured sentence or region of interest reading times by recording participants' reaction time. The RT in such tasks is usually measured by the duration of time that the participant takes from reading a stimulus before going to the next one (Jiang, 2013). The last two studies to use RTs as dependent measures were Weber, Christiansen, Indefrey, and Hagoort (2019), which included overall reading-aloud times marking the onset of the stimulus up to participants' reading aloud, and Giavazzi et at. (2018) in which RTs were time-locked to the onset of the picture presentation.

The two[9] eye-tracking reading studies measured reading times but based on the eye-tracking paradigm, the dependent measure was eye-fixation which included different fixations times. In Tooley (2020), the four dependent measures analyzed were first-pass time (sum of all fixations in each region), regression-path time (the sum of fixations from the regressive movements into different regions), total time (total duration of fixations in each region, including the regressive movements), and regressions out (a binary measure to observe if there were any regressions from one specific region to another). In Tooley, Pickering, and Traxler (2019), the authors also included first-pass time, total time, and regression path time, the only difference was the inclusion of first-pass regressions (the percentage of eye-movements that crossed each region after the first-pass fixations) instead of the regressions out measure.

The dependent measures included in the category Others were animate preference, grammaticality judgment, accuracy, and picture-choice. In Ziegler and Snedeker (2019), the animate preference, used in the visual-world eye-tracking study from, was calculated by measuring the average looks to the animate referents during the 500ms time window. In Hsieh (2017), participants' grammaticality judgments of the target sentences were analyzed as one of

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[9] Studies 3, and 13

the dependent variables from the study. In Giavazzi et al. (2018) and Weber, Christiansen, Indefrey, and Hagoort, (2019) the studies measured both accuracy and picture choice, respectively, by coding participants' answers as correct or incorrect.

In conclusion, the choice of which dependent measure to include in the analysis seems to be directly related to the modality of the study. Except for the study of Fukuta et al. (2018) all of the other studies that included structure choice as the dependent measure were either production or comprehension-to-production studies. However, considering that the same pattern was not observed in the comprehension studies, the type of task and the structure of interest also need to be taken into consideration.

In relation to the type of task, for instance, the eye-tracking reading studies analyzed four different time measures, while self-paced reading studies generally analyzed a single time measure. Moreover, other comprehension studies using different types of tasks such as Weber, Christiansen, Indefrey and Hagoort (2019), Giavazzi et al. (2018) and Ziegler and Snedeker (2019) also showed varied dependent variables. Finally, the structure of interest also seems to play a role in this methodological decision considering, for example, the studies of Hsieh (2017) and Fukuta et al. (2018), both were self-paced reading studies that investigated ambiguous sentences, and for this reason they not only analyzed reaction times but also included one more dependent measure to the analysis.

RQ 2: How are the experimental trials designed and organized?

First, before addressing the trials design, it is important to briefly address the choice of tasks included in the studies — given that the type of task may affect how the trials are organized. Most of the tasks focused on participants' choice of structure — such as the picture description paradigms — which were used both as a unique form of data collection, and

combined with other paradigms like picture-matching or written/oral sentence completion tasks. Comprehension studies on the other hand were mainly composed by self-paced reading tasks or eye-tracking reading paradigms.

The types of tasks included in each of the studies are specified in Table 1 and will not be individually addressed since they were previously described in the review of literature. Even though the tasks can follow different procedures depending on the study, they still have some general features in common. However, methodological decisions on design and organization within tasks are as important as the choice for a task. Table 2 shows the modalities of prime and target used in each of the studies.

Table 2

Modalities of prime/target pairs in production studies

Article's number	Study	Modality of the Study	Modality of Prime	Modality of Target	Prime/Target Presentation Design
1	Chia, K., Hetzel-Ebben, H., Adolph, M., Amaral, M., Arriaga, M., Booth, H., ... & Kaschak, M. P. (2020)	Production	Auditory	Auditory	Primes were subsequently followed by a target
2	Zhang, C., Bernolet, S., & Hartsuiker, R. J. (2020)	Production	Auditory and visual	Visual	Prime and targets were separated by either an easy or difficult math problem
3	Tooley, K. M. (2020)	Comprehension	Visual	Visual	Primes were subsequently followed by a target
4	Son, M. (2020)	Production	Visual	Visual	Prime and targets were separated by a comprehension question
5	Hardy, S. M., Wheeldon, L., & Segaert, K. (2020)	Production	Visual	Visual	Primes were subsequently followed by a target
6	Ivanova, I., Horton, W. S., Swets, B., Kleinman, D., & Ferreira, V. S. (2020)	Production	Auditory and visual	Visual	Primes were subsequently followed by a target

