Tapping into semantic recovery : an event-related potential study on the processing of gapping and stripping

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Date: 2018-05-31

CHAPTER 1

Introduction

1.1 The nature of this study

This dissertation is an example of interdisciplinary experimental linguistic research. The pivotal aim is to connect theoretical linguistic insights with behavioural and neuroscientific data. While PhD research in the natural sciences is normally concluded with a collection of (submitted) peer-reviewed journal publications, the motivating force behind this dissertation has been to compose a long essay – a book. In that sense, the title of the grant which has fuelled this research, *Promoties in de Geesteswetenschappen* (PhDs in the Humanities) provided by the Netherlands Organisation for Scientific Research, has been entertained quite formally. However, to a certain extent this thesis differs from a typical linguistic dissertation. Some chapters may resemble the form of a journal article reporting experiments where footnotes are scarce.

1.2 Interpretation of elided structures: some basic concepts

In spoken and written language, there are often cases where words that can be understood from contextual clues can be omitted. For example, we are able to interpret the second clause *Jerry a bike* in (1) as meaning that Jerry stole a bike, even though the verb *stole* is not physically present in the second clause.

(1) Tom stole a car, and Jerry a bike.

Jerry a bike is linguistically speaking not a proper clause, but an incomplete linguistic structure. Yet, we are able to understand that *Jerry* **stole** *a bike*; he did not, for example, buy one. We term this phenomenon "ellipsis". Ellipsis is arguably the most prominent example in human language of compromised mapping between linguistic form and meaning. When we study ellipsis, we aim to understand how it is possible for language users to arrive at an interpretation in the absence of form. While there are several ellipsis types (I refer the interested reader for a concise introduction to Merchant, 2017)[1], this dissertation employs the ellipsis type "Gapping"and its sub-type "Stripping", of which we see examples in (1) (Gapping) and (2) (Gapping and Stripping). Elided elements are denoted by <*e*>.

(2) a. Eva bought a book, and Agnes <*e*> a CD. (*Gapping*)
b. Eva bought a book in the shop, and Agnes <*e*> in the supermarket. (*Gapping*)
c. Eva bought a book in the shop, and Agnes <*e*> too. (*Stripping*)

As can be observed, Gapping-like constructions are characterised by an omission of at least the finite verb in the second conjunct of a coordinate structure. The remaining phrases in the second conjunct – called "remnants"– contrast with their correlates in the first conjunct. Gapping involves at least two remnant phrases, Stripping involves one remnant and an additive marker ("too"). Crucially, we are able to recover the meaning of the omitted material – called the "antecedent" – in order to fully interpret the right conjuncts in (2). We use information that we retrieve from the left conjunct and we integrate this information in the right conjunct (also sometimes referred to as "reduced" conjunct).

Ellipsis might be conceived of as an "anaphoric" relation between an antecedent and omitted structure. However, in contrast to overt anaphoric relations such as those constituted by pronouns (he, she, etc.) and reflexives (himself, herself, etc.), ellipsis lacks overt form. For example, the reflexive *herself* in (3) is overt linguistic material that refers to the antecedent *Sheila*.

(3) Sheila saw herself in the mirror.

It is important to realise that in order to understand the elliptical constructions in (1) and (2) the interpreter can only use the antecedent within the linguistic context. Gapping (and Stripping), by definition, "requires a verbal context" (Cremers, 1993:117); that is, linguistic material is required in the process of interpretation. Listeners (or readers) somehow need to retrieve the intended proposition, and the missing information is provided by the left conjunct. Therefore, the ellipsis type under investigation in the current study is not just an instance of so-called "underspecification", which is abundant in human

[1] I follow Merchant (2017) in categorising Gapping as an ellipsis type (see for contrasting ideas Johnson, 2009; Lappin & Benmamoun, 1999)

language. For example, to interpret a sentence such as (4), we add information which cannot be inferred on the basis of the sentence alone.

(4) She waited there but he didn't show up.

Without an antecedent within the *linguistic* context we make use of *extra-linguistic* context, which helps us to capture, for instance, time and place. In this thesis I will be concerned with elliptical structures that can only be resolved within a linguistic context.

