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Kamal Kumar Choudhary: Incremental Argument Interpretation in a Split Ergative Language: Neurophysiological Evidence from Hindi. Leipzig: Max Planck Institute for Human Cognitive and Brain Sciences, 2011 (MPI Series in Human Cognitive and Brain Sciences; 127)

Impressum

Max Planck Institute for Human Cognitive and Brain Sciences, 2011

Druck: Sächsisches Druck- und Verlagshaus Direct World, Dresden

ISBN 978-3-941504-11-0

Incremental Argument Interpretation in a Split Ergative Language: Neurophysiological Evidence from Hindi

Dissertation

zur Erlangung des akademischen Grades
Doctor Philosophiae
(Dr. Phil.)

Eingereicht an der
Philologischen Fakultät der
Universität Leipzig

von

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Tag der Verteidigung: 20-05-2010

Acknowledgements

First and foremost, I would like to thank Prof. Dr. Ina Bornkessel-Schlesewsky for all her support. This thesis would not have been possible without her help. I am also thankful to her for giving me the opportunity to work in the Neurotypology group. It has been really a great and enriching experience for me to work with her.

I would also like to thank Prof. Dr. Matthias Schlesewsky for his help and comments in several respect. His encouraging attitude helped me from the very beginning since I joined my Ph.D., and it has always been a wonderful experience to interact with him.

My thanks go to Prof. Dr. Balthasar Bickel for agreeing to supervise my thesis and all his help.

Thanks also to Prof. Dr. Angela Friederici for her support at the MPI.

I would also like to thank Prof. Dr. Dietmar Roehm for all his help. Several times he took pain to help me in designing the Experiment and was always there when I encountered any problem.

I would also like to thank my colleagues and friends Dr. Baris S. Demiral, Dr. Susann Wolff, Dr. Friederike Haupt, R. Muralikrishnan, Sabine Frenzel, Luming Wang, Sarah Tune and Jona Sassenhagen for their support at various time and the good company that they provided.

My thanks go to Katja Brüning for her help in data acquisition and Kerstin Flake for providing graphics support.

I would also like to thank all the participants, without whose support the experiments would not have been possible. Thanks to Dr. Pallavi Tripathi for helping me in recording the auditory stimuli. I would like to thank my friends Dr. Vikas Baranwal and Dr. Sarika Jalan for helping me in checking the Hindi stimuli whenever it was necessary.

My friends in Delhi have been helpful in several ways. I would like to thank Veerendra Mishra, Bablu Ray, Arun Roy and Parmendra Mishra for all their help.

I would also like to thank Dr. Tanmoy Bhattacharya, my M.Phil thesis supervisor, for all his guidance and support.

Thanks also to Arpana for all her patience while I have been working on this thesis.

Last but not the least, I would like to thank my parents for all the support I have received from them throughout my life.

Kamal Kumar Choudhary

Abbreviations

1	First person
2	Second person
3	Third person
Acc	Accusative
Asp	Aspect
Aux	Auxiliary
Dat	Dative
DOM	Differential Object Marking
eADM	Extended Argument Dependency Model
Erg	Ergative
EEG	Electroencephalogram
ERP	Event-related potentials
F	Feminine
IPFV	Imperfective
Inf	Infinitive
M	Masculine
Nom	Nominative
Pl	Plural
Prog	Progressive
PFV	Perfective
Sg	Singular

Contents

Introduction

In the past decades, psycholinguists have investigated online language comprehension using methodologies such as EEG and fMRI in order to find out how human sentence processing takes place. There are currently several models of language processing that were proposed in recent years (e.g. Frazier & Rayner, 1982; Friederici, 2002; Hagoort, 2005; MacDonald, Pearlmutter & Seidenberg, 1994). As it is well-known that there are around 6000 languages spoken all over the world, it has been a challenge for any model to capture them all, as the languages of the world vary in several respects. One such difference is case marking, as languages of the world show different case marking patterns. The two most common case marking patterns are nominative-accusative and ergative-absolutive (Comrie, 1978; Dixon, 1994).

So far, most of the studies conducted on online language comprehension have been based on nominative-accusative languages. The question of how ergative languages are processed has been mostly unaddressed so far. The basic goal of this thesis was to test whether the findings from the nominative–accusative languages can be generalised to ergative languages or whether argument interpretation takes place differently in ergative languages. It is an accepted fact in psycholinguistics that arguments are processed incrementally (Crocker, 1994) and that information like case, word order and animacy influence the argument interpretation (Bornkessel & Schlesewsky, 2006a). As the role of case, word order and animacy have already been tested for the nominative-accusative languages, this study aims to shed some light on the online processing of Hindi, a split-ergative language. We use a neurocognitive model of language processing, namely the extended Argument Dependency Model (eADM, Bornkessel & Schlesewsky, 2006a) for the interpretation of our results, since this model provides predictions about the processing of ergative languages.

This thesis is organised as follows: Chapter 1 provides a general introduction to incremental argument interpretation and discusses the methodology used in our studies. In addition, we discuss how information types such as case, word order and animacy play an important role in argument interpretation. The last section of this chapter presents a brief introduction to the neurocognitive model mentioned above, the eADM (Bornkessel & Schlesewsky, 2006a).

Chapter 2 provides information about ergativity and general features of Hindi. Next, some earlier works on Hindi as well as on other ergative languages are briefly discussed from the comprehension perspective. Furthermore, we discuss the research questions of this thesis.

Chapter 3 presents the first experiment[1] of the thesis followed by a questionnaire study. The main purpose of this experiment was to test the role of case in argument interpretation in Hindi. We investigated in this experiment whether ergative, nominative and accusative cases behave similarly or differ in terms of argument interpretation.

Chapter 4 presents Experiment 2, which explored the role of word order variation in Hindi. Results from studies on nominative-accusative languages show that word order variations play an important role in language comprehension. We tested whether similar results could be observed in split-ergative languages like Hindi.

We discuss Experiment 3 in Chapter 5, which tested the role of animacy in argument interpretation in Hindi and its interaction with ergative and accusative cases.

Chapter 6 explored the agreement pattern in Hindi. Though there have been several studies on agreement violations within the clause, this study explored the extra-clausal agreement pattern in Hindi, the so-called long distance agreement (LDA). We tried to find out whether LDA violations are processed similarly to violations in simple clauses. Long distance agreement in Hindi is dependent on the case marking of NP1. That is, when NP1 is ergative or dative, LDA is possible; when it is nominative, LDA is not possible. We used ergative arguments at NP1 in this experiment. We tested whether simple violations and violations involving LDA showed similar results.

Chapter 7 presents a general discussion of the thesis. We discuss here how the different results observed in this thesis can be analysed and how these issues could be investigated in the future.

Chapter 8 concludes the thesis and provides possible directions for future research.

[1]Experiment 1 (Chapter 3) and Experiment 4 (Chapter 6) are published partially in Choudhary et al.,(2009) and Bornkessel-Schlesewsky et al., (2008) and Experiment 3 (Chapter 4) in Schlesewsky et al., (2010).

I Theoretical Issues

Chapter 1

Electrophysiological Research and Incremental Argument Interpretation

Chapter 1 provides a general introduction to incremental argument interpretation and discusses the methodology used in our studies. In addition, we discuss how information types such as case, word order and animacy play an important role in argument interpretation. The last section in this chapter presents a brief introduction to a neurocognitive model, the extended Argument Dependency Model (eADM, Bornkessel and Schlesewsky, 2006a).

1.1 Language comprehension

Psycholinguistic studies conducted during the past decades have tried to address the question of how the human brain processes language in real-time using several experimental methods. It is clear that processing a sentence involves processing it in all its levels, that is syntax, phonology, semantics and pragmatics. Each level is important in its own right to arrive at what a sentence means. But how these various levels are used in real-time comprehension is an important question that psycholinguists have been trying to answer. There are several methods (behavioural methods such as acceptability judgement and speed-accuracy trade-off, eye-movement measures, self-paced reading, neurocognitive methods like electroencephalogram (EEG) / event-related brain potentials (ERPs), functional magnetic resonance imaging (fMRI), positron emission tomography (PET)) that are used to study how human sentence processing mechanisms work. As this thesis is based on EEG / ERP data, we restrict our discussion to this methodology, only. For a discussion of other methodologies, see Bornkessel-Schlesewsky & Schlesewsky (2009a). We discuss in detail the neurocognitive model that we use for the interpretation of our results, the eADM (Bornkessel & Schlesewsky, 2006a), and mention other models whenever necessary. One issue, on which most psycholinguists agree, is that sentences are processed incrementally (Crocker, 1994; Stabler, 1994). In the next section, we briefly describe what incrementality means in the context of language comprehension.

1.2 Incremental argument interpretation

It is well accepted that sentence comprehension takes place incrementally. This means that the processor interprets the arguments as they are encountered in real-time, and more importantly, it does not wait for the verb in case it has not been reached yet. This is the case in verb final languages. That is, each new input item is interpreted and analysed when it is encountered (for experimental evidence for this issue, see the examples in 1.4.1.5.2).

Principle of Incremental Comprehension (PIC): The sentence processor operates in such a way as to maximise the interpretation and comprehension of the sentence at each stage of processing (i.e., as each lexical item is encountered) (Crocker, 1994; p.251).

There is considerable experimental evidence showing that the interpretation of arguments takes place immediately. In case of ambiguity, the processing system prefers one interpretation to the other. While it is clear that processing takes place incrementally, what are the factors that help the processing system to interpret the arguments? There are several factors like case, word order and animacy that influence argument interpretation. The weighting of each of these factors varies from language to language (Bates, McNew, MacWhinney, Devescovi, & Smith, 1982; MacWhinney & Bates, 1989). Bornkessel & Schlesewsky (2006a) propose that the features like case, word order and animacy are used to establish the so-called prominence relations (i.e., in determining which argument is more agent-like and which one is more patient-like) between the arguments even before the verb is reached. In a later section we discuss the role of case, word order and animacy from the interpretation perspective. But before focusing on the role of these factors in detail, in the following sections we briefly introduce the EEG/ERP methodology used in our experiments.

1.3 The electroencephalogram (EEG)

The first human electroencephalogram was recorded by Hans Berger in 1929, who also suggested that EEG measures correlate with cognitive processing (Berger, 1929). The EEG methodology is used in several disciplines of cognitive and brain research.

The neurophysiological activity measured by the EEG results primarily from the summed postsynaptic activity of parallelly oriented pyramidal cells perpendicular to the surface of the scalp. The activity of electrodes is calculated relative to a given reference site. Reference sites could be those where no cortical activity is measured, for example the mastoids. The EEG signal is amplified and digitised by sampling the continuous signal at a certain sampling rate. We used a sampling rate of 250 Hz in our studies reported here.

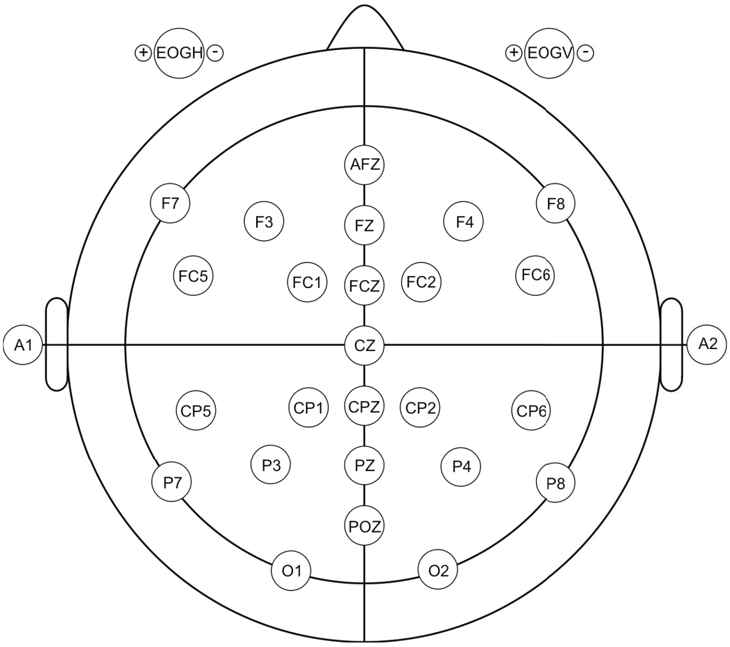

Figure 1.1. The electrode setup used for this thesis.

1.4 Event-related brain potentials (ERPs)

Event-related brain potentials (ERPs) are small changes in the spontaneous electrical activity of the brain, which occur in response to sensory or cognitive stimuli and which may be measured non-invasively by means of electrodes applied to the scalp. A schematic ERP experimental setup is shown in Figure 1.2 below. This critical stimulus-related activity is isolated from the background brain activity by an averaging procedure applied to the set of stimuli (30 to 40 items). As the data from a single participant cannot be interpreted, a grand average is computed over all the participants.

ERPs provide a very high temporal resolution, which is particularly useful as a means of tracking real-time language processing. Furthermore, ERP components can be characterised along a number of different dimensions, thus providing a qualitative measure of the different processes involved in language comprehension. These dimensions are polarity, topography, latency and amplitude. Polarity describes the direction of change in the potential difference, that is, positive or negative. Topography expresses the distribution of effects on the different electrode positions. Latency offers information about the time span of the effect relative to the onset of a critical stimulus and the amplitude shows the strength of the effect.

The ERP methodology only provides relative measures, i.e. an effect always results from the comparison of a critical condition with a minimally differing control condition. Thus, the components can only be interpreted relative to a control condition but never in absolute terms. In the above description, we have briefly described ERPs. In the following section, we discuss language related ERP components.