7	Carminati, M. N., van Gompel, R. P., & Wakeford, L. J. (2019)	Production	Visual	Visual	Primes were subsequently followed by a target
8	Wei, H., Boland, J. E., Cai, Z. G., Yuan, F., & Wang, M. (2019)	Comprehension	Visual	Visual	(1) Three conditions: 0-Lag, 1-Lag, and 2-Lag; (2) Two conditions: 0-Lag, and 2-Lag
9	Ziegler, J., Bencini, G., Goldberg, A., & Snedeker, J (2019)	Production	Auditory and spoken	Visual	A written sentence prime asked to be read out loud was followed by a target picture
10	Ziegler, J., & Snedeker, J. (2019)	Comprehension	Auditory and visual	Visual	2 primes followed by a target
11	Xiang, M., Grove, J., & Merchant, J. (2019)	Production	Visual, auditory, and spoken	Visual	The same prime sentence presented in different modalities and repeated by the participant and was then followed by the target picture
12	Weber, K., Christiansen, M. H., Indefrey, P., & Hagoort, P. (2019)	Comprehension	Visual and spoken	Visual and read out loud by the participant	Primes were subsequently followed by a target
13	Tooley, K. M., Pickering, M. J., & Traxler, M. J. (2019)	Comprehension	Visual	Visual	Primes were subsequently followed by a target
14	Schoot, L., Hagoort, P., & Segaert, K. (2019)	Comprehension-to-production	Auditory and visual	Visual	Primes were subsequently followed by a target
15	Jacobs, C. L., Cho, S. J., & Watson, D. G. (2019)	Comprehension-to-production	Auditory and visual	Visual	The study had a pre-priming production phase, a priming phase, and a post-priming production phase
16	Hwang, H., & Shin, J. A. (2019)	Production	Visual	Visual	Primes were subsequently followed by a target
17	Fukuta, J., Goto, A., Kawaguchi, Y., Kurita, A., & Murota, D. (2018)	Comprehension	Visual	Visual	Primes were subsequently followed by a target

18	dos Santos, M. P., & Mota, M. B. (2018)	Comprehension	Visual	Visual	Primes were subsequently followed by a target
19	Giavazzi, M., Sambin, S., de Diego-Balaguer, R., Le Stanc, L., Bachoud-Lévi, A. C., & Jacquemot, C. (2018)	Comprehension	Auditory and visual	Auditory and visual	Primes were subsequently followed by a target
20	Ziegler, J., & Snedeker, J. (2018)	Production	Auditory	Visual	Experiments 1-10 had 2 primes followed by a target, and experiment 11 had 3 primes before the target
21	Kootstra, G. J., & Şahin, H. (2018)	Production	(1) No prime; (2) Auditory	(1) Visual; (2) Visual	(1) unprimed picture description experiment; (2) Primes were subsequently followed by a target
22	Song, Y., & Do, Y. (2018)	Production	Visual and spoken	Visual and spoken	Primes were subsequently followed by a target
23	Hsieh, Y. (2017)	Comprehension	Visual	Visual	Primes were subsequently followed by a target
24	Scheepers, C., Raffray, C. N., & Myachykov, A. (2017)	Comprehension-to-production	Visual and spoken	Visual	Primes were subsequently followed by a target
25	Jacob, G., Katsika, K., Family, N., & Allen, S. E. (2017)	Production	Visual and spoken	Visual	Primes were subsequently followed by a target
26	Jackson, C. N., & Ruf, H. T. (2017)	Comprehension-to-production	Visual	Visual	Primes were subsequently followed by a target
27	Ivanova, I., Wardlow, L., Warker, J., & Ferreira, V. S. (2017)	Production	Auditory and visual	Visual	Prime and targets were separated by a verification picture for the prime sentence
28	Ivanova, I., Branigan, H. P., McLean, J. F., Costa, A., & Pickering, M. J. (2017)	Production	Visual	Visual	Prime and targets were separated by a verification picture for the prime sentence
29	Heyselaar, E., Hagoort, P., & Segaert, K. (2017)	Production	Auditory and visual	Visual	Primes were subsequently followed by a target

As can be seen, 16 studies[10] used mixed techniques to introduce prime and targets — such as auditory and visual primes with a single visual target — while 13 studies[11] kept the same technique — such as having both prime and target visually presented. The general modalities included in Table 2 were auditory, visual, and spoken primes (the latter meaning that the participant was asked to read or repeat the stimuli out loud). Both auditory and visual stimuli could be introduced in different ways. Auditory primes could be read out loud by the researcher (e.g. Chia et.al, 2020; Zhang, Bernolet, & Hartsuiker, 2020) or played in the form of pre-recorded audios (e.g. Ziegler, Bencini, Goldberg, & Snedeker, 2019; Xiang, Grove, & Merchant, 2019; Ziegler, & Snedeker, 2019). The study of Heyselaar, Hagoort, and Segaert (2017), for instance, included both types of auditory stimuli due to the objectives of the study. The authors aimed to observe if syntactic priming effects in humans would be the same when interacting with another human compared to when interacting with either a human-like avatar or a computer-like avatar in a virtual environment. Therefore, participants interacted both with a confederate researcher and with an avatar using pre-recorded audios.