The theoretical literature on ellipsis is generally concerned with questions regarding the conditions under which ellipsis is permitted (or "licensed") and the level of description at which the relation between antecedent and ellipsis site should be formalised. For example, some scholars emphasise the import of syntactic operations, while others favour a semantic perspective. Prosody is also considered to be an important factor. In Chapter 2, I will examine these issues with reference to Gapping-like constructions. It will appear, that to account for distributional properties of Gapping and Stripping, a successful account should combine syntactic, semantic and prosodic factors. By extension, recovery strategies that are employed to resolve ellipsis include these factors. The question remains: what is the division of labour between syntactic, semantic and prosodic-based mechanisms?

While Gapping (and other ellipsis types) have been studied extensively in the theoretical literature, the present study investigates the neurophysiological processes that are at work to resolve "gapped" or "stripped" elements such as *bought* in (1) and *bought a book* in (2b) and *bought a book in the shop* (2c).

1.3 Levels of analysis: grammar, processing and neurons

How do we connect theoretical concepts to processes that take place in the brain? While neurophysiological literature on ellipsis is still in its infancy, many theoretically-oriented scholars have explored how theoretical constructs might be realised cognitively. At least within the Generative enterprise, formal theories of linguistic structure are theories of *competence*: the abstract mental speaker-hearer's knowledge of a language – the finite set of rules for producing and comprehending an unlimited amount of utterances. Chomsky (1965) was the first to contrast this with the notion of *performance*: the actual utterances produced by speakers. Theoreticians, including those who work on ellipsis, try to formulate conditions that explain the "grammaticality" of a certain construction – without being interested *per se* in how these conditions are accessed during language production and comprehension. This has consequences for the way theories have been developed, but also for experimental researchers, who need to be able to refer to theory, but whose methodology concerns the actual production and comprehension of language. One of the objectives of this dissertation is to try to bring together the best parts of both the theoretical and experimental worlds.

Both theoreticians and experimental researchers conceive of the speaker-hearer's mental knowledge of language in terms of mental representations. I will use the definition as proposed by Marr (1982):

> A representation is a formal system for making explicit certain entities or types of information, together with a specification of how the system does this.
>
> [Marr (1982:69)]

Like cognitive scientists, I will use the word "representation" as referring to a psychological object. I assume that processes of human behaviour, cognition, are guided by computational procedures which operate on and amount to internal representations. Computation requires a "grammar", i.e. rules for a combinatorial mechanism, in order to apply unification. It is widely accepted that the human language system exploits a "mental lexicon", a mental dictionary containing information regarding a word's syntactic characteristics, meaning and pronunciation. There is, however, less agreement as to the level of detail contained in the lexicon. Despite this we may assume a computational procedure during which a word is retrieved from the mental lexicon to be integrated with linguistic material processed earlier. For example, in sentence (2a), the items *buy* and *a book*, both having representations at a lexical level, can be unified to form a representation of a verb phrase. How does such a representation look in the right conjunct *Agnes a CD*? In ellipsis research, as we will see, much has been written about representation and computation. Broadly speaking, syntax-oriented accounts hold that the interpretation of elliptical structures depends on the reconstruction of syntactic structure or a copy thereof. A representation of a fully-fledged syntactic structure would resemble a "surface" structure, which would be pronounced if it was not elided. The ellipsis site reflects the syntactic identity of the antecedent. This contrasts with semantics-oriented accounts that emphasise the role of (rules at) a conceptual level of representation. Here, the idea is that ellipsis is resolved at a "deeper" level of representation, rather than by means of a representation of unpronounced surface structure. Syntactic accounts emphasise the notion of parallel syntactic structure, while semantic-oriented accounts are concerned with parallel properties of more fully interpreted chunks.

Translating theory into procedural (or "processing") terms may not always be straightforward, however. With reference to the implementation of such processes in the brain (i.e. how the representation and computation of elliptical structures is executed at a neuronal level), little has been achieved so far. The current study hopes to contribute to all three levels – grammar, processing and implementation – because it is my conviction that language should be understood at all these levels.