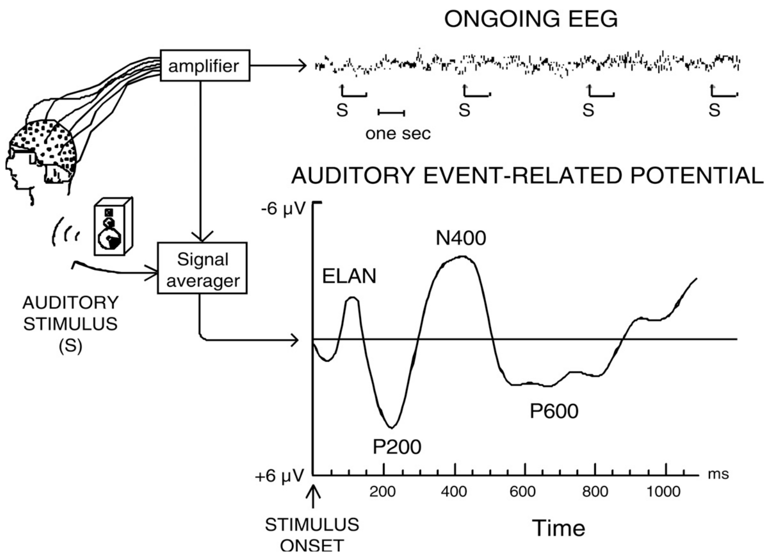

Figure 1.2. Schematic depiction of the setup of an ERP experiment on language processing (adapted from Rugg and Coles, 1995).

1.4.1 ERP components

In psycholinguistic research several language related ERP components have been reported and these components have been related to different kinds of linguistic phenomenon. The advantage of ERP measures lies in the fact that they can reveal qualitative differences between different types of processing problems. There are four major ERP components: early left anterior negativity (ELAN), left anterior negativity (LAN), N400 and P600. In general, the ELAN has been associated with word category violation, the LAN with morphosyntactic violations, the N400 with semantic violations and the P600 with syntactic violations. Nevertheless, such a one-to-one mapping of the components has been challenged, as similar components have been observed in different cases (see Bornkessel & Schlesewsky, 2006a; Haupt et al. (2008). In the following section, we discuss these components in brief and show in which cases these components have been reported.

1.4.1.1 The N400

The N400 component (Figure 1.3), first reported by Kutas & Hillyard (1980), has traditionally been considered to be related to lexical–semantic processing. In the original Kutas and Hillyard study, a negative deflection was observed peaking at around 400 ms after the onset of the word (*socks*) in a sentence like: *He spread the warm bread with socks*. That is, this effect was observed at the position of the word that mismatched with the preceding context semantically. Though the N400 effect has been considered to be reflecting problems arising during lexical-semantic processing, it has also been observed in other cases in several studies.

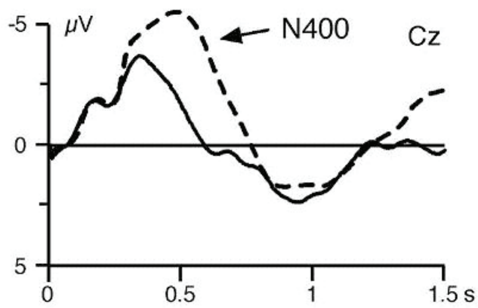

Figure 1.3. Illustrates the N400 effect (adapted from Friederici and Alter, 2003).

For instance, Weckerly & Kutas (1999) observed an N400 effect for inanimate vs.. animate arguments in English (see section 1.5.3). This study can be related in some sense to interpretive processes. The N400 has also been observed in other studies, in which it cannot be related to interpretive processes: for instance, for word order variations (Bornkessel et al., 2004; Haupt et al., 2008), for structures that require syntactic reanalysis (Osterhout, 1997; Bornkessel, 2002) and for case conflicts (Frisch & Schlesewsky, 2001, 2005).

1.4.1.2 The early left anterior negativity (ELAN)

The so-called early left anterior negativity (ELAN) effect (see figure 1.4) has been observed for phrase structure violations induced by word category errors during sentence comprehension. This effect occurs between 150 and 200 ms after the onset of the critical word. Neville et al. (1991) studied violations such as *Max's of proof the theorem,* and observed an ELAN on the position of *of.*

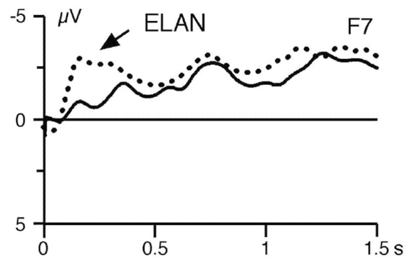

Figure 1.4. Illustration of an ELAN effect (adapted from Friederici and Alter, 2003).

The ELAN is generally interpreted to be reflecting problems arising during initial structure building processes (Friederici, 1995; Hahne & Friederici, 1999).

1.4.1.3 Left anterior negativity (LAN)

The LAN is a negativity observed in the left anterior electrode locations at around 300-500 ms after the stimulus onset (see figure 1.5). This component has been related to morphosyntactic violations and working memory load. LAN effects have been found for agreement violations (e.g., de Vincenzi et al. 2003; Hagoort & Brown, 2000), as well as for case violations. For instance, Coulson, King & Kutas (1998) observed a LAN effect at the position of the word *we* in the following sentence:

(1.1) The plane took we to paradise.

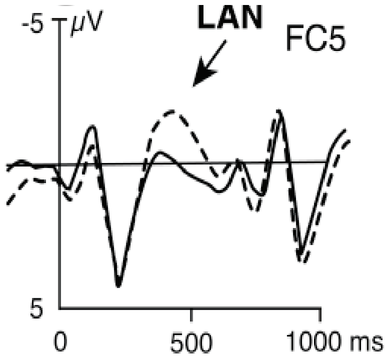

Figure 1.5. Illustrates the LAN effect (adapted from Bornkessel-Schlesewsky & Schlesewsky, 2009a).

There are two types of LAN, namely focal and sustained LAN. All the effects discussed above are focal LANs. A sustained LAN is also a left anterior negativity, but unlike a focal LAN, it has a sustained effect on the whole sentence, starting at around 300 ms after the onset of the critical word. It has been considered to be reflecting an increased working memory load (Kluender & Kutas 1993; Münte et al. 1998).

1.4.1.4 The P600/SPS

The P600, as shown in the Figure 1.6 below, is a positive-going component, which is traditionally considered to be reflecting syntactic violations and syntactic reanalysis (Osterhout & Holcomb, 1992, 1993). A P600 is observed with a peak latency at 600 ms post stimulus. This P600 is also known as syntactic positive shift (SPS). This term was proposed by Hagoort et al. (1993). Bornkessel & Schlesewsky (2006a) use the term late positivity for this effect. However, these authors assume that there is a separate P600 effect. That is, they use these two terms to refer to two different mechanisms in their neurocognitive model of language processing. We shall return to this functional dissociation in section 1.6 below.

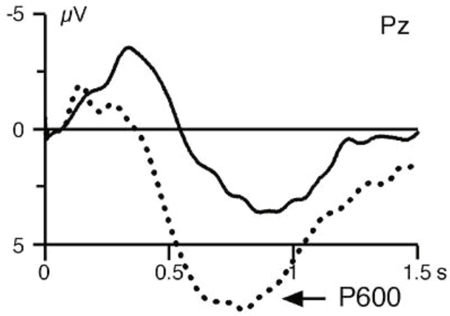

Figure 1.6. Illustration of the P600 effect (adapted from Friederici and Alter 2003).

Though the P600 effect has been traditionally related to syntactic processing, it has also been observed in other cases such as reanalysis (Friederici, 2002) and ambiguity (Frisch et al., 2002).

Research in recent years has shown that the late positivity effect is also observed in some other cases. For instance, Roehm et. al. (2007) observed a biphasic N400-late positivity pattern for the word *nice* in sentences like *The opposite of black is nice,* in which the expectation of the antonym was not fulfilled. In this case, there is no syntactic problem. Bornkessel and Schlesewsky (2006a) interpret the late positivity as reflecting a global evaluation of the well-formedness of a sentence.

Although the late positivity was earlier considered to be reflecting only syntactic processes, it has also been observed in other cases in more recent studies. Apart from that, there has been much debate about the so-called semantic P600, as some studies have shown that the P600 appears to reflect semantic processes as well (e.g. Kolk et al., 2003; Kuperberg et al., 2003; Hoeks et al., 2004; Kim & Osterhout, 2005).

1.4.1.5 Further positivity effects

There are other positivities that have been reported in several studies, namely the P300 and the early positivity.

1.4.1.5.1 P300

The P300, observed with a latency ranging from 300-900 ms post stimulus onset, is of two types, namely the P3a and the P3b. While the P3a has generally been observed for new, unexpected stimuli, the P3b has been related to the target word (Polich, 2004). The P3a is observed at frontocentral electrode sites while the P3b is most pronounced over parietal sites. Roehm et. al. (2007) observed a P300 effect for the word *white* in sentences like *The opposite of black is white,* in which the expectation of an antonym was fulfilled.

1.4.1.5.2 Early positivity

Bornkessel et al. (2003) observed an early positivity in German, which they interpret as reflecting thematic reanalysis. The following German sentences were used in their experiment.

(1.2) a. Obj-Exp (NOM-DAT)
. . . dass der Priester dem Gärtner imponiert und . . .
. . . that the$_{NOM}$ priest the$_{DAT}$ gardener impresses and . . .
'. . . that the priest impresses the gardener.'

b. Obj-Exp (DAT-NOM)
. . . dass dem Priester der Gärtner imponiert und . . .
. . . that the$_{DAT}$ priest the$_{NOM}$ gardener impresses and . . .
'. . . that the gardener impresses the priest.'

While comparing the nominative-dative and dative-nominative sentences at NP2, an early positivity was observed for the dative-nominative sentences. In addition, the early positivity was also found at the position of the verb for experiencer verbs (e.g., *impress*) in comparison to active verbs such as *help*. The authors argued that this is due to the reanalysis of the arguments' thematic hierarchy before encountering the clause-final verb. When the verb turns out to be an object-experiencer verb, the thematic ordering of the arguments has to be reanalysed. This is because object-experiencer verbs in German require a dative-nominative thematic ordering as opposed to active verbs, which require a nominative-dative ordering. The early positivity effect is observed due to such a thematic reanalysis.

We have presented a brief description of ERP components here, but it should be noted that several studies have provided evidence against a one-to-one mapping of components to distinct processes (see Bornkessel & Schlesewsky 2006a; Bornkessel-Schlesewsky & Schlesewsky, 2009a, Roehm et al., 2004 and Haupt et al., 2008 for further discussions).

1.5 Role of case, word order and animacy in incremental argument interpretation

Argument interpretation involves processing each argument encountered to identify its thematic role in the sentence, and further, building relationships between arguments. The thematic role of an argument could be determined based on various factors such as animacy, case, the linear position of this argument in the sentence and so on. An argument could thus be more agent-like (which we call actor in our discussions here) or patient-like (which we call undergoer hereafter). As mentioned earlier, information types such as case, word order and animacy influence argument interpretation. However, these information types may be more or less prominent depending on the language under consideration. For example, in a language with extensive morphological case marking, this could be a more reliable cue for argument interpretation, and thus more prominent, than say, in a language, in which there is no morphological case available. In a language like English with almost no morphology at all, the word order can indicate which argument is the actor and which argument is the undergoer.

Animacy, on the other hand, can also be informative in this regard. For example, animate arguments, and in particular human arguments, are sentient and capable of volition. Thus, they have the properties to be ideal actors, whereas inanimate arguments are ideal undergoers because they lack the properties of sentience and volition.

The eADM (discussed in section 1.6.1) proposes that information types like case, word order and animacy play a very important role in interpreting an argument in a sentence even before the verb. In the following sections, we discuss some studies that illustrate the role of case, word order and animacy in argument interpretation.

1.5.1 The role of case in sentence processing

Frisch & Schlesewsky (2001) showed for the first time that morphological case information is used to establish thematic relations during language comprehension. Consider the following examples:

(1.3) a. *...welcher Mönch der Bischof begleitete.
...[which monk]$_{NOM}$ [the bishop]$_{NOM}$ accompanied

b. *...welcher Mönch der Zweig streifte.
...[which monk]$_{NOM}$ [the twig]$_{NOM}$ brushed

The sentences (1.3a) and (1.3b) become ungrammatical at the position of the second noun phrase as both the arguments in these sentences are in the nominative case. In (1.3a), the second argument is animate, while it is inanimate in (1.3b). All the ungrammatical sentences showed a late-positivity at the position of NP2 as opposed to their grammatical counterparts. In addition, sentences such as (1.3a), in which both the arguments were animate, showed an N400 effect at NP2 as well. No such effect was observed for sentences like (1.3b), in which one argument was animate and the other inanimate. Frisch & Schlesewsky (2001) interpret this N400 effect as reflecting the inability to thematically hierarchise the arguments with respect to one another. The late positivity in this study is independent of the thematic interpretation of the arguments because this effect was found for both animate and inanimate arguments.

Bornkessel et al. (2003a) also showed that, in German, case is used for the thematic hierarchisation. They reported an early positivity at NP2 and at the verb, if it happened to be an object-experiencer verb that requires a dative-nominative thematic ordering in German. It is important to note here that the sentences used in this study were fully grammatical (for details, see the discussion on early positivity above).

Frisch & Schlesewsky (2005) followed up their earlier study and compared double nominative with double dative and double accusative structures. They reported that all types of double case ungrammaticalities showed a biphasic pattern N400-P600 response. While double datives showed a larger P600, double accusatives revealed a stronger N400 in comparison to double nominatives. The larger P600 suggests that ill-formedness is more salient in structures with two dative arguments. Double accusatives cause more severe semantic–thematic integration problems because, in this case, identical case-marked argument cannot be hierachised thematically. The authors argue that in German, both nominative and dative arguments have the properties to function as either actor or undergoer in a transitive relation but an accusative argument can only bear an undergoer role. So in this case, thematic hierarchising is not of much help. It is because an accusative-marked argument is always +dependent (undergoer is dependent on actor) and it needs a thematically higher argument. Thus, in the case of double accusative arguments, an enhanced N400 is evoked. Different to this, nominative and dative can co-occur with both higher and lower arguments. The authors argue that a dative object in German is always exceptional in a transitive construction, and because of this saliency of the dative case in transitive constructions, a more pronounced P600 is evoked for the double dative construction.