The visually presented prime stimuli also varied across studies. They could be only composed by written words/sentences to be silently read (e.g. Son, 2020; dos Santos & Mota, 2018), written words/sentences to be read out loud by the participant (e.g. Carminati, van Gompel, & Wakeford, 2019; Xiang, Grove, & Merchant, 2019), pictures (e.g. Giavazzi et al. , 2018; Ivanova, Wardlow, Warker & Ferreira, 2017), or both written words/sentences and pictures (e.g. Weber, Christiansen, Indefrey & Hagoort, 2019; Jackson & Ruf, 2017). Table 2

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[10] Studies 1, 2, 6, 9, 10, 11, 12, 14, 15, 19, 21, 22, 24, 25, 27, and 29
[11] Studies 3, 4, 5, 7, 8, 13, 16, 17, 18, 19, 23, 26, and 28

also shows another important design feature of syntactic priming experiments related to research question 2: prime/target presentation. In most of the studies (18[12] out of 29) primes and targets were presented directly after each other.

In the studies of Ziegler and Snedeker (2019) and Ziegler and Snedeker (2018), the authors included at least two primes in each experimental trial, that is because in Ziegler and Snedeker (2018) experiments 1-10 had two prime sentences before the target while experiment 11 included three primes before the target. In the studies of Ivanova, Wardlow, Warke and Ferreira (2017) and Ivanova et al. (2017) prime and target were separated by a verification picture related to the prime sentence. In Xiang, Grove, and Merchant (2019) and Ziegler, Bencini, Goldberg, and Snedeker (2019) the same prime was asked to be repeated out loud by the participant before the target presentation. In Zhang, Bernolet, and Hartsuiker (2020) and in Son (2020) prime and targets were separated by either an easy or difficult math problem, or a comprehension question, respectively. Wei et at. (2019) included lag conditions between prime and target (Experiment 1 had 0-lag vs 1-lag vs 2-lag conditions, and Experiment 2 had 0-lag vs 2-lag conditions). At last, the study of Jacobs, Cho, and Watson (2019) had a different task design, the study was divided in three phases (Production 1, Comprehension-priming, Production 2). In the first and the second production phases participants were free to choose the sentence structure they would use to describe the pictures, while in the comprehension priming phase, participants would hear an auditory stimulus as many times as needed and rate from 0-100 whether the sentence matched the picture or not.

We can conclude then that the prime modalities (e.g. auditory, visual, or spoken) and the use of same or mixed techniques did not rely neither on the study modality (e.g. production,

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[12] Studies 1,3, 5, 7, 12, 13, 14, 16, 17, 18, 19, 22, 23, 24, 25, 26, and 29

comprehension, or both), nor on the type of task. From the 16 production-only studies, nine[13] studies kept the same prime modalities during the whole experimental trial, while seven[14] varied the prime modalities within the trial. Such variety must be due to the different objectives and specificities related to each study. In addition, as discussed, apart from the studies that included two primes before the target, and the ones that included an item (e.g. comprehension question, filler item, mathematical problem), all the other studies presented primes and targets subsequently, which shows a pattern for the syntactic priming experiments.

RQ 3: What type of fillers are used?

As can be seen in Table 1, the types of fillers are very similar across studies and may depend on other methodological choices such as the task type and structure of interest. All of the studies using picture-description tasks or studies that combined picture-matching with picture-description tasks included both sentences and pictures in the filler trials; in most of the studies the filler sentences were from various unrelated structures. A number of studies in which the structure of interest was PO/DO datives mentioned, for instance, the use of transitive/intransitive sentences and pictures depicting transitive/intransitive actions (e.g. Son, 2020; Ivanova et. al. 2020; Carminati, van Gompel, & Wakeford, 2019; Jacobs, Cho, & Watson, 2019; Kootstra, & Şahin, 2018). Intransitive structures and pictures were also broadly used as fillers for studies focusing on transitive passive/active sentences (e.g. Hardy, Wheeldon, & Segaert, 2020; Ziegler, Bencini, Goldberg, & Snedeker, 2019; Schoot, Hagoort & Segaert, 2019; Hwang, & Shin, 2019; Heyselaar, Hagoort, & Segaert, 2017).