1.3.1 Grammatical levels of analysis

This research takes as starting point that a sentence - either written or spoken - is a pairing of form and meaning. The form of a sentence comprises the actual output (orthographic when written, phonetic when spoken) and its structural properties. A framework that has proponents in both linguistics and psychology is the "tripartite parallel architecture of the grammar"as depicted in Figure 1.1 (see Jackendoff, 1997 and subsequent work). In this framework, three distinct levels of representation - phonological (output), syntactic (structural), and semantic (meaning) - are assumed to be components that are governed by principles and rules of their own. Interface modules are included to specify the links between the parallel components.

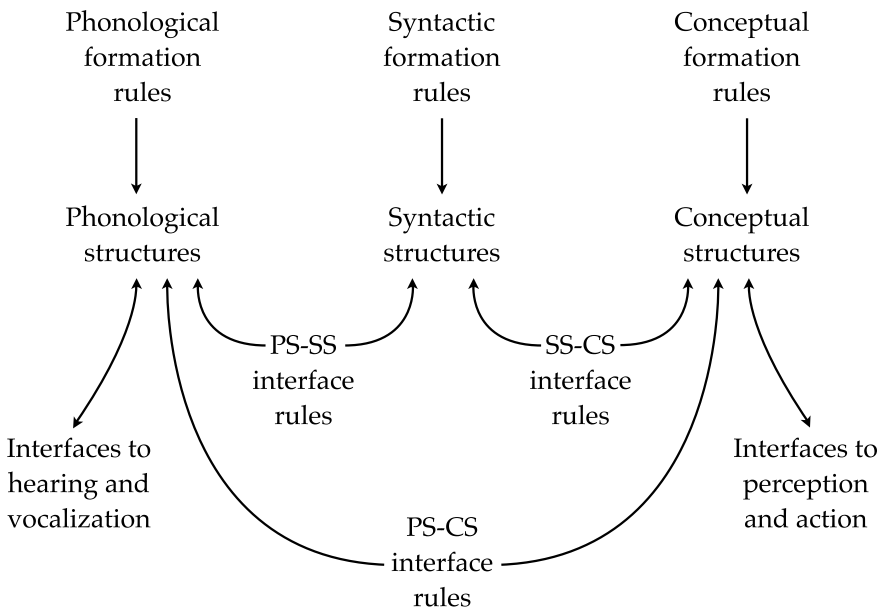

Figure 1.1: The parallel grammar architecture (Jackendoff, 2002:125). Phonological structures is abbreviated as PS, syntactic structures as SS, and conceptual structures as CS.

In the spirit of parallel architecture I acknowledge the independent combinatorial character of three information types: phonology, syntax, and semantics. The rationale behind this view is the assumption that, in contrast to, for example, Minimalist approaches (initiated by Chomsky, 1993), phonological and semantic representations are not exclusively derived from syntactic structure but rather constrained by it. In that sense the Chomskyan tradition is unidirectional and syntax-centred, as can be seen in Figure 1.2 which represents a modern version of a minimalist model. Lexical items are combined through syntactic formation rules. At some point during the derivation, the computation is split and interpreted at the components Phonological Form (PF) and Logical Form (LF); this point is known as “Spell-Out”. PF interfaces with an Articulatory Perceptual (also referred to as “sensorimotor”) system while LF interfaces with a Conceptual Intentional system. Since this is a competence model, it is only concerned with the syntactic derivation up until the components PF and LF, culminating in representations at these interpretative levels. Note that LF cannot be seen as a semantic level as it is an intermediate representation for matching syntactic structure with rules of interpretation. Although Spell-Out is assumed to occur throughout the derivation in cyclic ”phases”, a derivation does not represent processing steps. Since this model does not make claims about the way PF and LF communicate with the output systems, it is not straightforwardly utilised outside the field of syntactic analysis. Nonetheless, Minimalist approaches have contributed a great deal of work on ellipsis.