In German, it has been shown that the processing of an initial accusative-marked argument leads to the prediction of a subsequent animate nominative argument, because it has the properties of an ideal actor. When an inanimate nominative argument is encountered instead of an animate one it evokes an N400 effect (Roehm et al., 2004), thus suggesting that an initial accusative argument in German predicts an upcoming argument. The following sentences were used in the experiment. In sentence 1.4b, an N400 was observed at the position of *der Zweig*.

(1.4) a. Peter fragt sich, welchen Arzt *der Jäger* gelobt hat.
Peter asks himself, [which doctor]$_{obj}$ [the hunter]$_{subj}$ praised has

b. Peter fragt sich, welchen Arzt *der Zweig* gestreift hat.
Peter asks himself, [which doctor]$_{obj}$ [the twig]$_{sub}$ brushed has

Additional evidence for the prediction of an upcoming argument comes from Wolff et al. (2008). These authors reported that initial accusative arguments engender a late positivity in Japanese. In Japanese constructions, an actor is expected in an event after perceiving an accusative argument, so it is claimed that the late positivity is observed due to dependency formation, i.e. the prediction of an upcoming argument from the current one. The example is cited from Wolff et al. (2008).

(1.5) nisyuukanmae hanzi-o daizin-ga manekimasita.
two weeks ago Judge-acc minister-nom invited
"Two weeks ago the minister invited the judge."

In summary, it is clear that case marking can be very informative from the perspective of argument interpretation in a language with an extensive case marking system. Nevertheless, it needs to be noted that some cases are more informative than others: for an accusative, it is possible to infer that the argument is an undergoer, while this is not the case for nominative-marked arguments (in languages like German or Japanese). Case is used to thematically hierarchise the arguments. Problems in this process elicit a centro-parietal negativity (N400). When the case marking indicates that an event is transitive and that another argument may follow in the event (which evokes dependency formation), a late positivity effect is observed. Still, there are other works that have reported a LAN for case violation instead of an N400 in cases of formal mismatches that can be treated as morphosyntactic violations. One such study is from Coulson et al. (1998). In the sentence *The The plane took we to paradise,* at the position of *we* a LAN was observed. Further evidence comes from Friederici & Frisch (2000), who found a LAN for the violation of the grammatical type of an argument (direct vs. indirect object) that is indicated by case marking in German. An example from Friederici & Frisch (2000) is shown below.

(1.6) * Anna weiß, dass der Kommissar (Nom) den Banker (Acc) beistand (V) und wegging.
'Anna knows that the inspector (Nom) the banker (Acc) helped and left.'

The choice of dative vs. accusative case is verb-dependent in German. Therefore, one could distinguish between verb-independent case violations in German, which appear to reflect thematic hierarchising and engender N400 effects (Frisch & Schlesewsky, 2005), and verb- dependent case violations, which appear to reflect mismatches with respect to the case required by a particular verb and thereby seem to be treated similarly to formal mismatches (Friederici & Frisch, 2000).

1.5.2 Role of word order in sentence processing

There are different types of word order possible in the languages of the world. For instance, the basic word order could be SVO (subject-verb-object) like English or SOV (subject-object-verb) like Japanese, Hindi and others. Languages could also have other word orders. But the main concern here is that while in some languages the constituents can be permuted freely, in other languages, this is not possible. Languages like English are considered to be rigid word order languages, whereas those like German or Hindi allow for a more flexible word order. This means that while in Hindi the canonical word order is SOV, the arguments can be re-arranged in any order (OSV; VSO; VOS etc., all six permutations are possible) without changing the interpretation of the sentence. The word order phenomenon has been investigated from different perspectives and it is also considered important from the perspective of argument interpretation in online language comprehension. Bornkessel & Schlesewsky (2006a) argued that a complete understanding of the neurocognitive architecture of language comprehension cannot be attained without a close examination of how word order permutations are processed.

The costliness of permuted word orders is often derived via the assumption that they engender an increased working memory load (e.g. Gibson, 1998, 2000; Kaan & Swab, 2002). Though the costliness of an object-initial order has been investigated using different methods like fMRI, ERPs and behavioural studies, we will mainly discuss the findings from the ERP studies. In previous studies, it has been shown that different types of word order variation show different results, and that in some cases, word order variations do not show costliness at all**.** It has been observed that argument permutation in the German pre-field[2] and middle-field show distinct results.

In German, an object moved to the pre-field shows a sustained LAN, while it elicits a focal LAN when it is permuted in the middle-field. The latter effect has been termed as "*scrambling negativity"* by Schlesewsky et. al. (2003). It is because this negativity is found at around 300 and 500 ms post onset and its distribution lies between the classical distribution of the LAN (left-anterior) and the N400 (centro-parietal). Furthermore, it has also been reported that when the permuted argument (that deviates from an unmarked word order) is a pronoun it does not engender any processing costs and hence does not cause a scrambling negativity in the German middle-field (Schlesewsky et. al., 2003). Hence, it is assumed that the scrambling negativity is observed when a moved object can be unambiguously identified as permuted. Bornkessel et al. (2002) also observed that dative objects following a complementiser in German do not engender a scrambling negativity.

The scrambling negativity has also been reported in Japanese when initial objects were marked with a prosodic boundary (Wolff et al., 2008). Examples of the type shown in (1.7) were used in this case. The NP1 was either followed by a prosody boundary or not. Though the initial argument is unambiguously marked as an object in both cases, whether it is identified as permuted (scrambled) or not depends on the presence or absence of the prosodic boundary. When no boundary is present, the initial object could be interpreted as the (non-permuted) object of a sentence with a dropped subject. In the presence of a boundary, by contrast, a scrambled reading is expected. Thus, a scrambling negativity is observed when the argument is marked with a prosodic boundary.

(1.7) nisyuukanmae hanzi-o daizin-ga manekimasita.
two weeks ago Judge-acc minister-nom invited
"Two weeks ago the minister invited the judge."

This suggested that the scrambling negativity is observed when a scrambled argument is unambiguously identified. When this is not the case, no such effect is observed. Additional evidence comes from Turkish where no scrambling negativity was observed (Demiral et al., 2008). This suggests that the scrambling negativity is not observed in the default case, i.e. when a pro-drop reading is possible. All these results have suggested that the scrambling negativity reflects relational mechanisms for the word order processing.

[2]In German, there are two clausal regions known as pre-field and middle-field. In a declarative sentence, the sentence-initial argument or the region that is right before the finite verb is known as pre-field. In this language, the finite verb always comes in the second position in a declarative main clause. The section that is between the finite verb/ complementizer and verb at the end is known as middle-field.

Perhaps more surprisingly, electrophysiological effects have also been observed for simple sentences with a subject-before-object order. The effects have been observed both in German (Bornkessel et al., 2004) and Japanese (Wolff et al., 2008). In both cases, an initial nominative is ambiguous between an intransitive and transitive reading, but the intransitive reading is preferred initially (Bornkessel et al., 2004)**.** When a second argument is encountered in the sentence, an N400 effect follows. Consider the following examples from German (Bornkessel et al., 2004):

(1.8) Herbert fragte sich, ...
Herbert wondered, ...

a. … welcher Autor … den Senator kritisierte.
… [which author]$_{NOM}$ … [the senator]$_{ACC}$ criticised
'... which author criticised the senator.'
b. … welchen Autor … der Senator kritisierte.
… [which author]$_{ACC}$ ... [the senator]$_{NOM}$ criticised
'... which author the senator criticised

In these examples, at the position of NP2, a centro-parietal negativity (N400) was observed for the sentence 1.8a (canonical, subject-object) in comparison to sentence 1.8b (object-subject). The N400 effect observed in this case has been interpreted as reflecting the reanalysis of the initial intransitive reading to a transitive reading.

From the above discussion it is clear that different types of word order permutations evoke different ERP signatures, and in some cases, they do not engender any extra processing costs at all. For a detailed discussion of the role of word order in argument interpretation, see Wolff et al. (2008) and Bornkessel-Schlesewsky & Schlesewsky (2009a).

1.5.3 Role of animacy in sentence processing

So far we talked about the role of case and word order with respect to argument interpretation. In the following, we discuss the role of animacy in argument interpretation. Comrie (1989) proposed that "the most natural kind of transitive construction is one where A [Agent] is high in animacy and definiteness and P [patient] is lower in animacy and definiteness; and any deviation from this leads to a more marked construction" (Comrie, 1989: 128).

The animacy hierarchy Human > Animals (animate) > Inanimate is well established in typological studies and seems to play an important role in several linguistic phenomena. This type of studies suggests that human arguments have the properties of a prototypical actor role, while inanimate arguments have the quality to be patients or undergoers. The animacy hierarchy is also important from the perspective of differential object marking, as in some languages only animate nouns are marked with accusative case while inanimate nouns do not need accusative case marking. See Aissen (2003) and de Swart (2007, 2008) for more details on the phenomenon of differential object marking. For a description of why animacy is important for different types of linguistic phenomena and how this has been interpreted from different perspectives, see de Swart et al. (2008.)

In the following, we present experimental evidences that provide converging support for the role of animacy in argument interpretation in online language comprehension.
In the study of Weckerly & Kutas (1999), inanimate and animate sentence-initial arguments were compared (1.9a and b). The inanimate initial arguments evoked an N400 effect in comparison to their animate counterparts.

(1.9) a. The *novelist* that the movie inspired praised the director for staying true to the complicated ending.

b. The *movie* that the novelist praised inspired the director to stay true to the complicated ending.

As English is a position-based language (i.e. there is a high likelihood that an initial NP in an active sentence will be the actor), this finding suggests that an inanimate argument does not have the properties to be a potential actor in the same way as an animate argument. Thus, an N400 effect is evoked for the inanimate arguments in comparison to animate arguments. However, one could argue that in this case it could be due to lexical differences (i.e. inherent difference between animate and inanimate nouns) rather than prototypical vs.. less prototypical actors.

Recall from above that Frisch & Schlesewsky (2001) and Roehm et al. (2004) observed an N400 effect for inanimate arguments in comparison to animate ones following an initial accusative argument. In German, an initial accusative argument suggests that the sentence is transitive and that an actor is expected to follow. But when the NP2 turns out to be inanimate (*der Zweig),* an N400 effect is observed, as inanimate arguments are not prototypical actors. The relevant examples from section 1.5.1 are repeated in 1.10.

(1.10) a. Peter fragt sich, welchen Arzt *der Jäger* gelobt hat.
Peter asks himself, [which doctor]$_{obj}$ [the hunter]$_{subj}$ praised has

b. Peter fragt sich, welchen Arzt *der Zweig* gestreift hat.
Peter asks himself, [which doctor]$_{obj}$ [the twig]$_{sub}$ brushed has

This effect can be interpreted in relational terms. When an accusative-marked argument is encountered, there is a prediction for an animate nominative argument, as this would be a prototypical actor. But when an inanimate nominative argument is encountered instead of an animate argument, an N400 effect is evoked.

Similar results have also been observed in languages like Chinese and Tamil. For Mandarin Chinese, Philipp et al. (2008) reported similar results when an inanimate actor follows an animate undergoer.

(1.11) a. wáng zǐ bèi tiǎo zhàn zhě cì sǐ le
Prince bèi contender stab PFV
'The prince was stabbed by the contender.'

b. wáng zǐ bèi shéng zi lēi sǐ le
Prince bèi cord strangle PFV
'The prince was strangled by the cord.'

In Chinese, the co-verb *bèi* unambiguously identifies the initial argument as an undergoer. So when an inanimate argument follows, as in 1.11b, an N400 effect, similar to that in German, is observed.

Muralikrishnan (2007) also reported similar results for Tamil, a Dravidian language. This suggests that this interpretive relation works cross-linguistically, when animacy is taken into account. For the experiments in Chinese and Tamil an influence of lexical difference can be ruled out. In both the languages, there was no effect observed at the position of the first NP for identical words (animate vs.. inanimate nouns).

Generally, animacy is considered to be a semantic factor, while word order and case are taken to be syntactic factors. From a sentence processing perspective, Bornkessel-Schlesewsky & Schlesewsky (2009b) show that prominence information is an integral part of the form-to-meaning mapping during language comprehension, and that animacy is equivalent to syntactic information like case marking and word order. Though, in general, case and word order have been seen to control role identification and animacy as determining role prototypicality,[3] the authors argue that it could also be vice versa and that all these information types play a functionally equivalent role in form-to-meaning mapping during online comprehension (see prominence scales in 1.6.1.2). They show that in some languages animacy may be the primary determinant of role identification. The evidence for this comes from a language of Papua New Guinea. In Awtuw, the argument that is higher in animacy is treated as the A-argument. In this language, the role identification is primarily based on animacy. Keeping these observations in mind, Bornkessel-Schlesewsky & Schlesewsky proposed the "interface hypothesis of incremental argument interpretation", which states that:

> "*Incremental argument interpretation (i.e. role identification and assessment of role prototypicality) is accomplished by the syntax-semantics interface, that is, with reference to a cross-linguistically defined set of prominence scales and their language-specific weighting.*"
>
> (Bornkessel-Schlesewsky & Schlesewsky, 2009:10)

For the prominence scales proposed by them, see section 1.6.1.2.

It should be noted that undergoers are defined in opposition to the actor role. That is, undergoers are dependent on actors but not vice versa (Primus, 1999). In this respect, Bornkessel-Schlesewsky & Schlesewsky (2009b) argue that the apparent prototypicality effects involving undergoers should be attributed to the increased competition for the actor role. Thus, the basic idea is that the system could not predict a prototypical undergoer in the same way as it can predict a prototypical actor. We tested this in Experiment 3.

We have briefly discussed the role of case, word order and animacy in incremental argument interpretation. In the next section, we give a summary of the extended Argument Dependency Model (eADM, Bornkessel & Schlesewsky, 2006a). This will illustrate more concretely how the above mentioned factors case, word order and animacy influence incremental argument interpretation.