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[13] Studies 2, 6, 9,11, 20, 21, 25, 27, and 29
[14] Studies 1, 4, 5, 7, 16, 22, and 28

Two studies did not mention the use of filler sentences. In Chia et al. (2020), the authors proposed to replicate Levelt and Kelter's (1982) paradigm. Each experimenter called 40 local businesses and asked one of the two questions "What time does the shop close?" or "At what time does the shop close?". The authors included three other conditions in addition to the one from the original study in order to add interaction between the speakers and investigate whether interaction affected the strength of the priming effects. Except for one condition — in which the experimenter repeated the same question as if s/he did not understand the answer —, each of the 931 participants only heard a single experimental trial, therefore, no fillers were used.

Giavazzi et al (2018) included two study conditions, heterogeneous vs. homogeneous, each presented in a different presentation block. The heterogenous block contained both passive and active prime sentences, while the homogeneous block only contained passive prime sentences. The matching target images from both blocks were the same. The order of trials was pseudorandomized in each of the lists and the block's presentation was counterbalanced among participants. No filler sentences or pictures were mentioned in the materials section.

From all this, we can conclude that the types of fillers depend mostly on the general trial design and organization, most of them just followed the same pattern of the experimental trials forming filler trials. These filler trials were composed by the same items (e.g. sentences, pictures) as the experimental trials and were presented the same way, they were just formed by sentence structures that differed the ones from the critical trials or pictures that elicited different syntactic structures.

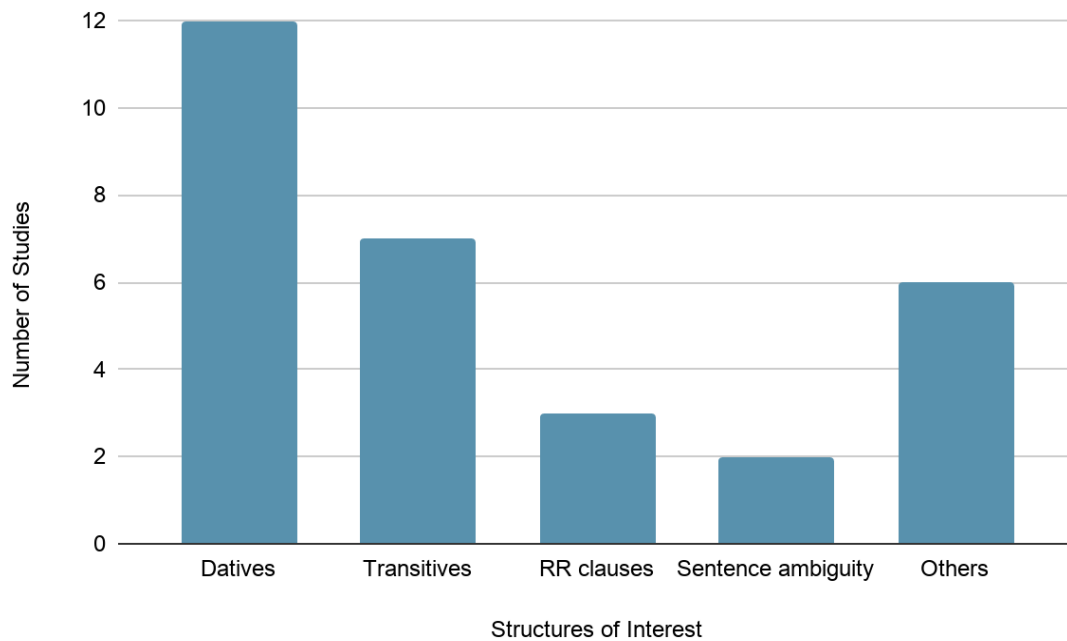**RQ 4: Which syntactic structures are investigated?**

Figure 3 shows that most of the studies investigated either dative structures[15] (e.g. Son, 2020; Ivanova et al., 2020; Carminati, van Gompel, & Wakeford, 2019; Ziegler, & Snedeker, 2019;) or transitives structures[16] (e.g. Hardy, Wheeldon, & Segaert, 2020; Ziegler, Bencini, Goldberg, & Snedeker, 2019;). The Others bar refers to sentence structures that were included in only one study such as prepositional phrases (PP) (see Chia et al., 2020), Dutch genitives (see Zhang, Bernolet, & Hartsuiker, 2020), subject-to-object raising (STOR) construction (see Song, & Do, 2018), locatives (see Ziegler, & Snedeker, 2018), temporal phrases (see Jackson, & Ruf, 2017), and verb phrase ellipsis and null complement anaphora (see Xiang, Grove, & Merchant, 2019). The total number of sentence structures included in Figure 3 is larger than the number of studies because some of the research articles conducted more than one experiment, therefore some of them also investigated more than one syntactic structure per study (e.g. Hwang, & Shin, 2019; Ziegler, & Snedeker, 2018).