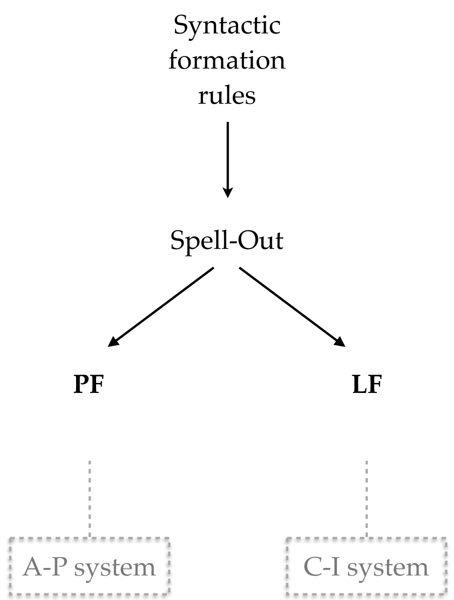

Figure 1.2: A minimalist model of the grammar (after Hornstein et al., 2005:73). Phonological Form is abbreviated as PF, Logical Form as LF, Articulatory Perceptual as A-P and Conceptional Intentional as C-I. The model is silent as to how PF and LF interact with the output systems.

Whereas in the Minimalist approach syntactic operations are core and inherent, in Jackendoff's model phonological and semantic structures are subject to combinatorial rules of their own levels, which may produce structures that, apparently, do not have a one-to-one correspondence with syntactic structures (SS). In (5) we see an example of a mismatch between intonational and syntactic structures. The bracketing in (5b) and (5c) represents possible intonational phrasings (denoted by IntPs) that do not always converge with syntactic constituents as represented in (5a), while no semantic difference between (5b) and (5c) can be identified.

(5) a. [$_{\text{NP}}$ *Sesame Street*] [$_{\text{VP}}$ is [$_{\text{NP}}$ a production [$_{\text{PP}}$ of [$_{\text{NP}}$ the Children's Television Workshop]]]]
b. [$_{\text{IntP}}$ *Sesame Street* is a production of] [$_{\text{IntP}}$ the Children's Television Workshop]
c. [$_{\text{IntP}}$ *Sesame Street*] [$_{\text{IntP}}$ is a production] [$_{\text{IntP}}$ of the Children's Television Workshop]

[Jackendoff (2002:118-119)]

Jackendoff notes that intonational contours do not follow syntactic phrases at all times. In other words, phonological rules seem to apply to phonological constituents that are not always exact mappings of syntactic categories; the intonational bracketing is governed by independent phonological rules which may apply independently of syntactic rules. While minimalist approaches have tried to circumvent intonational-structural mismatches (see for example Dobashi, 2009), Jackendoff (1997, 2002) reasons that conceptual structures may be governed by independent rules too, as he demonstrates with the famous example (6) from Chomsky (1957). Although neither of the sentences make sense, native speakers of English have the intuition that (6a) is grammatical and (6b) is not.

(6) a. Colorless green ideas sleep furiously.
b. Furiously sleep ideas green colorless.

[Chomsky (1957:15)]

While structurally (6a) is correct, the mechanism that determines the nonsensical status of this sentence must be sought at the level of conceptual structures. In addition to the above example, Jackendoff (1997:33-35) puts forward other phenomena to show that the mapping between syntactic structure and conceptual structure is not a one-to-one relation. It should be noted that Conceptual Structure (CS) is not assumed to be part of the language faculty per se, though the SS-CS interface rules are part of the language system. Crucially different from a Minimalist approach, this framework specifies links to enable the language system to interact with processes of logical and heuristic reasoning. Jackendoff considers the language faculty as consisting of levels of representation as shown in Figure 1.2, yet, they are assumed to interact and to have combinatorial power of their own. The level of syntax is assumed to consist of "syntactic formation rules" that play a mediating role – rather than a deterministic role – between linearly ordered phonological strings and the linearly unordered structure of meanings.