[3] Role identification: how does the human language comprehension system identify which is the A and which is the P argument? Role prototypicality: how prototypical are A and P arguments.

1.6 Model of language comprehension

In the following, we present the summary of the extended Argument Dependency Model (Bornkessel & Schlesewsky, 2006a). This model, though based on nominative-accusative languages, also provides predictions about ergative languages. For alternative neurocognitive models of language comprehension, see Friederici (2002) and Hagoort (2005).

1.6.1 The extended Argument Dependency Model (eADM)

Bornkessel & Schlesewsky (2006a) proposed a neurocognitive model of incremental language comprehension, which is an extension of the model presented in Bornkessel (2002) and Schlesewsky & Bornkessel (2004). This model is primarily concerned with the processing of core relations, that is, the relations holding between sentential arguments and between arguments and verbs.

The eADM assumes that core constituent processing proceeds in three hierarchically organised phases: (1) constituent structure building without relational interpretation, (2) argument role assignment via a restricted set of cross-linguistically motivated information types (e.g. case, animacy), and (3) completion of argument interpretation using information from further domains (e.g. discourse context, plausibility). We discuss the details of all three phases below (but see Bornkessel & Schlesewsky 2006a for more details). Figure 1.7 shows the architecture of the model.

1.6.1.1 Phase 1

The most important features of constituent structure (phrase structure) building are that it is mainly based upon word category information and does not yet lead to argument interpretation. It is assumed that the output of phase 1 is an activated phrase template (for one argument it will activate one argument template (NP-V), for two arguments: NP-NP-V) without any relational information attached to it (i.e. no agreement, case marking or thematic roles).

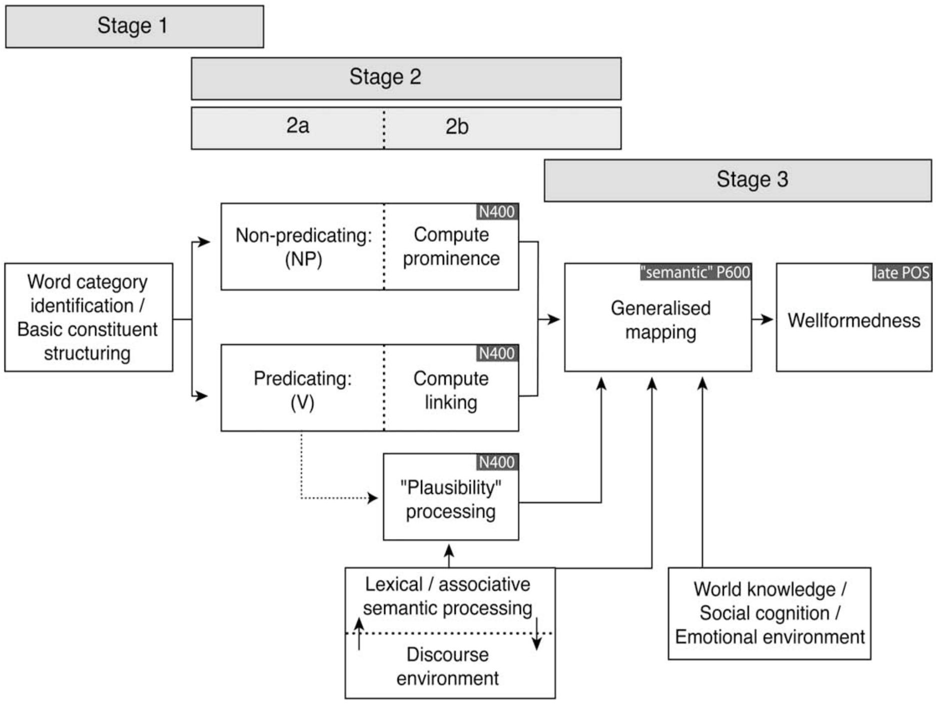

Figure 1.7. The architecture of the eADM (Bornkessel and Schlesewsky, 2006a, 2008)

1.6.1.2 Phase 2

Phase 2 is the most important part of the model. As shown in Figure 1.7, phase 2 is divided in two parts: phase 2a and phase 2b. Phase 2a models how the input is used to encode features relevant for relational processing and phase 2b reflects the results of that encoding (i.e., relational processing). Following Van Valin and colleagues (e.g. Foley & Van Valin, 1984; van Valin & LaPolla, 1997), the eADM assumes two generalised semantic roles (GSRs)**,** actor and undergoer, which correspond to the agent and patient prototypes. These also stand in a dependency relation stating that the undergoer is hierarchically dependent upon the actor (Primus, 1999). As the goal of the model is to capture the diversity of languages, the eADM assumes that the arguments are ranked hierarchically and assigned GSRs (actor and undergoers) on the basis of prominence information. Prominence information can be encoded by both morphosyntactic information (morphological case, argument position) and a small set of additional cross-linguistically motivated information types (e.g.

animacy and definiteness). Bornkessel-Schlesewsky & Schlesewsky (2009b) proposed the following prominence scales:

(1.12) a. morphological case marking (nominative > accusative / ergative > nominative)
b. argument order (argument 1 > argument 2)
c. animacy (+ animate > - animate)
d. definiteness / specificity (+ definite / specific > -definite/ specific)
e. person (1^{st}/ 2^{nd} person > 3^{rd} person)

All these information types are used to assign the actor and undergoer roles to the arguments even before the verb is encountered in the sentence, via the so-called *compute prominence* step. Finally, on the basis of prominence information, an argument is also assigned agreement properties: the *+/- agrt* feature. Prominence and agreement are interconnected when sufficient information is available for the assignment of the prominence status. When prominence can not be computed because of a lack of information, agreement is assigned via Minimality and independently of prominence.

As is apparent from the figure above, there is a dissociation between processing of arguments and verbs. We talked about the processing of arguments above. In the following, we show how the verb is processed. When a verb is recognised in phase 1, its logical structure (LS), voice and agreement features are extracted in phase 2a. The argument, which has been assigned a +agrt role on the basis of prominence information, needs to match the agreement in the *establish agreement* step, which is the part of *compute prominence*. Establish agreement is a prerequisite for the *compute linking* process in languages with agreement. The role assigned to the arguments on the basis of the prominence information is mapped to the lexical entry of the verb in the *compute linking* step. In this step, the verb's lexical argument representation is associated with arguments that have already been processed. Thus, the roles, which have been assigned to the arguments on the basis of prominence information, are matched with verb's lexical entry. This is accomplished via a decomposed semantic structure (logical structure, LS) based on the verb's *Aktionsart*. The LS representations assumed within the eADM are adopted from Role and Reference Grammar (Van Valin, 2005). The logical structure (LS) for the verb *to hit* is shown below:

(1.13) (do'(x, *hit'*(x,y)))

1.6.1.3 Phase 3

The model is considered to be hierarchical. In phase 1, only word category information is taken into account, while in phase 2 actor and undergoer roles are assigned to the arguments on the basis of prominence scales. Further, *compute linking* takes place between the arguments and the verb on the basis of the verb's LS. The argument interpretation is completed in phase 3, where all the core relations (described in previous phases) and non core relations (e.g. prosody, plausibility, world knowledge and discourse context) are integrated in the *generalised mapping* step. It is assumed that factors like prosody, plausibility, world knowledge and discourse context do not modulate the processing of core relations in phase 2. Thus, the influence of these factors is observed in phase 3 when all these informations are integrated together. Furthermore, the structure's well-formedness is evaluated in phase 3 and, if necessary, a repair process is initiated. The well-formedness step evaluates the acceptability of the sentence structure under different environments, for example, discourse or context.

The separation of the three phases is based on the characteristics of different languages and well supported by the results of various studies (see Bornkessel & Schlesewsky, 2006a).

1.6.1.4 MINIMALITY

Now, let us consider the principle of minimality. The eADM assumes a least-effort principle, called MINIMALITY**,** which applies in all phases of processing:

(1.14) **Principle of Minimality**
In the absence of explicit information to the contrary, the human language comprehension system assigns minimal structures. This entails that only required dependencies and relations are created.
(Bornkessel & Schlesewsky, 2006a:790)

Minimality avoids unnecessary relations. Hence, there is a preference for an intransitive structure over a transitive structure. Minimality is considered to apply at all levels of representation, that is, structural and relational levels. Thus, it governs both the structure building and argument linking steps. In brief, minimality assumes that minimum relations and minimal dependency are created during online language comprehension. This predicts that when an argument is encountered, it will be interpreted as the only argument in the sentence and therefore, no dependency will be created in this case. Extending this proposal further Bornkessel-Schlesewsky & Schlesewsky (2009c) proposed that minimality should be taken as a vacuous distinctness principle, which means that one argument should be distinct from the other for the ease of processing:

(1.15) **Principle of Distinctness**
The participants in an event should be as distinct as possible from one another in terms of all available dimensions of prominence.
(Bornkessel-Schlesewsky & Schlesewsky, 2009b)

Bornkessel-Schlesewsky & Schlesewsky, (2009c) argue that a single minimal event is not always sufficient for determining processing behaviour. In some cases, it could be possible that two separate events or an unmarked ditransitive event are preferred over a marked transitive event. Thus, minimality should be viewed as a sub-case of the distinctness principle rather than a separate principle. Therefore, the simplest way for an argument to be distinct is for it to be the only argument of an event.

The eADM has been extended further in Bornkessel-Schlesewsky & Schlesewsky (2009b,c). Though earlier this model was considered to be serial, it is now assumed to have a cascaded processing architecture. It is cascaded because phase 1 can have an influence on phase 2 but not other way round. The evidence comes from several studies in which an ELAN can block an N400, but an N400 can not block an ELAN. Hence, it is assumed to be cascaded as stage 2 does not affect stage 1. For a detailed discussion, see the above mentioned work (Bornkessel-Schlesewsky & Schlesewsky, 2009a).

In section 1.4, we gave a brief description of ERP components and discussed the cases in which these effects are evoked. In the following, we describe these components in respect to the eADM, i.e which phase of processing engenders which components. The ELAN is observed in phase 1 when there is a problem to establish the phrase structure representation on the basis of word category information. In phase 2, an N400 is assumed to occur when there is a problem in either argument prominence computation or argument linking. The LAN occurs when there is a problem in the *establish agreement* step. An additional linking LAN has also been proposed in the eADM. A linking LAN is considered to be rare as it is only possible when there is neither an agreement mismatch nor a conflict with respect to previous GR assignment. This suggests that when there is no problem with the input in the *compute linking* step but a conflict between the GR hierarchy and the argument hierarchy, this effect is observed. So far, this effect has only been observed in German.

A late positivity effect is associated with generalised mapping and well-formedness. Further, it has been shown that the *generalised mapping* step should evoke a “ semantic P600”, while a late positivity is due to problems in well-formedness (Bornkessel-Schlesewsky & Schlesewsky, 2009b). Additionally, the plausibility information, which is processed independently of the *compute prominence* and *compute linking* steps in phase 2, evokes an N400 if there is a problem concerning the plausibility (see Figure 1.7). As it was mentioned above, the N400 and P600[4] effects have been associated with different phenomena rather than generally interpreting the N400 as a semantic and the P600 as a syntactic effect. The discussion shows that the clear-cut division between syntax and semantic does not hold (for more detail see, Bornkessel & Schlesewsky, 2006a; Bornkessel-Schlesewsky & Schlesewsky 2009a,b).

1.7 Summary

In this chapter, we have briefly introduced the incremental argument interpretation and the role of case, word order, and animacy in argument interpretation. We also gave a brief introduction to the ERP methodology and its components, which will be important to understand the results of this thesis. At the end, we presented a summary of extended Argument Dependency Model (Bornkessel and Schlesewsky, 2006).

[4]In this thesis, for the positivity effects, we generally use the term late positivity. We use the term P600 for a different effect, which is observed in the *generalised mapping* step. Apart from that, we mention P600 effects in reference to the work where people have reported a positivity and have used the term P600.

Chapter 2

Ergativity and Typological Characteristics of Hindi

In this chapter, we give a brief description of how ergative-absolutive languages differ from nominative-accusative languages. We then present the typological characteristics of Hindi, particularly the issues that are relevant for this thesis. Next, we discuss the work that has been done on Hindi from a language comprehension perspective and present a summary of the work that has been done on other ergative languages. Finally, we outline the main research questions of the thesis.

2.1 Ergativity

The languages of the world show different case marking patterns. The two most prominent of these patterns are the nominative-accusative and ergative-absolutive[5] alignment. It is conventional to use S for the sole argument of intransitive verbs, A for the actor argument of transitive verbs and O for the undergoer of transitive verbs. In the nominative-accusative case pattern, the S argument of intransitive verbs and the A argument of transitive verbs are identically case-marked, whereas the O argument of transitive verbs is case-marked differently. In the ergative-absolutive system, the S argument of intransitive verbs and the O argument of transitive verbs are marked identically, whereas it is the A argument of transitive verbs that is marked differently.

(2.1) a. Ergative-absolutive alignment b. Nominative-accusative alignment

a.		b.	
S_i		S_i	
A	O_i	A_i	O

The description in 2.1a and 2.1b shows the pattern of case marking in ergative-absolutive and nominative-accusative languages (see Butt, 2006 for a general discussion). In recent years, it has been proposed that accusative or ergative alignment should be treated as a phenomenon occurring at the construction level, rather than the language level (see Bickel, in press).

[5]In this thesis, we use the term ‘ergative language’ for languages that show an ergative- absolutive case marking pattern and accusative languages which show nominative-accusative case marking pattern.

There are several languages which show split in the pattern of case marking. While some constructions take nominative-accusative pattern the other takes ergative-absolutive pattern. This split has been also known as split ergative system. This means that the case pattern shown above can be restricted by factors like aspect/tense or person. For instance, in Hindi, when the verb is in perfective aspect, the A argument will be assigned the ergative case (2.2a) but when the verb is imperfective, it bears the nominative case (2.2b):

(2.2) a.

mohan-ne	kitaab	paDh-ii	hai
Mohan.m-erg	book.f(Nom)	read-PFV.3sg.f	aux

"Mohan has read a book."

b.

mohan	kitaab	paDh-taa	hai
Mohan.m(Nom)	book.f(Nom)	read-IPFV.3sg.m	aux

"Mohan reads a book."