Figure 3

Structures of interest included in the research articles

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[15] Studies 4, 6, 7, 10, 15, 16, 20, 21, 24, 25, 27, and 28
[16] Studies 5, 9, 12, 14, 16, 18, 19, 23, and 29

In conclusion, the result that dative and transitive sentences are among the most investigated syntactic structures is in line with previous syntactic priming research, since these structures have been investigated since Bock (1996) by a large number of syntactic priming studies (e.g. Pickering & Branigan, 1998; Schoonbaert, Hartsuiker, & Pickering, 2007; Demuth, Moloi, & Machobane, 2010; Segaert, Menenti, Weber, & Hagoort, 2011; Segaert, Kempen, Petersson, & Hagoort, 2013). Considering the active and passive voice, for instance, the active voice has shown to be a much more frequent structure than the passive voice in language production, therefore the use of these structures to observe priming effects is justified because the effects become more visible (Jaeger & Snider, 2007).

RQ 5: What are the main differences in task design in terms of modality?

One of the differences that could be observed between production and comprehension studies was related to the dependent variables chosen. All of the production and comprehension-to-production studies, twenty in total, used structure choice as the dependent measure which showed a certain regularity in the pattern of the studies. On the other hand,

comprehension studies showed to be more varied considering that six studies from the ten comprehension-only studies measured RT, two measured fixation times, and four used other dependent measures. This variety might be explained by the nature of the tasks. In self-paced reading tasks, for instance, the time between the participant being presented to a stimulus and pressing the button to go to the next one is seen as the time s/he takes to read that same stimulus. In the other two studies using RTs, there was one more dependent variable related to the accuracy of participants' responses to analyze the data. At last, in the eye-tracking reading tasks the reading process is interpreted by the fixation durations. As stated by Kliegl and Laubrock (2017), "Fixation durations and locations yield many measures that are sensitive to language-related processing difficulty" (p.68), therefore events must be time-locked to be interpreted.

Another difference among production and comprehension modalities in the studies selected is that task types in production studies tend to be more varied than in comprehension studies because of task type combinations — which could be observed in both production and comprehension-to-production studies. As can be observed in Table 1, even though a total of sixteen[17] production and comprehension-to-production studies used a type of picture-description task, in most cases they were combined with another task type such as picture-matching or sentence completion. Comprehension-only studies tended to use a single task type per study.

Regarding RQ 5, we can conclude that from the other research questions addressed in the present review, and apart from the dependent measures analyzed, and the types of task, not many other relevant differences were found across the study modalities. Considering the other research questions, the methodological decisions on design and organization of experimental

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[17] Studies 2, 4, 5, 6, 7, 9, 11, 14, 15, 16, 20, 21, 26, 27, 28, and 29

trials, types of fillers used, and structure of interest did not depend on which study modality the article focused on.

Final Remarks

The investigation of language and cognitive processes relies on a number of experimental methods and techniques that have been developed for the last decades in many research areas, such as Psycholinguistics. On that note, syntactic priming research works as an important tool to investigate the language processing system. The present study revisited the latest studies in syntactic priming in both production and comprehension modalities in order to determine the experimental design of these studies

The analysis of the design of the syntactic priming studies included for review shows, in summary, that: (1) most syntactic priming studies analyzed the data by considering participants' choice of structure or reaction time — this methodological choice is mainly related to the study's modality (production or comprehension), but it can be also affected by the choice of task and structure of interest; (2) the majority of the studies presented primes and targets subsequently, one right after the other, and used different prime modalities (e.g. auditory prime, and visual target); (3) the fillers were very similar among all studies: since most of the articles did not include fillers between the prime/target pair, fillers were organized in separate trials and followed the same pattern of the experimental trials; (4) the dative PO/DO and transitive passive/active sentences were the most investigated syntactic structures; and (5) the main differences in task design across the different study modalities are related to the dependent measures included in the analysis, and the types of task chosen.

Other than the results presented, some other conclusions can be inferred from the data. One of them is that production is the modality of language processing that is the most

investigated: from the 29 studies selected for analysis of the design used, 16 studies were related to production, nine studies were related to comprehension, and four studies addressed both modalities.

One aspect that was not directly addressed during the present research but is worth mentioning concerns the languages of interest. Despite the fact that most of the studies investigated syntactic priming effects in English about half of the articles (15 out of 28) included at least one other language in the study — both as L1/L2 and/or within/cross linguistic contexts. Also, the only Brazilian Portuguese study regarding syntactic priming effects in healthy adults was conducted at Laboratório da Linguagem e Processos Cognitivos (Labling), at UFSC, coordinated by professor Mailce Borges Mota (see dos Santos & Mota, 2018).