The advantage of the tripartite framework is twofold. Firstly, in the following chapters we will see that ellipsis is a multidimensional phenomenon in which syntactic, semantic and phonological constraints apply. Theoretical approaches usually take one of these dimensions as a starting point. The model can be used to evaluate and compare a variety of approaches, which may be embedded in different frameworks. Secondly, it may be used as an umbrella instrument to evaluate theoretical and experimental hypotheses, taking it as a starting point for an integrated framework accommodating theory and neurocognitive data. In particular, the architecture can be extended as a processing framework that integrates a crucial role for working memory (Jackendoff, 2002:196-200). Although it is not always explicitly integrated in theories of sentence processing, I assume that working memory plays an important role in language use.

Formation rules of the three components (phonology, syntax and semantics, in other words, the "grammar"), as depicted in Figure 1.1, may be attached to corresponding processors. Jackendoff refers to this linkage as an integrative process: "For each set of formation rules that defines a level of linguistic structure, the language processor requires an integrative process that uses these principles to construct structures at that level" (Jackendoff, 2002:198). Likewise, interface constraints guide corresponding processors that link the separate levels, as sentence comprehension (and production for that matter) consists in the integration of all levels of analysis. During language use, the integrative process is sustained by a linguistic working memory component that is to be understood as a "dynamic workbench" where three independent processors work in parallel, assembling and integrating linguistic structures of different levels (Jackendoff, 2002:200).

1.3.2 Sentence processing

While the tripartite architecture encompasses both language production and comprehension, this thesis focuses on the latter. There is general agreement that during listening and reading representations are built incrementally and that the sentence comprehension processor has four main tasks:

- retrieve grammatical and lexical information of incoming words
- analyse the grammatical structure identifying each word's position in the sentence; this is known as syntactic parsing
- analyse the prosodic structure identifying clause boundaries and the relative contrasts between phrases; this is known as prosodic parsing
- combine individual words, phrases and prosodic information to yield a representation of the meaning of a sentence; this part is referred to as semantic interpretation.

These processes of retrieval and integration are immediate, automatic and "it appears that there is no measurable lag between recognising a word and attempting to integrate it into a sentence-level syntactic and semantic representation" (Staub, 2015:204). On a word-by-word basis, the processor parses each new incoming word to retrieve the necessary information. Incrementally, the processor postulates phonological, syntactic and semantic representations to construct the meaning of a sentence. There is, however, less agreement as to the autonomous status of different information types and the way they interact. For example, to what extent are a word's syntactic features processed separately from its semantic information?

Historically, parsing is related to psycholinguistic "syntax-first models" of sentence processing: a syntactic structure is constructed serially using word-category information, independently of lexical-semantic information, which is processed at a later stage. The combination of the individual words and phrases results in a representation of the sentence's meaning. As a consequence, semantic interpretation relies on structure building. If an initial syntactic structure cannot be completed, reanalysis may take place. Frazier's research, starting in 1978 in collaboration with Fodor but revised in later (still ongoing) work, is grounded on this conception. In their proposed "Sausage Machine model", a syntactic analysis is constructed by means of funelling incoming information through a window of roughly six words, at which point the parse is clipped off (visualise the sausage machine here) and passed to a second stage to complete the interpretation. To a large extent Frazier adheres to a modular position as proposed by Fodor (1983). Influenced by Chomsky's ideas, Fodor apprehends language as an encapsulated input system operating on domain-specific information structures. The output of this system is then open to further evaluation by a general cognitive system. The fact that every module is assumed to be impenetrable means that no other cognitive process may affect its operation. Nevertheless, Frazier's recent position appears to be to arguing for a rather dynamic approach in which a competence module and performance module may interact (Frazier, 2015).