There are several ergative languages that show a split system based on aspect and tense, while it can also be based on person and animacy (inanimates takes ergative case marking, while animate ones do not (Silverstein, 1976) ; see Dixon, 1994 for more detail).

In brief, we have shown which types of alignment are known as nominative-accusative and ergative-absolutive case patterns. For more details on ergativity, see Dixon (1994).

2.2 Hindi[6]

Hindi is an Indo-Aryan language spoken mainly in northern and central India. According to 2001 census, there are around 420 million Hindi native speakers. Hindi is an SOV language with flexible word order and a split ergative system.

2.2.1 Word order

The basic word order of Hindi is subject-object-verb (SOV). As shown in (2.2a), Hindi is a verb-final language, which means that the verb is positioned at the end of a sentence. Though the canonical word order in Hindi is SOV, the scrambling of constituents within a clause is possible. As

[6] There are several varieties of Hindi spoken. So in this thesis, we are mainly discussing the characteristics of the Hindi variety that is considered to be the standard Hindi used in newspapers. The characteristics of other varieties may differ from this (which we mention in the thesis whenever it is relevant).

shown in this example, all six permutations are possible for a simple transitive sentence. For instance:

(2.3) a. raam-ne mohan-ko dekh-aa. hai
Ram.m-erg Mohan.m-acc see-PFV.3sg.m aux
"Ram saw Mohan."

b. mohan-ko raam-ne dekhaa. hai

c. mohan-ko dekha hai raam-ne.

d. dekhaa hai raam-ne mohan-ko.

e. dekhaa hai mohan-ko raam-ne.

f. raam-ne dekhaa hai mohan-ko.

2.2.2 Case in Hindi

In this section, we discuss the use of nominative, ergative, accusative and dative cases in Hindi. Nominative case is null in Hindi, while ergative, accusative and dative are overtly case-marked by a postposition. Accusative case marking is optional in Hindi for inanimate nouns; that is, they generally do not bear overt case marking. This is explained in more detail in a later section of this chapter.

2.2.2.1 Nominative case

Both S (2.4a) and A (2.4b) arguments can be assigned nominative case in Hindi. When an O argument is inanimate, it can also bear nominative case (*book* in 2.4b). Furthermore, the O argument can be in the nominative case in dative constructions (as shown in 2.4c).

(2.4) a. Raam gir-aa.
Ram.m(nom) fall-pst.3sg.m
"Ram fell down."

b. Raam kitaab padh-taa hai.
Ram.m(nom) book.f(nom) read-IPFV.3sg.m aux
"Ram reads a book."

c. Raam-ko Mohan pasand hai.
Ram.m-dat Mohan.m(nom) like aux
"Ram likes Mohan."

2.2.2.2 Ergative

The ergative case marker is *ne* in Hindi. Ergative case is used for an A argument when the verb is transitive and its aspect is perfective.

(2.5)	a. raam-ne	aam	khaay-aa	hai
	Ram.m-erg	mango.m(nom)	eat-PFV.3sg.m	aux
	"Ram ate a mango."			

This was already shown in the discussion above. However, there are some intransitive verbs that can take an ergative marker in Hindi.

(2.6)	us-ne	khans-aa.
	He-erg	cough-pst.sg.m
	"He coughed."	

As the ergative case can occur in sentences like (2.6), several studies have related ergativity with volitionality (see Mohanan, 1994; Davison, 1999). Similarly, there are some transitive verbs like *laanaa* (to bring), *bolanaa* (to speak) that can optionally assign the ergative (see Mohanan, 1994; Butt, 2006).

2.2.2.3 Accusative

The canonical case for animate objects in Hindi is the accusative and the canonical case for inanimate objects is the nominative (McGregor, 1972). This can be seen from the examples (2.7a) and (2.7b). While in (2.7a), *Mohan* obligatorily takes the accusative case, in (2.7b) *book* has nominative case marking. In (2.7c), *book* takes an accusative marker but here it has a definite/specific meaning.

(2.7)	a. raam	mohan- ko	dekh-taa	hai.
	Ram.m(nom)	Mohan.m-acc	see-IPFV.3sg.m	aux
	"Ram sees Mohan."			
	b. Raam	kitab	padha-taa	hai.
	Ram.m(nom)	book.f(nom)	read-IPFV.3sg.m	aux
	"Ram reads a book."			

c. Raam	kitab-ko	padha-taa	hai.
Ram.m(nom)	book.f-acc	read-IPFV.3sg.m	aux

"Ram reads the book."

in Hindi, some researcher have interpreted the *ko* marking as a dative case marker only (Mahajan 1990; Davison, 1998), while others treated it as both accusative and dative marker (Butt, 1993; Masica, 1991; Mohanan, 1994). In this thesis, we descriptively treat *ko* as an accusative marker for animate objects and as a dative marker in case of recipients/goals (see below). When it occurs with inanimate objects, it is a marker for definite/specific arguments. The theoretical analysis of *ko* is beyond the scope of this thesis, so for the discussion on accusative case in Hindi, see the above mentioned works.

2.2.2.4 Dative case

Dative case occurs on the A/S argument of psych verbs and with recipients/goals in Hindi.

(2.8)

a. raam-ko	gussaa	aay-aa	hai.
Ram.m-dat	anger.m	come-PFV.3sg.m	aux

"Ram got angry."

b. raam-ko	pyaas	lag-ii	hai.
Ram.m-dat	thirst.f	feel-PFV.3sg.f	aux

"Ram is thirsty".

c. raam-ko	aam	pasand	hai.
Ram.m-dat	mango.m	like	aux

"Ram likes the mango".

In the following example, *ko* appears with recipients/goals and is interpreted as dative.

(2.9)

raam	mohan-ko	kitab	de-taa	hai.
Ram.m(nom)	Mohan.m-dat	book.f(nom)	give-IPFV.3sg.m	aux

"Ram gives a book to Mohan."

The S argument can be dative-marked in some other cases, for example:

(2.10)

a. raam-ko	jaa-naa	hai.
Ram.m-dat	go-inf.m	aux

"Ram has to go."

b. raam -ko jaa-naa cahiye.
Ram.m-dat go-inf.m should
" Ram should go".

2.3 Aspect

Hindi has three aspects: imperfective, progressive and perfective. The imperfective marker is *-ta*[7] (taa/tii), which appears with the verb (2.11a). The progressive marker in Hindi is *-rah* (*raha, rahe*), which occurs separately and follows the verb (2.11c). The perfective marker *-ya* (*yaa, yii),* like the habitual marker, is marked directly on the verb (2.11b).

(2.11) a. raam aam khaa-taa hai.
Ram.m(nom) mango.m(nom) eat-IPFV.3sg.m aux
"Ram eats a mango".

b. raam-ne aam khaa-yaa hai.
Ram.m-erg mango(Nom) eat-PFV.m aux
"Ram has eaten a mango".

c. raam aam khaa rahaa hai.
Ram(Nom) mango.m(Nom) eat prog.3sg.m aux
"Ram is eating a mango".

2.4 Tense

Hindi has three tenses: present, past and future. As we show in the following examples, the present tense auxiliary is *hai,* (*haiN, ho*). The past tense auxiliary is *tha* (*thaa, the, thii*) and the one indicating future is *-ga* (*gaa, ge, gii*). While present and past tense markers are independent of the verb and follow it, the future tense marker is part of the verb form.

(2.12) a. Raam kitaab paDh-taa hai.
Ram.m(nom) book.f(nom) read-IPFV.3sg.m aux
"Ram reads a book."

b. raam kitaab PaDh-taa thaa.
Ram.m(nom) book.f(nom) read-IPFV.3sg.m aux.pst
"Ram was reading a book."

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[7] It is to be noted that *-taa* has also other functions and used as gerund and participle marker for example in an expression like *dauD-taa bacaa* "running child". Similar is the case with the perfective marker *aa* and *ii,* which are also used as participle markers. In this thesis, for the habitual marker *taa/tii,* we use the term imperfective aspect and for *aa/ii* the term perfective aspect.

c. raam kitaab paDhe-gaa.
Ram.m(nom) book.f(nom) read-fut.3sg.m
"Ram will read a book."

The auxiliary also differs in terms of agreement: while present tense auxiliary agrees only in number and person with the nominative argument, the past tense auxiliary agrees in gender and number. The auxiliary for future tense agrees in person, number and gender.

2.5 The agreement system in Hindi

The verb in Hindi agrees with highest nominative argument in person, number and gender. In the following, we describe the agreement pattern of Hindi.

2.5.1 Agreement in simple sentences

The main verb in Hindi agrees with the nominative argument (participles and past tense auxiliary agree in gender and number, the present tense auxiliary and subjunctive agree in number and person, and the future auxiliary agrees in person, number and gender). In example (2.13b), the past auxiliary shows masculine agreement as Ram is masculine. In example (2.13a) gender is not reflected by the present tense auxiliary.

(2.13) a. Raam kitaab paDha-taa hai.
Ram.m(nom) book.f(nom) read-IPFV.3sg.m aux.prs
"Ram reads a book."

b. Raam kitaab paDha-taa thaa.
Ram.m(nom) book.f(nom) read-IPFV.3sg.m aux.pst
"Ram read a book".

When there are two nominative arguments, the verb agrees with the highest-ranking nominative (Mohanan, 1994) i.e with S or A nominative arguments and when there is no nominative A argument with nominative O-argument. When an argument is overtly case-marked in Hindi, the verb does not agree with that argument (when the argument has ergative, accusative or dative case marking). Case blocks agreement in Hindi. When one argument is case-marked and another bears the nominative, the verb agrees with the nominative argument (2.14a). When all the arguments are case-marked, the verb shows default agreement, i.e. third person masculine singular (2.14b).

(2.14) a. Mohan-ne kitaab paDh-ii hai.
Mohan.m-erg book.f(nom) read-PFV.3sg.f aux
"Mohan has read a book".

b.	Mohan-ne	sitaa-ko	dekh-aa	hai.
	Mohan.m-erg	Sita.f-acc	see-PFV.3sg.m	aux

“Mohan has seen Sita.”

2.5.2 Long distance agreement in Hindi

Hindi has a system in which the verb can agree with an argument outside the clause, the so-called long distance agreement (LDA). LDA is a phenomenon, in which the verb agrees with an argument that is not its own, but the object of an embedded clause. See the example below:

(2.15)	Raam-ne	[kitaab	paDh-nii]	caah-ii	hai.
	Ram.m-erg	book.f(nom)	read-inf.f	want-PFV.3sg.f	aux

“Ram wanted to read a book.”

In the above example, the control verb agrees with the object of the infinitival clause (*book)* and this phenomenon is known as long distance agreement. However, consider the following example:

(2.16)	Raam-ne	[kitaab	paDh-naa]	caah-aa	hai.
	Ram.m-erg	book(nom).f	read-inf.m	want-PFV.3sg.m	aux

“Ram wanted to read a book.”

The example (2.16) demonstrates that both the infinitive and the control verb (*caah*) show the default agreement pattern. The above example suggests that LDA is optional in Hindi. Apart from that it must be kept in mind that both infinitive and control verb should bear the same agreement. So when the infinitive agrees with *book,* the control verb also needs to agree with this argument. Consider the following example (2.17), where the infinitive is marked as feminine (agrees with *book*) and *caah* is marked as masculine; the sentence is thus ungrammatical:

(2.17)	*Raam-ne	[kitaab	paDh-nii]	caah-aa	hai.
	Ram.m-erg	book.f(nom)	read-inf.f	want-PFV.3sg.m	aux

“Ram wanted to read a book.”

LDA is only possible when the matrix subject is case-marked, i.e. it bears either ergative or dative case, while when it is nominative, LDA is not possible. Let us consider the following example:

(2.18)	*Raam	[kitaab	paDh-nii]	cah-tii	hai.
	Ram.m(nom)	book.f(nom)	read-inf.f	want-PFV.3sg.f	aux

“Ram wants to read a book.”

The above sentence is incorrect because the matrix verb agrees with the object (book). The following sentence (2.19a) is correct because, in this case, the verb agrees with matrix subject (Ram).

(2.19) a.	Raam	[kitaab	paDh-naa]	cah-taa	hai.
	Ram.m(nom)	book.f(nom)	read-inf.m	want-IPFV.3sg.m	aux
	"Ram wants to read a book."				
b.	Raam	[kitaab	paDh-nii]	cah-taa	hai.
	Ram.m(nom)	bookf.(nom)	read-inf.f	want-IPFV.3sg.m	aux
	"Ram wants to read a book."				

For a theoretical description of LDA in different frameworks, see Bhatt (2005), Butt (1995), Chandra (2007) or Mahajan (1990).

Now let us consider the sentences with the nominative case again. As stated above, LDA is only possible when the matrix subject is case-marked (i.e., not nominative). Sentence (2.20a) is correct because both the control verb and the infinitive agree with the matrix subject. But in (2.20b), the infinitive agrees with the object of the embedded clause, while the matrix verb agrees with the matrix subject. Example (2.20b) is considered to be correct in some varieties of Hindi, while it is incorrect in others (see Butt, 1995; Bickel & Yadav, 2000).

(2.20) a.	Raam	[kitaab	paDh-naa]	cah-taa	hai.
	Ram.m(nom)	book.f(nom)	read-inf.f	want-IPFV.3sg.m	aux
	"Ram wants to read a book."				
b.	Raam	[kitaab	paDh-nii]	cah-taa	hai.
	Ram	book.f(nom)	read-inf.f	want-IPFV.3sg.m	aux
	"Ram wants to read a book."				

In Butt's approach, in example (2.20b), the infinitive predicate agrees with its only nominative argument *kitaab* (book) and the matrix verb agrees with its highest nominative argument *raam*.