The present review has 3 important limitations. One important limitation refers to the databases used in the search for articles: Web of Science and Wiley. The use of only two databases certainly left many published studies outside the selection process. Future research should follow examples of other systematic reviews such as Mahowald, James, Futrell and Gibson (2016). The authors used not only database search (ProQuest, Scopus, and Web of Science) as the literature searching method, but also included recording references listed in relevant review papers, and searching for records which cite relevant work from the area. Another limitation is intrinsic to the status of an undergraduate dissertation - due to the time limitations it was only possible to include research articles published within a 3-year period, even though the initial idea was to include studies published from 2015 to 2020. Future research should encompass a larger publishing period. Finally, a third limitation is that syntactic priming studies with other populations such as children and people with language impairments were

excluded from the analysis. Future research should include studies carried out with these populations.

Syntax is a core component of language use. By investigating the mechanisms and underpinnings of syntactic processing we may be able to gain a better understanding of its nature. In this sense, syntactic priming effects may serve as a window from which to inspect how our cognitive system deals with these types of linguistic structures. The present review aimed at contributing to the body of research on syntactic priming by looking at the methods and design of recent studies. The results of this review add to the family of syntactic priming experiments run at LabLing/UFSC and may be useful to those interested in this intriguing linguistic phenomenon of the human mind.

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Appendices

Appendix A

List of eligible research articles excluded after the new time cut (2017-2020 instead of 2015-2020) and the sixth criterion (only studies with healthy adults). The references are organized in order of publication year along with a brief summary of the study.

Havron, N., Scaff, C., Carbajal, M. J., Linzen, T., Barrault, A., & Christophe, A. (2020). Priming syntactic ambiguity resolution in children and adults. *Language, Cognition and Neuroscience*, *35*(10), 1445-1455.

- In this comprehension study, the authors conducted a forced-choice task (picture-naming) with eight-one 5–6-year-old children and 80 university students; all participants were native French speakers. The study focused on comparing how children and adults solved ambiguous sentences. For this means, the prime-target pairs (which shared the same verbs) were constructed to have two characters and an object, and the French preposition *avec* ("with") had to be used as in "*la fille chatouille le bébé avec le pinceau*" which means "the girl is tickling the baby with a brush", such a sentence is ambiguous in both languages. The filler sentences did not use the preposition and were not ambiguous sentences. The study was excluded because it

Lee, J., Hosokawa, E., Meehan, S., Martin, N., & Branigan, H. P. (2019). Priming sentence comprehension in aphasia: Effects of lexically independent and specific structural priming. *Aphasiology*, *33*(7), 780-802.

- The authors prepared a written sentence-picture matching task to observe if syntactic priming effects, which have been previously found in production studies with people with aphasia (PWA), could also be seen in sentence comprehension. The same task was used in two different experiments with different lags. Experiment 1 was 0-lag, which means that no filler sentence intervened the prime-target pair, and Experiment 2 was lag-2, which means that two filler sentences were placed between the prime-target pair. The participants from both studies were the same (20 healthy older adults and 18 PWA) and they took part in each study with an interval of at least 2 weeks in a counterbalanced order.

Lee, J., Man, G., Ferreira, V., & Gruberg, N. (2019). Aligning sentence structures in dialogue: evidence from aphasia. *Language, cognition and neuroscience*, *34*(6), 720-735.

- The study focused on a recent and specific type of syntactic alignment, called *syntactic entrainment*, which as stated by the authors is independent from syntactic priming and is "based on the discovery that interlocutors develop associations between event-semantic content and syntactic structures" (Lee, Man, Ferreira & Gruberg, p. 2, 2019). Two different experiments using a picture-matching card game were conducted to assess *syntactic entrainment* in people with aphasia (PWA). Both experiments used a collaborative picture-matching card game and participants would play it with a confederate researcher, they would both match the descriptions from the confederate with the set of pictures available, and describe the pictures to the confederate.

Man, G., Meehan, S., Martin, N., Branigan, H., & Lee, J. (2019). Effects of verb overlap

on structural priming in dialogue: implications for syntactic learning in aphasia. Journal

of Speech, Language, and Hearing Research, 62(6), 1933-1950

- The authors used two comprehension-to-production tasks to investigate source and
duration of syntactic priming effects in PWA. Participated in both tasks the same 17
PWAs and 20 healthy older adults in a counterbalanced order with at least 2 weeks
apart between experiments. The difference between experiments was that in
Experiment 2, in order to assess the persistence of the priming effects, two intransitive
filler items were included between the prime and the target; in Experiment 1, targets
directly followed the primes and the two filler sentences would be presented after the
prime-target pair.