Contrasting serial models, some scholars have proposed that different types of information are processed incrementally in parallel in an interactive way. While a less differentiated representational vocabulary is assumed, interplay among different types of information is far less constrained. For example, lexical or more global semantic information is assumed to be able to influence structure building right away. Tyler and Marslen-Wilson (1977) could be taken as the starting point of this line of research, which has evolved to give us interactive "constraint-based models" in which (for example) syntactic constraints may be overruled by semantic constraints. Note that, just as the syntax-first tradition, this line of research acknowledges the notion of hierarchical structure. The outer end of parallel models, however, argues that the relation of words in a sentence can be explained in statistical terms – word order based on probabilities. Within the framework of so-called "connectionism" it has been proposed that language use is characterised by domain-general "low-level" processing units (at the neuronal level), in disagreement with the notion of "high-level" (abstract) symbolic representations proposed by formal linguists (see for example Rumelhart & McClelland, 1986).

The concept of probability is quite common in the psycholinguistic literature, where frequency effects on language processing are commonly reported. For example, the identification of a given word is much faster if it is a frequently used word (see for a discussion Bradley & Forster, 1987). In that sense, word frequency can help to build a probabilistic word model. As such, frequency effects are expected to be important during sentence comprehension. And not only at a lexical level: on the basis of syntactic frequency, the parser may predict certain structures. Some scholars have modelled this phenomenon in terms of probabilities (see for example Hale, 2011; Levy, 2008). However, to date there is, to my knowledge, no processing model that can account for syntactic, semantic, and prosodic phenomena including predictions. As has been suggested by Gibson and Pearlmutter (1998), such a model would be both parallel and constraint-based in nature.

Jackendoff's architecture may be seen as compromise between nativists (Chomskyan tradition) and behaviourists (connectionist approach). On the basis of "structure-constrained modularity" he adopts a flexible version of Fodor's proposal (Jackendoff, 1997:219). Like Fodor, he regards the brain "as a collection of specialists rather than an all-purpose cognizer", yet modules may interact through interface rules (as can be seen in Figure 1.1). While the distinction between the three levels of representation in Jackendoff's model may be module-like, it does not imply that each module has a one-to-one encapsulated mapping in the brain, which is rather dynamic. For example, Poeppel and Embick (2005) have argued that parts of cortical networks at work during syntactic computations may also be involved in phonological processes. While both nativists and behaviourists would agree that a representation of a linguistic unit, like *Agnes a CD* in (2a), is a mental state that is reflected by the activation of some group of neurons in the brain, the debate surrounds the degree to which it is guided by general principles; in other words, to what extent is a representation guided by language-specific rules?

1.3.3 Event-related brain potentials

Electroencephalography (EEG) is a method used to record electrical activity in the brain. Neurons communicate by pumping ions from one to another. In large amounts, ionic current flows result in tiny changes in electric potential when compared with a reference point. This amounts to a tiny change in voltage, which can be measured in microvolts. EEG enables us to measure the exact point in time when such changes in ion exchange occur.

Typically, EEG data can be analysed as event related potentials (ERPs). This means that the EEG signal (“potential”) is inspected relative to specific time points (“events”) in the experimental presentation. For example, when experimenters mark the time point at which a stimulus appears on-screen (this is referred to as “time-locking”), they can then analyse how the brain activity responds to that particular stimulus. The EEG responses are averaged across stimuli and participants; these average responses that are time-locked to such a stimulus are what is known as ERPs. It is a common methodological approach for tackling questions regarding the nature of semantic, syntactic and (to a lesser extent) prosodic processes and how they interplay.

In response to distinct experimental manipulations, discrete ERP patterns (also known as “ERP components”) have been found. For example, experimenters may manipulate a syntactic characteristic of sentences to see to what extent this manipulation causes differences in the EEG waveforms in terms of polarity (positive of negative), latency (onset and duration of a deflection) and distribution (topographic reference). ERPs that have been consistently identified in the literature are typically given names according to the polarity and onset. Typically, “P” and “N” refer to positive or negative (note that this does not imply that positivity is ‘good’ and negativity is ‘bad’!). Numbers of a component refer to the time point in milliseconds when the potential is observed after stimulus onset. For example, a negative component around 200 ms after stimulus onset is called an N200 or N2. The duration and distribution further help to determine the relationship of the ERP to underlying cognitive processes.