From the above examples it becomes clear that there are three factors that are important for LDA: (a) case marking of the matrix subject, (b) agreement of the infinitive, and (c) agreement of the matrix verb.

2.6 Hindi as a pro-drop language

Like many languages of the world, Hindi allows pro-drop. Both the A or S-argument and the O-argument can be dropped. Example (2.21a) shows a sentence with a dropped A-argument, while in (2.21b) the O-argument is omitted.

(2.21) a. *pro* kitaab padh-ii hai.
book.f(nom) read-PFV.3sg.f aux
"(He/She...) has read the book."

b. us-ne *pro* padh-ii hai.
he-erg read-PFV.3sg.f aux
"He has read (something)."

Both A-argument and O-argument drop are quite common in informal conversation in Hindi. In the above examples, whether the dropped argument is ergative or not, can be derived from the agreement system of Hindi. In (2.21a), the verb agrees with *book,* it thus indicates that the dropped argument must be ergative, while in (2.21b), the object can be anything that is readable (a book, novel, newspaper...) but the agreement pattern indicates that it is a feminine object.

Please note that the aim of this section has been to introduce the reader to the basic facts of Hindi. Hence, we have not adopted any theoretical framework for the analysis of how these phenomena could be treated. We will mention the work related to Hindi in the following chapters wherever it is relevant.

2.7 Hindi from the perspective of language comprehension

Hindi has been extensively explored from a theoretical perspective, but from the perspective of language comprehension, there has been very limited study on Hindi. One of the earliest works is by Vaid, Jyotsna & Pandit Rama (1991) who explored the role of cues like animacy, word order and agreement in Hindi and English, both with healthy participants and aphasic patients. Other works on Hindi are Vasishth (2003) and Nevins et. al (2007). While the work of Vasishth is based on self-paced reading, the work of Nevins et al. is the only study based on ERP data. We now briefly present a summary of the work of Vasishth (2003) and Nevins et al. (2007).

Vasishth (2003) conducted seven experiments on Hindi with centre-embedded sentences (CES) and, in conclusion, proposed a new model of sentence processing called the Abductive Inference Model

(AIM). The basic idea of the work was to test three existing models of sentence processing, namely the Early Immediate Constituency (Hawkins, 1994), the Dependency Locality Theory (Gibson, 1998; Gibson, 2000) and the Retrieval Interference Theory (Lewis, 1998). We will summarise the result of all the experiments briefly.

The first three experiments mainly explored the effect of identical case marking. In the first two experiments, the author explored the effect of case marking in centre-embedding constructions with one level of embedding (2.22a) or two levels of embedding (2.22c):

(2.22) a. Siitaa-ne hari-ko [kitaab khariid-neko] kahaa.
Sita-erg Hari-dat book buy-inf told
"Sita told Hari to buy a book."

b. Siitaa-ne hari-ko [kitaab-ko khariid-neko] kahaa
Sita-erg Hari-dat book-acc buy-inf told
"Sita told Hari to buy the book.

c. Siitaa-ne hari-ko [ravi-ko [kitaab khariid-neko] bolne-ko kahaa.
Sita-erg Hari-dat Ravi-dat book buy-inf tell-inf told
"Sita told Hari to tell Ravi to buy a book."

d. Siitaa-ne hari-ko [ravi-ko [kitaab-ko khariid-neko] bolne-ko kahaa.
Sita-erg Hari-dat Ravi-dat book-acc buy-inf tell-inf told
"Sita told Hari to tell Ravi to buy the book."

The results showed that the double nested centre-embedding constructions are more difficult to process than the single nested CESs, and that *ko*-marked objects were more difficult to process than non *ko*-marked arguments. The reaction time was longer in these cases.

Further experiments tested direct and indirect object fronting in Hindi in similar sentences. It was observed that both direct object and indirect object fronting showed similar results. When the direct or indirect object is fronted, the reading time for the verb *kharid-ne-ko* was longer.

In the last experiment, an adverb intervenes before the embedded verb as exemplified in the sentence below:

(2.23) siitaa-ne hari-ko [ravi-ko [kitaab-(ko) jitni jaldii ho sake khariid-neko]
Sita-erg Hari-dat Ravi-dat book-acc as-soon-as possible buy-inf

bolne-ko kahaa.
tell-inf told
"Sita told Hari to tell Ravi to buy a book a soon as possible."

In this case, a decrease in the reading time was noted for the verb *kharidne-ko* which was not predicted by any of the models. Finally, the author proposes his model of sentence comprehension so called the Abductive Inference Model (AIM). We do not present the details of this theory because the focus of the present work is completely different (for details, see Vasishth, 2003).

There are two major differences between the above mentioned work and the goal of this thesis. While Vasishth's work focused on centre-embedding constructions, in the present study, we investigated how simple transitive sentences are processed in Hindi and what role features like case, word order and animacy play in this regard. Another issue concerns the methodological level: while the data from Vasishth is based on self-paced reading time, in this thesis, the data is based on ERP studies.

Nevins et al. (2007) investigated whether responses to syntactic agreement violations vary as a function of the type and number of incorrect agreement features in Hindi. To test this hypothesis, they used sentences in future tense. This is, because, in Hindi, only in this tense are all the agreement features (i.e. gender, person, number) marked on the verb. Hence, they compared ungrammatical conditions that mismatched the correct conditions in respect to different dimensions (gender, number, gender/number and person/gender).

The authors observed a P600 effect for all types of violations. The double violations did not show different effects than the single violations, i.e. the responses to gender/number violations did not differ from those to individual gender and number violations. The combined person/gender violations showed a stronger P600 response than all the other violations. The authors argue that the larger positivity is due to the special status of person and not due to the fact there is a double violation in this case. There was no negative effect (neither LAN nor N400) observed in this experiment. Visual inspection of their data shows some negative effects for the violations but the authors report that it did not reach significance in the statistical analyses. Thus, no previous studies on Hindi have examined the implication of ergativity for processing.

2.8 Ergative language from language comprehension perspective

One study that was concerned with an ergative language from the processing perspective is a work on Basque (Zawiszewski, 2007). The research focus of this study was different from the present work as the author wanted to investigate differences in the processing of certain aspects of Basque between native and non-native speakers. For this purpose, he tested phrase structure violations, case violations and object agreement violations. In the following section, we briefly show the results that were observed for ergative case violations. For more details, see Zawiszewski (2007). The sentences that were used are presented below:

(2.24) a. Goizean ogia erosi dut nik dendan.
This morning bread bought have I-erg in the shop
"This morning we brought the bread in the shop."

b. Goizean ogia erosi dut **ni* dendan.
This morning bread bought have *I-Abs in the shop
"This morning we brought the bread in the shop."

As the above examples show, in (2.24b) the absolutive case (*ni*) instead of the required ergative. Thus, there was an ergative case violations in this case. The results revealed a biphasic N400-P600 effect for the ergative violations in the case of native speakers, while non-native speakers only showed an N400 without a P600. The author also tested phrase structure violations, semantic violations and agreement violations between direct object and verb. For direct object agreement violations, he reported a right posterior negativity (N400)-P600 pattern. He argued that since the LAN-P600 effect has been observed for subject-verb agreement violation in earlier studies, the direct object agreement violations should be considered to be different from subject-verb agreement violations. The following sentences were used for the object agreement violations:

(2.25) a. Zuk ni hondartzara eramaten nauzu batzuetan.
'YouSG me to the beach takePROG me-have-youSG sometimes'
Sometimes you take me to the beach

b. Zuk ni hondartzara eramaten *duzu batzuetan.
'YouSG me to the beach takePROG *it-have-youSG sometimes'
Sometimes you *take me to the beach

In brief, Zawiszewski (2007) showed that agreement and case violation (ergative) are processed differently in native and non-native speakers. However, it was observed that semantic and phrase structure violations were treated similarly by both native and non-native speakers.

It is interesting that ergative case violations in Basque show an N400 rather than a LAN and are therefore rather comparable to double case violations in German (Frisch & Schlesewsky, 2005) than to subcategorised case violations (Friederici & Frisch, 2000). Since Basque is a relatively consistent ergative language, this might be expected, as a violation of ergativity is a violation of general properties of the case marking system. However, in a language with an aspect-based split such as Hindi, the question arises whether a violation of ergativity might be closer related the verb-based violations in German.

2.9 Research questions

As discussed in the previous chapter, case, word order and animacy play an important role in argument interpretation, but most of the languages investigated so far are nominative-accusative languages. Thus, the basic goal of this thesis was to find out whether the findings from the nominative-accusative languages can be generalised to a split ergative language like Hindi. To test this, we conducted four ERP experiments and two questionnaire studies.

2.9.1 Experiment 1

In Experiment 1, we tested the role of nominative, ergative and accusative case in Hindi. In this experiment, there were three critical positions: NP1, NP2 and aspect/verb. Verb-final transitive sentences were used in this experiment. At NP1, the arguments were either nominative or ergative case-marked.

The first question of this experiment concerned dependency formation. Recall from the previous chapter that Wolff et al. (2008) reported a positivity for initial accusative arguments in Japanese and argued that this result is observed due to dependency formation, as the existence of a further argument is predicted. If dependency formation works universally, we should also observe a positivity for ergative arguments at NP1 in comparison to nominative arguments. In Hindi, ergative-marked argument clearly state that one more argument is present in the event. Though different from Japanese, in Hindi, an undergoer is expected as the ergative-marked argument is an actor.

The next question in this experiment was related to case violation. Again, recall from the previous chapter that case violations have revealed different results. Frisch & Schlesewsky (2005) reported an N400-late positivity pattern for double case violations in German and Friederici & Frisch (2000) found a LAN-late positivity for the violation of the object's case (i.e. accusative vs.. dative, which is verb-dependent in German) in German.

In Experiment 1, violations of nominative, accusative and ergative case will be tested. The accusative case violation will be investigated at NP2. In this experiment, only human common nouns were used; so when they were not marked with accusative case, the sentences were ungrammatical. We compare nominative and accusative arguments at NP2. The violation of nominative and ergative case is tested at the position of the aspect marker/verb. In Hindi, the ergative case occurs with A arguments when the verb is perfective, while in all other cases, it is assigned nominative case marking (see section 2.1). Thus, we there was a mismatch of aspect and case (imperfective with ergative and perfective with nominative; this was compared with control conditions). We propose that if a case violation in Hindi is simply a formal mismatch, we should observe a LAN. If it is reflecting a mismatch between the previously computed argument prominence information and the current input, it should reveal an N400 (Bornkessel & Schlesewsky, 2006a). Furthermore, we also expect a late positivity for all the case violations because of problems with respect to the well-formedness of the sentence (Bornkessel & Schlesewsky, 2006a).

2.9.2 Experiment 2

Experiment 2 will explore the role of word order variations in Hindi in argument interpretation. Several experiments have indicated the importance of word order variations in many languages, but almost all of theses studies have been based on nominative-accusative languages. We will examine this issue in Hindi to see whether findings from nominative-accusative languages can be generalised to a split ergative language like Hindi. Following up from Experiment 1, we will test dependency formation in this experiment, too. Here, the O- argument (accusative-marked) was permuted in front of the subject both across nominative and ergative argument. Thus, at NP1, we compare nominative, ergative and accusative marked arguments.

We assume that both ergative and accusative-marked argument should show a positivity at NP1 for dependency formation. Recall from the previous section that Wolff et al.(2008) observed a positivity at NP1 in Japanese when NP1 accusative for dependency formation. In the present experiment, the accusative argument was ambiguous between accusative and dative, but we show that it should not make any difference from the perspective of dependency formation and that we should observe a positivity both for ergative and accusative arguments at NP1.
Since the permuted accusative argument was ambiguous between dative and accusative and pro-drop is possible in Hindi, we did not expect to observe a scrambling negativity in this case.

Apart from that, we also predict an N400 effect at NP2 for an accusative-marked argument preceded by a nominative argument (NP1(nom)-NP2(acc)-verb)), as several studies have reported an N400 effect for canonical sentences due to the reanalysis of an intransitive event to a transitive event (Bornkessel et al 2004, Wolf et al 2008).

2.9.3 Experiment 3

Experiment 3, will test the role of animacy in argument interpretation in Hindi. We will explore the role of animacy and its interaction with both ergative and accusative case. Recall from the previous chapter that, in German, when an initial accusative argument (undergoer) is processed, a prediction is made for an animate nominative argument (actor). When this criterion is not fulfilled and an inanimate nominative argument is encountered instead, an N400 effect is observed (Roehm et al., 2004). A similar result has been observed for Chinese (Philipp et al., 2008). In Experiment 3, there are two critical positions: NP1 and NP2. At NP1, there is a comparison of inanimate and animate ergative arguments, while at NP2, animate and inanimate nominative arguments are compared to animate and inanimate accusatives. However, the difference between Hindi and other languages like German or Chinese is that, in these languages, the data were interpreted via semantic dependency relations between undergoers and actors, rather than via a formal dependency between accusative and nominative cases. Hence, the present experiment can be seen as a contrast to these earlier studies.

Recall from Chapter 1 (section 1.5.3) that undergoers are defined in opposition to the actor role. That is, undergoers are dependent on actors but not vice versa (Primus, 1999). Bornkessel-Schlesewsky & Schlesewsky (2009b) proposed that the comprehension system could not predict a prototypical undergoer in the same way as it can predict a prototypical actor. We wanted to test in Hindi if an undergoer can be predicted from the actor in the same way as an actor can be predicted from the undergoer. For this experiment, we propose that an inanimate argument at NP1 should engender an N400 effect. Since inanimate arguments are not prototypical actors, there should problem in the *compute prominence* step (Bornkessel & Schlesewsky, 2006a). At NP2, the comparison of animate nominative arguments to inanimates ones should engender an N400 effect. Further, we also propose that an interaction of animacy and case should revealed an N400 at the position of NP2 when inanimate O-argument is marked with accusative case. An N400 is predicted in this case because of a prominence mismatch between the animacy and definiteness/specificity dimensions.