Teixeira, M. T., & Buchweitz, A. (2019). O efeito de priming sintático na produção de

sentenças ativas e passivas por crianças falantes do português brasileiro. *Revista da

Anpoll*, *1*(48), 64-77.

- The authors investigated syntactic priming effects in 60 Brazilian children native
Brazilian Portuguese (BP) speakers. The study aimed not only to observe questions
directly related to syntactic priming effects in BP, but also to assess the consolidation
of abstract grammatical knowledge of active and passive sentences in 8-9 year-old
children native BP speakers. The trials of the picture-description task were formed by
the presentation of a green transitive verb followed by a coloured prime picture with
two human characters that elicited either a passive or an active sentence (indicated by
the green figure) followed by a gray target transitive verb followed by a grayscale target
picture. Filler trials were composed of one-figure pictures and intransitive verbs

following the same design: intransitive green verb, coloured picture, intransitive gray verb, and grayscale picture. Each participant saw a total number of 91 trials, which also means that each participant orally produced a total of 182 sentences.

Wolleb, A., Sorace, A., & Westergaard, M. (2018). Exploring the role of cognitive control in syntactic processing: Evidence from cross-language priming in bilingual children. *Linguistic Approaches to Bilingualism*, *8*(5), 606-636.

- To investigate the role of cognition in syntactic processing of bilingual children, Wolleb, Sorace, and Westergaard (2018) administered a picture-description task game with 38 Norwegian-English bilingual children and 28 monolingual Norwegian age-matched children to test syntactic priming effects in both within and between languages. The game, which was designed similarly to the "Snap!" game, was played by the experimenter and the child. Each of them would have 20 cards (16 prime-target pairs and 4 Snap cards) with an image and a verb to be used in the description, if the description and the card formed a match, the first to say "Snap!" would win the card. The examiner would always start the game to prime the child with either a DO or PO structure (experimental trials were 50% DO and 50% PO), and the Snap cards served as fillers depicting intransitive actions. The examiner would always read the description from one of four pre-prepared scripts; the order of the cards and the structure to be used were pseudo-randomised.

Yan, H., Martin, R. C., & Slevc, L. R. (2018). Lexical overlap increases syntactic priming in aphasia independently of short-term memory abilities: Evidence against the explicit memory account of the lexical boost. *Journal of Neurolinguistics*, *48*, 76-89.

- Yan, Martin, and Slevc (2018) aimed to investigate the source of lexical boost effects - often related to explicit short-term memory (STM) - in 12 PWA and eleven age-matched healthy control speakers; STM of aphasic participants was assess and they showed varying degrees of STM and language deficits. The priming task was a picture-description task for which the authors built four lists of 64 trials with four conditions - active vs. passive structures, and same vs. different verbs between prime and target sentences. Each list consisted of 32 experimental trials (transitive passive-active prime sentences paired with transitive-eliciting pictures) and 32 filler trials (16 dative prime/target pairs and 16 pairs with varied syntactic structures).

Cho-Reyes, S., Mack, J. E., & Thompson, C. K. (2016). Grammatical encoding and learning in agrammatic aphasia: Evidence from structural priming. *Journal of Memory and Language, 91*, 202-218.

- Cho-Reyes, Mack and Thompson (2016) studied people with agrammatic aphasia to investigate (1) whether they used thematic or animacy information to build sentences, (2) the persistence of syntactic priming effects, and (3) if the severity of language impairment is associated with increased priming. In this production study participants were asked to repeat visually or auditorily-presented prime sentences and then were asked to produce dative sentences using the word arrays.

Hartsuiker, R. J., Beerts, S., Loncke, M., Desmet, T., & Bernolet, S. (2016). Cross-linguistic structural priming in multilinguals: Further evidence for shared syntax. *Journal of Memory and Language*, *90*, 14-30.

- Four experiments using either a written sentence completion task (Experiments 1, 2, and 3) or a simulated simulated chatting task (Experiment 4) were used to investigate

syntactic representations in different languages. Participants were all native Dutch speakers with English, French, and German as L2. Experiments 1, 2, and 3 contained a set of prime sentence fragments in Dutch, French, or English that either forced a high attachment or low attachment completion, the difference between them was that on Experiment 1 prime sentences were followed by a Dutch target fragment, Experiment 2 by a French target fragment, and Experiment 3 by an English target fragment. Experiment 4, investigated the production of dative sentences and primes were followed by English targets.

Huang, J., Pickering, M. J., Yang, J., Wang, S., & Branigan, H. P. (2016). The independence of syntactic processing in Mandarin: Evidence from structural priming. *Journal of Memory and Language*, *91*, 81-98.