Five main markers have been identified in the literature with respect to language processing: Closure Positive Shift (CPS), Early Left Anterior Negativity (ELAN), Left Anterior Negativity (LAN), Negative 400 (N400), and Positive 600 (P600). Table 1.1 below lists the five ERP components categorising their latencies, distributions, and relationships to linguistic processes.

Friederici (2002) is an example of a sentence processing model that is based on findings from ERP data. This model of auditory sentence processing aligns very much with a syntax-first approach while linking the sequential processing steps to distinct brain sites connected to working memory. As can be observed in Table 1.1, the ERP findings can be formulated as a serial procedure starting with (superficial) syntactic structure-building on the basis of a word’s category, after which interpretation may take place. At different times during this process prosodic information may be deployed. However influential in

Component	Latency (ms)	Distribution	Linguistic process(es)
CPS	0-600	bilateral centro-parietal	phonological/prosodic phrasing
ELAN	120-220	either bilateral or left anterior	syntactic structure building and phrase structure violations
LAN	300-500	either bilateral or left anterior	processing of semantic relations and morphosyntactic violations
N400	around 400	centro-parietal bilateral often with a slight right hemisphere focus	processing of conceptual/semantic information
P600	300-900	centro-parietal (fronto-central related with complexity)	wide variety of syntactic violations, syntactic reanalysis and repair, retrieval, increased syntactic complexity and ambiguity, syntactic and semantic integration

Table 1.1: Main ERP components related to linguistic stimuli: CPS (Closure Positive Shift), ELAN (Early Left Anterior Negativity), LAN (Left Anterior Negativity), N400 (Negative 400), P600 (Positive 600) and their latencies, distribution and relation to linguistic processes (after Friederici et al., 2002; Gouvea et al., 2010; Steinhauer, 2003; Swaab et al., 2012).

the field of neurolinguistics, the strictly serial nature of Frederici's model has been criticised by subsequent proposals which promote parallel or interactive procedures (see for example Hagoort, 2005; Hickok & Poeppel, 2004). In a later version, Friederici (2011) does endorse a comprehension process that consists of "several subprocesses that take place in a serial cascading and partly parallel fashion" encompassing neuronal pathways supporting sound-to-motor mappings and higher-level language processes.

Not everybody agrees that all components listed in Table 1.1 reflect processes specific to language. For example, it has been argued that the P600 belongs to the P300 family known to reflect domain-general phenomena such as context updating and surprise effects of unexpected stimuli (see for an initial discussion Coulson, King, & Kutas, 1998; Osterhout & Hagoort, 1999). Gouvea et al. (2010) suggest that a P600 may reflect retrieval and relation-forming processes but that it depends on the onset and duration. While their study was not intended to take a stance in the "P600 as P300" debate, they note that their account "could be extended to a domain-general account of the P600" (Gouvea et al., 2010:183).

More recently, the P600 generated by frontally-oriented neuronal activity is assumed to be a reflection of integration processes proper, that is, the relative difficulty in establishing a coherent utterance representation (Brouwer, Crocker, Venhuizen, & Hoeks, 2016; Brouwer & Hoeks, 2013). In this account, the N400 amplitude is assumed to exclusively reflect the relative difficulty of retrieval of lexical information from memory, contrasting with others who additionally relate semantic composition or integration to the N400 effect. Coined as the "Retrieval-Integration" account, it is underpinned by a neurocomputational model that successfully simulates ERP modulations in semantic processing. While an analogous process is required for ellipsis resolution, it is an open question to what extent this account can be extended to ellipsis data, given that an antecedent for ellipsis is retrieved from an earlier interpreted chunk rather than from lexical memory.

Since the details of ellipsis processing models and their relation to biologically plausible neurocognitive models of language comprehension will be examined later on, the purpose of this section is to lay out a road map of sentence processing in relation to grammar and ERPs. Noting different starting points, syntax-oriented and semantics-oriented, I would like to make clear that I do not take a position *a priori*, for the reason that research groups having a clear *a priori* preference for model *X* tend to provide evidence in favour of model *X* more often than not. For example, data may be analysed in such a way that a statistically significant result is forced to occur. This phenomenon is also known as "confirmation bias". Although the existence of confirmation bias in science has been acknowledged and suggestions have been made to prevent it, it remains a delicate issue (see for example MacCoun & Perlmutter, 2015; Nickerson, 1998). I would like to avoid any such 'predisposition', though I will follow the generally accepted notion of that phonological, syntactic and semantic structures are built incrementally during listening and reading.