2.9.4 Experiment 4

Experiment 4 will investigate the processing of long distance agreement in Hindi. The agreement of subject and verb has been well studied from a processing perspective within simple sentences. Recall from the discussion on Hindi that long distance agreement (LDA) is possible. The main question of this experiment will be to test whether an agreement mismatch in the case of LDA would show ERP results that are similar to those observed in other languages. Earlier studies have either shown a LAN-P600 pattern or only a P600 effect for an agreement mismatch. Thus, we assume that if LDA is treated in same way, then we should observe similar results. Apart from that, as it was shown above, LDA depends on the case marking of the matrix subject. Therefore, in this experiment, LDA is only possible when the matrix subject is marked with the ergative case. When the matrix subject is nominative-marked, there is no LDA. So we will further test whether result vary in these two cases, depending on the case marking of matrix subject.

In brief, the basic goal of this thesis is to see how nominative-accusative languages and ergative-absolutive languages vary from a processing perspective. Is the ergative case processed differently? Is the role of case, word order and animacy in argument interpretation in a split ergative language like Hindi the same as observed in earlier studies? Can the findings from other languages (nominative-accusative) be generalised to ergative languages or not?

2.10 Summary

In this chapter, we briefly discussed how ergative-absolutive and nominative-accusative case patterns differ with respect to one another. We provided a short introduction to the characteristics of Hindi that are important for the focus of the present thesis. We discussed the scarcity of studies on Hindi (or other ergative languages) that focus on language comprehension. Finally, we presented the research questions of this thesis.

II Empirical Issues

Chapter 3

Experiment 1 The Role of Case in Argument Interpretation in Hindi

3.1 Introduction

As discussed in Chapter 2, the languages of the world vary in respect to their case marking and they can be categorised as nominative-accusative and ergative-absolutive languages, respectively. Hindi falls under the latter category. It has been well established in the psycholinguistic literature that case plays an important role for the interpretation of arguments in language comprehension (see Chapter 1, 1.5.1). Bornkessel & Schlesewsky (2006), reviewed in detail in section 1.6.1, suggested that prominence assignments are based on morphosyntactic information like morphological case and argument position, and that dependency relations are created between the arguments in the absence of the verb. There are several other studies that also speak for the role of case in argument interpretation. As discussed in section 1.5.1, Frisch & Schlesewsky (2001) showed that morphological case information is used to establish thematic relations during language comprehension.

It has been shown in German that the processing of an initial accusative-marked argument leads to the prediction of a subsequent animate nominative argument, since an animate argument has the properties of an ideal actor. When this criteria is not fulfilled and an inanimate actor is encountered instead of an animate one, an N400 effect is found (Roehm et el. 2004). Similar results have been reported for Chinese (Phillip et al., 2008) and Tamil (Muralikrishnan et al., 2008).

Wolff et al. (2008) reported that when an initial accusative argument is perceived in Japanese, it evokes a late positivity effect. As an actor is expected, this late positivity was suggested to be due to the establishment of dependency relations. Zawiszewski (2007) observed an N400-late positivity pattern for ergative case violations in Basque, an ergative language (see Chapter 2 for detail).

As briefly discussed in Chapter 2, in the first experiment, we wanted to test the role of case in argument interpretation in Hindi. How is the ergative case processed? What role do ergative, nominative and accusative cases play in argument interpretation in Hindi? Can we expect similar results for the different types of case violation? We will discuss these questions in detail in the next section.

3.2 The present study

As discussed in Chapter 2, Hindi is a language with a split-ergative system, whereby the actor in the sentence is marked with the ergative when the verb is in the perfective aspect and with the nominative in all other cases**.** Since the case marking, nominative or ergative, depends on the aspect of the verb, it does not become clear until the verb (aspect marker) is processed whether the actor should bear nominative or ergative case. There are basically three differences between a nominative case-marked argument and one marked with the ergative case in Hindi.

Firstly, an argument marked with the nominative case is ambiguous, as it could be the S argument of an intransitive event or the A argument of a transitive relation. The ergative case, on the other hand, is unambiguous as it suggests a transitive reading of the sentence being processed, and an undergoer will be expected after seeing/hearing an ergative-marked NP[8]. Although object drop is possible in Hindi, a second participant is expected in a transitive event even if the object is dropped. Hence, an ergative-marked argument always leads to a transitive event. Secondly, nominative/absolutive case marking is null in Hindi, while the ergative case is overtly marked. Thirdly, the verb agrees only with nominative arguments in Hindi, but never with ergative arguments.

Another issue to consider here is the differential object marking in Hindi. The accusative case marker *ko* is obligatory only with animate nouns, while inanimate nouns are generally not marked with accusative case. However, an inanimate noun can be accusative-marked when it is specific/definite (see Chapter 2). In this experiment, all the arguments that we used were animate and human, which obligatorily required accusative marking for objects. Not marking animate nouns bearing the object relation with accusative case leads to an accusative case violation.

The present study aimed to investigate three questions: the first question concerns the formation of dependency relations. It has been shown that in nominative-accusative languages, an accusative-initial sentence indicates that it is a transitive event and thus, an actor is expected to follow, as it has been shown for German and Japanese. But as the discussion on Hindi illustrates, this language

[8] It should be noted that there are some intransitive verbs in Hindi like *bark, sneeze*, *cough*, *bathe* that can optionally take ergative case marking, but we are not taking such verbs into account here, since they are very few in number.

behaves differently from languages like German or Japanese, because Hindi has a different case system, that is, it is a split ergative language. In spite of this, Hindi is, in some sense, comparable to German and other nominative-accusative languages. An accusative argument in German suggests that it is an undergoer and gives the sentence a transitive reading. Hence, when an initial accusative argument is observed in German, an actor is expected in the event. Similarly, an ergative-marked argument in Hindi suggests a transitive reading. However, unlike an accusative-marked argument in German, an ergative-marked argument in Hindi is an actor and so, an undergoer is expected to follow. Thus, while Hindi shows a different case system and therefore enables us to study the processing of the ergative case, it is nevertheless comparable to a certain extent to languages like German.

So the question of interest here is whether we can find any effect at NP1 for the ergative argument in Hindi in comparison to a nominative one. As it is clear from the discussion above that an ergative marked argument indicates a transitive reading in Hindi, we expect that there will be a dependency formation because a second argument is expected in the event. So at NP1, we expect to see a positivity for an ergative-marked argument in comparison to a nominative-marked argument. Naturally, the question is whether an ergative-marked argument shows a similar kind of dependency formation as an accusative-marked argument in other languages or if it is different.

The second question addressed in this experiment is about the violation of accusative case marking, whereby we wanted to test whether such a case violation caused any processing costs at NP2. As discussed above, it has been shown for German that double nominative and accusative violations lead to a biphasic N400-P600 pattern. Can we observe a similar result for accusative case violations in Hindi? In this case, the hypothesis is that we should observe a N400-late positivity pattern. This is so, because human nouns in general cannot be assigned an undergoer role without an accusative case marker. Thus, recall from Chapter 1 that according to the eADM, there will be a problem in the *compute prominence* step (Bornkessel & Schlesewsky, 2006a), and such problem should engender an N400 effect. In addition, a late positivity effect is expected due to the problem in well-formedness check.

The third issue that we wanted to address in this study is the mismatch of case marking at NP1 and the aspect of the verb. As shown above, the case marking of NP1 is dependent on the verbal aspect (perfective aspect requires ergative case marking, while imperfective aspect requires nominative case marking for the subject). For the mismatch of aspect and case of NP1 we propose three hypotheses:

Bornkessel & Schlesewsky (2006) proposed that when the case marking pattern of the argument is not compatible with the aspect of the verb in Hindi, it should engender a linking LAN. This is because this language is verb-final and aspect is only disambiguated at the end of the clause. Apart from that, Hindi shows gender agreement between the unmarked (nominative/ absolutive) argument and the verb. So when one observes a clause containing an ergative argument and it is disambiguated towards imperfective aspect in a clause-final position, there is a conflict between GR hierarchy and argument hierarchy specified by the aspect.

Friederici & Frisch (2000) reported a LAN-P600 pattern for the incorrect case marking of an argument (direct vs. indirect object) in German. Friederici & Frisch (2000) show that, in an experiment where the arguments precede the verb, incorrect object case marking (direct vs.. indirect object) produce a LAN-P600 pattern, while semantic violations and number of argument violations evoke an N400-P600 pattern. They interpret the LAN as reflecting the morphosyntactic violation. Similarly, for the mismatch of aspect and case in the present study, one might expect a LAN because, like certain verbs call for certain object cases in German, the perfective aspect calls for ergative case marking in Hindi.

The third option is that the case violations in Hindi should show an N400-late positivity pattern. Frisch & Schlesewsky (2005) reported that double nominative in German shows an N400-late positivity pattern. Bornkessel & Schlesewsky (2006) state that the N400 observed here (that is, in Frisch & Schlesewsky, 2005) is due to the mismatch between previously computed prominence information and the current information. They argue that "N400 mirrors the degree of interpretive conflict arising in the Compute Prominence" (Bornkessel & Schlesewsky, 2006:796).

Thus, for the verbal aspect, there are three options: we can expect to see a linking LAN, as stated above, a LAN if it is interpreted as morphosyntactic violation or an N400 if the problem arises due to a prominence mismatch. Furthermore, we expect to find a late positivity for a well-formedness problem.

Conditions	Sentences
***INN**	Shikshak maalii dekh-taa hai teacher.m(nom) gardener.m(nom) see-IPFV.3sg.m aux "The teacher sees the gardener."
IKN	Shikshak maalii-ko dekh-taa hai teacher.m(nom) gardener.m-acc see-IPFV.3sg.m aux "The teacher sees the gardener."
***INE**	Shikshak-ne maalii dekh-taa hai teacher.m-erg gardener.m(nom) see-IPFV.3sg.m aux "The teacher sees the gardener."
***IKE**	Shikshak-ne maalii-ko dekh-taa hai teacher.m-erg gardener.m-acc see-IPFV.3sg.m aux "The teacher sees the gardener."
***PNN**	Shikshak maalii dekh-aa hai teacher.m(nom) gardener.m(nom) see-PFV.3sg.m aux “The teacher has seen the gardener."
***PKN**	Shikshak maalii-ko dekh-aa hai teacher.m(nom) gardener.m-Acc see-PFV.3sg.m aux “The teacher has seen the gardener."
***PNE**	Shikshak-ne maalii dekh-aa hai teacher.m-erg gardener.m(nom) see-PFV.3sg.m aux "The teacher has seen the gardener."
PKE	Shikshak-ne maalii-ko dekh-aa hai teacher.m-erg gardener.m-acc see-PFV.3sg.m aux "The teacher has seen the gardener.”

Table 3.1. Example sentences for each of the critical conditions in Experiment 1 (Abbreviations: I-imperfective, P-perfective, E-ergative, N-nominative, K-accusative).

3.3 Materials and methods

3.3.1 Participants

Twenty four native speakers of Hindi participated in the experiment (seven women; mean age 26 years, range 19-38). All were right-handed as assessed by an adapted Hindi version of the Edinburgh handedness inventory (Oldfield, 1971). At the time of their participation in the experiment, all participants were residing in Berlin, Germany. All participants had learned Hindi before the age of six, but most also spoke one or more other Indian languages.[9] Six additional participants were excluded from final data analysis because of excessive EEG artefacts.

[9] Note that truly “monolingual” native speakers are very rare even in India because of the high degree of language plurality in this country.

3.3.2 Materials

Eighty sets of the eight sentence conditions shown in Table 3.1 were constructed. The arguments were human common nouns. The two arguments were always of the same gender (masculine in 40 sets and feminine in 40 sets) in order to ensure that gender agreement could not be used as an additional cue to interpretation. The 640 resulting sentences were subdivided into two lists, each containing 40 sentences per critical condition. Each list was combined with 80 additional filler sentences, which were of a similar form to the critical conditions but included a non-human second NP in order to render the absence of *ko*-marking acceptable. List presentation was counterbalanced across participants.

The sentences were spoken by a female native speaker of Hindi and recorded digitally with a sampling rate of 44.1 kHz and a 16 bit resolution. Sentences were checked for naturalness by a native speaker of Hindi and re-recorded when necessary. They were recorded as natural speech and not manipulated in any way. The intensity of the sentences was normalised in order to ensure that all sentences would be perceived as approximately equal in loudness.

3.3.3 Acoustic analyses

For the acoustic analyses of the auditory stimuli, the following parameters were extracted for NP1, NP2, verb and auxiliary in each critical sentence: duration, intensity and fundamental frequency (F_0) for constituent onset and offset, and the F_0-maximum and minimum. Mean values for intensity and duration are given in Table 3.2 and pitch contours are visualised in Figure 3.1.

Condition	Mean intensity (dB)				Mean duration, constituent (ms)				Mean duration, pauses (ms)		
	NP1	NP2	Verb	Aux	NP1	NP2	Verb	AUX	NP1-NP2	Np2-Verb	Verb-Aux
INN	64.88(3.31)	64.88(3.70)	58.94(2.51)	58.35(2.09)	518(118)	387(91)	546(52)	186(25)	40(47)	31(38)	11(13)
IKN	64.51(3.49)	64.41(3.60)	59.19(2.41)	57.68(2.23)	516(107)	553(83)	564(60)	179(20)	35(46)	20(20)	11(9)
INE	63.51(3.51)	63.74(3.90)	57.54(2.34)	56.41(1.86)	678(102)	385(105)	544(54)	182(21)	34(44)	30(49)	12(11)
IKE	64.06(3.48)	63.56(3.78)	58.01(2.56)	56.05(2.11)	677(107)	550(83)	550(87)	178(23)	29(32)	30(65)	11(7)
PNN	63.84(4.90)	65.00(3.73)	63.00(2.72)	57.39(2.29)	511(131)	399(109)	483(79)	195(23)	47(69)	35(59)	10(12)
PKN	64.26(3.63)	64.36(3.73)	63.10(2.42)	57.53(1.89)	508(116)	555(93)	490(71)	189(25)	42(52)	27(23)	15(15)
PNE	63.43(3.36)	63.61(3.69)	61.99(2.68)	56.63(2.11)	666(91)	390(89)	473(76)	182(29)	33(39)	29(28)	21(32)
PKE	63.78(3.44)	62.89(3.85)	61.24(2.57)	55.95(1.92)	669(96)	556(82)	494(84)	187(26)	32(35)	23(21)	15(12)

Table 3.2. The mean intensities and duration for the each constituent for all the sentences, standard deviations are given in parenthesis.