- In order to investigate whether syntactic information is processed independently of semantic information in Mandarim, the authors conducted five experiments manipulating both syntactic structures and anymacy. Participants would always read a prime sentence, repeat it aloud, and then describe a target picture.

Segaert, K., Wheeldon, L., & Hagoort, P. (2016). Unifying structural priming effects on syntactic choices and timing of sentence generation. *Journal of Memory and Language*, *91*, 59-80.

- The authors aimed to investigate whether production latencies can be elicited by the same factors as structure choice: cumulativity and verb repetition. In order to do that, two experiments using a picture description task were conducted with native Dutch speakers. Participants were instructed to describe pictures that could be either colored — identifying in green the actor that should be named first — or in a grayscale — so

the participant could choose. Pictures elicited passive or active structures in the critical trials, and intransitive structures in the filler trials.

Wei, H., Dong, Y., Boland, J. E., & Yuan, F. (2016). Structural priming and frequency effects interact in chinese sentence comprehension. *Frontiers in psychology*, *7*, 45.

- In order to investigate structural priming and frequency effects in the comprehension of Chinese sentences, Wei, Dong, Boland & Yuan (2016) conducted a self-paced reading task with 54 native Chinese speakers focusing on the comprehension of ambiguous noun phrases.

Bernolet, S., Collina, S., & Hartsuiker, R. J. (2016). The persistence of syntactic priming revisited. *Journal of Memory and Language*, *91*, 99-116.

- The authors investigated syntactic priming persistence in three syntactic priming experiments in Dutch. Each of the experiments focused on a different syntactic syntactic structure — transitives (Experiments 1a and b), datives (Experiments 2a and b) and the choice between auxiliary-participle and participle auxiliary word order in relative clauses (Experiments 3a and b) — testing both priming and participants' memory. All three experiments used a picture description task combined with a picture-matching task.

Fine, A. B., & Jaeger, T. F. (2016). The role of verb repetition in cumulative structural priming in comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(9), 1362.

- In Fine and Jaeger (2016), eighty-eight native English speakers were tested three self-paced reading tasks in order to observe whether there is evidence for cumulative

syntactic priming effect in the comprehension of ambiguous/unambiguous relative

clauses (RC) and ambiguous main verbs and if so, if these effects are dependent on

verb repetition.

Gámez, P. B., & Vasilyeva, M. (2015). Exploring interactions between semantic and

syntactic processes: The role of animacy in syntactic priming. *Journal of Experimental

Child Psychology*, *138*, 15-30.

- This study investigated syntactic priming in sentence production in 5-6 year-old

  children . Two picture description experiments were used in which both sentence

  structure (Experiment 1) and animacy (Experiment 2) were manipulated.

McDonough, K., & Fulga, A. (2015). The detection and primed production of novel

constructions. *Language Learning*, *65*(2), 326-357.

- This study aimed to investigate to what extent native Thai (Experiment 1) and Farsi

  (Experiment 2) native speakers who had English as L2 could detect novel sentence

  structure patterns while learning Esperanto and be primed by them. Participants took

  part in vocabulary and construction learning sessions and were tested for it before

  participating in the priming picture-matching task.

Hall, M. L., Ferreira, V. S., & Mayberry, R. I. (2015). Syntactic priming in American

Sign Language. *PloS one*, *10*(3), e0119611.

- In Hall, Ferreira & Mayberry (2015) the authors conducted two experiments using a

  picture naming task to observe whether syntactic priming occurs in American Sign

  Language (ASL) and if the effects are lexically dependent or not. They also tested

  phonological boosts and the role of age in ASL acquisition in the participants. In both

experiments the structure of interest was pre-nominal/post nominal structures and the experiments consisted of a exposure phase — in which participants were exposed to 96 pictures (48 experimental items and 48 fillers) and they were instructed to name it as they wanted in ASL —, a comprehension phase, and a priming phase.

Traxler, M. J. (2015). Priming of early closure: evidence for the lexical boost during sentence comprehension. Language, cognition and neuroscience, 30(4), 478-490.

- The authors conducted two self-paced reading experiments with native English speakers to investigate the comprehension of sentences containing "early" vs. "late closure" ambiguities. In Experiment 1, prime and target sentences shared the same verb, while in Experiment 2 main verbs from prime and target sentences were different.

Santesteban, M., Pickering, M. J., Laka, I., & Branigan, H. P. (2015). Effects of case-marking and head position on language production? Evidence from an ergative OV language. *Language, Cognition and Neuroscience*, *30*(9), 1175-1186.

- In four experiments using picture-matching combined with picture-description tasks the authors investigated Basque native speakers' choice of description of events involving psychological-verbs.