1.4 Outline of this dissertation

This dissertation consists of two main parts. After the general introduction provided in this chapter, I discuss in Chapters 2-4 the relevant theoretical and experimental background on Gapping and Stripping in which it is shown that they have a multidimensional character. This provides us with a well-grounded starting point for the experiments that are reported in Chapters 5-8.

The theoretical accounts that I review in Chapter 2 can be broadly categorised as syntax-oriented and semantics-oriented. Syntax-oriented accounts emphasise the requirement of structural parallelism between antecedent and ellipsis and generally hold that the interpretation of elliptical structures depend on the reconstruction of syntactic structure or a copy thereof. This contrasts with semantics-oriented accounts that propose that interpretation is done by referral to (rules of) a conceptual level of representation. Although this rather simplistic differentiation between syntactic and semantic accounts has been the driving force behind the current project – linking this differentiation to electrophysiological data – I argue that Gapping-like constructions cannot be captured in either syntactic or semantic terms. An additional level of analysis, prosody, is discussed.

Chapter 3 covers experimental literature on ellipsis which reflects characteristic issues raised by the theoretical literature to a certain extent. Two behaviourally motivated parsing models that are grounded in theoretical insights are taken into consideration and are proposed as a possible link between theory and data. The proposal "Copy α" is inclined toward syntactic-oriented accounts. This contrasts with a "cue-based mechanism" that leans towards semantic-oriented accounts. Again, the role of prosody is examined, as well as the relevant ERP components that have been found in relation to the recovery of elliptical structures.

In Chapter 4, I argue that a mapping between existing theoretical insights and actual processing may not always be straightforward or even justifiable. Nonetheless, I arrive at a comparison of Copy α and the cue-based mechanism with respect to the timing of processes of retrieval and integration. By doing so, I can utilise these mechanisms to make hypotheses for the subsequent ERP experiments. Since individual differences may lead to differences in (amplitudes of) ERP components and may be ascribed to natural variability in the capacity of human working memory, I propose a suitable working memory test.

Chapter 5 starts with a report of a replication study on verb Gapping in Dutch. On the basis of stimuli used in this replication study, I designed and pretested new Gapping and Stripping stimuli for this dissertation. The method and results of the pretests are also reported in Chapter 5. In each of the following chapters, I test a representational dimension separately: syntax in Gapping and Stripping in Chapter 6, semantics in Stripping in chapter 7 and prosody in Gapping in chapter 8. Overall, I aim to estimate the relative import of these dimensions during the resolution process of Gapping-like constructions.

In Chapter 6, I report two ERP experiments on Gapping and Stripping constructions in which I modulate structure in the right conjunct and in the left conjunct. I hypothesise that modulation of structure would be reflected by early ERPs related to retrieval of a fully-fledged syntactic structure as a reflection of a Copy α mechanism. As an alternative, I suggest that a cue-based account predicts relative ease of retrieval but a relatively more costly integration process. With the results of the experiments I show that the recovery of elided structure starts at around 300 ms after onset of the critical word and is reflected by positive deflections. I argue that retrieval processes are underpinned by both linguistic and domain-general processes. In addition, I find a secondary positive component which I relate to more complex integration processes.

Chapter 7 investigates the difference between determiner *de* "the" and quantifiers *elke/alle* "every/all" in Stripping constructions. Again, I argue that retrieval processes are not exclusively steered by a syntax-related mechanism.

The experiment on prosody is reported in Chapter 8. I test the extent to which the prosody of the first conjunct predicts upcoming (deleted) structure. In an exploratory analysis, I show ERP effects related to attention/selection processes that are involved during the resolution of Gapping.

The overall findings, limitations and future prospects are discussed in the concluding Chapter 9.