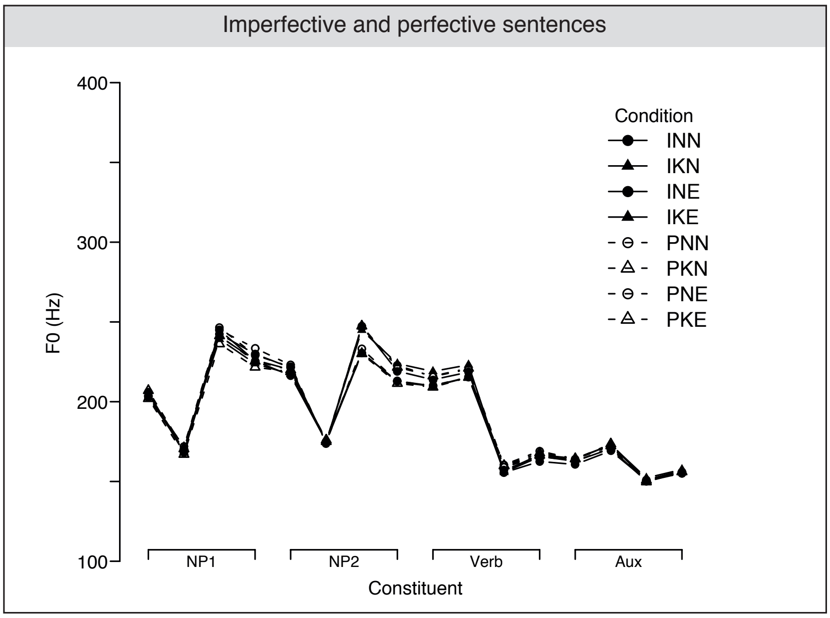

Figure 3.1 Pitch plot for all critical sentences.

3.3.3.1 Intensity

Statistical analysis for the mean intensity values revealed a significant main effect of the critical factor CASE for NP1: $F(1,79)=34.35$, $p<0.001$; NP2: $F(1,79)=82.72$, $p<0.001$ and Aux: $F(1,79)=56.16$, $p<0.001$, while for the verb it revealed a main effect of ASPECT: $F(1,79)=465.35$, $p<0.001$; CASE-NP1: $F(1,79)=60.18$, $p<0.001$ and also the interaction of CASE-NP1 x ASPECT: $F(1,79)=5.36$, $p<0.02$.

Resolving the interaction for the verb by ASPECT revealed a main effect of CASE-NP1 for both the imperfective: $F(1,79)=24.68$, $p<0.001$ and perfective aspect: $F(1,79)=53.53$, $p<0.001$.

3.3.3.2 Duration of constituent

For the duration of the constitutes, statistical analysis revealed a main effect of CASE for NP1 ($F(1,79)=458.28$, $p<0.001$). There was no significant effect observed for NP2. For the verb, a significant effect of ASPECT ($F(1,79)=111.72$, $p<0.001$), as well as an interaction of ASPECT x CASE-NP1 ($F(1,79)=3.66$, $p<0.05$) were observed. For the auxiliary, there was a main effect of ASPECT ($F(1,79)=9.76$, $p<0.002$).

Resolving the interaction for the verb by ASPECT did not show any significant effect for neither imperfective nor perfective aspect.

A repeated measures ANOVA for the duration of the three pauses[10] revealed a main effect of CASE for Pause 1(NP1-NP2) ($F(1,79)=3.91$, $p<0.05$), while Pause 2 (NP2-Verb) revealed an interaction of CASE x ASPECT ($F(1,79)=3.15$, $p<0.07$) and for Pause 3 (Verb-Aux), a main effect of aspect ($F(1,79)=7.24$, $p<0.008$) was found.

Further resolving the interaction of CASE x ASPECT for Pause 2 (NP2-Verb) revealed no significant effect for neither imperfective nor perfective aspects.

3.3.3.3 Fundamental Frequency (FO)

The analysis of the F_0 contours did not reveal any effects that exceeded the threshold for perception (Rietveld & Gussenhoven, 1985; t'Hart, Collier, & Cohen, 1990). Therefore we do not report the statistics for F_O contours.

[10]It is important in an auditory experiment to know whether the duration of the pause between the constituents in the stimuli was consistent for each condition. If there were significant differences in the duration of the pause, this could explain delays in some of the following effects.

In summary, the acoustic analysis did not show any crucial differences for the critical conditions that could affect the final ERP results.

3.3.4 Procedure

The sentences were presented auditory via loudspeakers. Each trial began with the presentation of a fixation asterisk for a duration of 500 ms before the onset of the sound file. After sentence offset, the asterisk remained on the screen for a further 1000 ms. Following a subsequent 500 ms of blank screen, participants completed two behavioural tasks. Firstly, they judged whether the sentence that they had just heard was an acceptable sentence of Hindi or not. As a cue for the judgement task, three question marks appeared in the centre of the computer screen. After a participant's response or after the maximal response time of 2500 ms had expired, a probe word appeared in the centre of the screen. Participants were then required to judge whether this word had occurred in the previous sentence or not. The probe detection task required the answers 'yes' and 'no' equally often, with 'no' responses required in the case of an exchanged content word. The maximal response time for the probe detection task was also 2500 ms. After both tasks had been completed, there was a 2000 ms pause before the beginning of the next trial. The experimental session was subdivided into ten blocks of 40 sentences each and lasted approximately three hours including electrode preparation.

3.3.5 EEG Recordings

The EEG was recorded by means of 25 AgAgCl-electrodes fixed at the scalp by means of an elastic cap (Electro Cap International). AFZ served as the ground electrode. Recordings were referenced to left mastoid but re-referenced to linked mastoids offline. Impedances were kept below 5kΩ. The electro-oculogram (EOG) was monitored to exclude eye movement artefacts. All EEG and EOG channels were amplified using a Twente Medical Systems DC amplifier and recorded with a digitization rate of 250 Hz. In order to eliminate slow signal drifts, a 0.3-20 Hz band-pass filter was applied to the raw EEG data.

3.3.6 Data Analysis

For the behavioural data, a repeated measures ANOVA (for participant (F_1) and item(F_2)) was performed for the factors CASE-NP1(nominative vs. ergative), CASE-NP2 (nominative vs. accusative) and ASPECT (imperfective vs. perfective).

Average ERPs were calculated per condition per participant from the onset of the critical positions NP1, NP2, and aspect marker to 1000 ms post onset, before grand-averages were computed over all participants. Trials, for which the probe detection task was not performed correctly, were excluded from the averaging procedure, as were trials containing ocular, amplifier-saturation or other artefacts. Repeated measures ANOVAs were performed with the factor CASE (nominative vs. ergative) for NP1. For NP2, critical factors were CASE-NP1(nominative vs. ergative) and CASE-NP2 (nominative vs. accusative), while for aspect the factors were ASPECT (imperfective vs. perfective) and CASE-NP1 (nominative vs. ergative).

The regions of interest (ROI) were as follows: Lateral ROIs were *left anterior* (F7/F3/FC5/ FC1), *left posterior* (P7/P3/CP5/CP1), *right anterior* (F8/F4/FC6/FC2), and *right posterior* (P8/P4/CP6/CP2). For the midline electrodes the ROI comprised the six levels: FZ, FCZ, CZ, CPZ, PZ and POZ. The statistical analyses were carried out separately for the midline and the lateral electrode sites.

3.4 Results

3.4.1 Behavioural data

Table 3.3 shows the mean acceptability rates and the reaction times for the acceptability judgement task, and accuracy rates and reaction times for the probe detection task for all the critical conditions.

Condition	Acceptability Judgement		Probe Detection	
	Correct (%)	Reaction time (ms)	Correct(%)	Reaction time (ms)
*INN	76(14)	522(158)	96(5)	836(128)
IKN	94(5)	480(104)	96(4)	822(118)
*INE	94(7)	458(161)	95(4)	851(116)
*IKE	92(11)	469(170)	95(4)	843(129)
*PNN	92(7)	468(148)	95(4)	852(141)
*PKN	68(25)	545(177)	95(5)	863(131)
*PNE	74(13)	527(170)	95(5)	824(132)
PKE	93(5)	471(128)	96(4)	814(111)

Table 3.3. The mean percentage rates for the behavioural tasks. Standard deviations are given in parenthesis. (Abbreviations: I-imperfective, P-perfective, E-ergative, N-nominative, K- accusative).

A repeated measures ANOVAs for the acceptability judgement task revealed a significant main effect of ASPECT ($F_1(1,23)= 20.89$, $p<0.0001$; $F_2(1,79)=55.99$, $p<0.001$) and CASE-NP1 ($F_1(1,23)= 9.91$, $p<0.0002$; $F_2(1,79)=36.02$, $p<0.001$). The following interactions were observed: CASE-NP2 x ASPECT ($F_1(1,23)=4.35$, $p<0.0009$; $F_2(1,79)=25.62$, $p<0.001$), CASE-NP1 x ASPECT ($F_1(1,23)=3.35$, $p<0.08$; $F_2(1,79)=11.62$,$p<0.001$), CASE-NP1 x CASE-NP2 ($F_1(1,23)=$

17.31, p<0.0004; $F_2(1,79)=32.52$, p<0.001) and ASPECT x CASE-NP1 x CASE-NP2 ($F_1(1,23)=$ 48.62, p<0.001; $F_2(1,79)=121.31$, p<0.001).

Resolving these interactions by CASE-NP2 revealed a main effect of ASPECT ($F_1(1,23)=3.83$, p<0.06; $F_2(1,23)=5.02$,p<0.03) and an interaction of ASPECT x CASE-NP1 ($F_1(1,23)=102.19$, p<0.001; $F_2(1,23)=102.09$, p<0.001) for the nominative case.

Further resolving the interaction of ASPECT x CASE NP1 by ASPECT revealed a significant effect of CASE-NP1 for both imperfective (F1(1,23)=77.98, p<0.001; *F2*(1,23)=69.08, p<0.001) and perfective (F1(1,23)=75.28, p<0.001; *F2*(1,23)=72.09, p<0.001) aspects.

For the accusative sentences, it showed a main effect of ASPECT ($F_1(1,23)=26.02$,p<0.001; $F_2(1,23)=88.94$, p<0.001) and an interaction of ASPECT x CASE NP1 ($F_1(1,23)=44.78$, p<0.007; $F_2(1,23)=44.74$, p<0.001).

When this interaction of ASPECT x CASE-NP1 was resolved by ASPECT, it revealed the effect of CASE-NP1 only for the perfective aspect ($F_1(1,23)=15.56$,p<0.0006; $F_2(1,79)=66.64$, p<0.001).
For the probe detection task, there was no effect observed for neither the participants (F_1) nor items (F_2).
The reaction time for the acceptability judgement task revealed a significant main effect of ASPECT ($F_1(1,23)=3.63$, p<0.07; $F_2(1,79)=10.84$, p<0.001).The interaction of ASPECT x CASE-NP1 reached significance only by items ($F_2(1,79)=4.46$, p<0.04) and the interactions ASPECT x CASE-NP1 x CASE-NP2 ($F_1(1,23)=23.01$, p<0.001; $F_2(1,79)=33.13$, p<0.001) was observed.

Resolving this three-way interaction by CASE-NP2 showed an interaction of ASPECT x CASE-NP1 ($F_1(1,23)=11.36$, p<0.003; $F_2(1,79)=38.47$, p<0.001) for the nominative case, only.

Further resolving the interaction of ASPECT x CASE-NP1 by ASPECT showed a main effect of CASE-NP1 both for the imperfective ($F_1(1,23)=11.28$, p<0.003; $F_2(1,79)=18.65$, p<0.001) and perfective ($F_1(1,23)=6.76$, p<0.02; $F_2(1,79)=15.75$, p<0.0002) aspects.

Resolving the interaction of ASPECT x CASE-NP1, for the items, by ASPECT showed a main effect of CASE-NP1 ($F_2(1,79)=20.38$, p<0.001) for the perfective aspect.

The statistical analysis for the reaction time (for the probe detection task) revealed an interaction of ASPECT x CASE-NP1(F_1(1,23)=16.90, p<0.0004; F_2(1,79)=5.44, p<0.02). When this interaction was resolved by ASPECT, there was no significant effect of CASE-NP1 for neither imperfective nor perfective aspect.

Analysis of the accuracy rates

The correctness for the acceptability judgement task shows that in the three conditions, nom-nom-imperfective, erg-nom-perfective and nom-acc-perfective, the accuracy was lower in comparison to the other conditions. The lower accuracy for these three conditions does not seem to be accidental as the reaction times also show that the participant needed more time to respond in these conditions. Whenever there was a case violation (nominative instead of either ergative or accusative), the accuracy was low and the subjects needed more time to respond.

3.4.2 ERP Data

3.4.2.1 NP1

Time window 1 (350-500 ms) We compared nominative vs. ergative case-marked arguments at NP1. The visual inspection showed an effect in this time range which seemed like an N400 effect but there was no significant effect observed when the statistical analysis was performed. There was an interaction of ROI x CASE for the midline electrodes (F(5,115)=2.94, p<0.06) but when this was resolved further by ROI, no significant effect was observed for any of the ROIs.

Time window 2 (650-1100 ms) Visual inspection showed a late positivity effect for the ergative-marked arguments in comparison to the nominative arguments. See Figure 3.2:

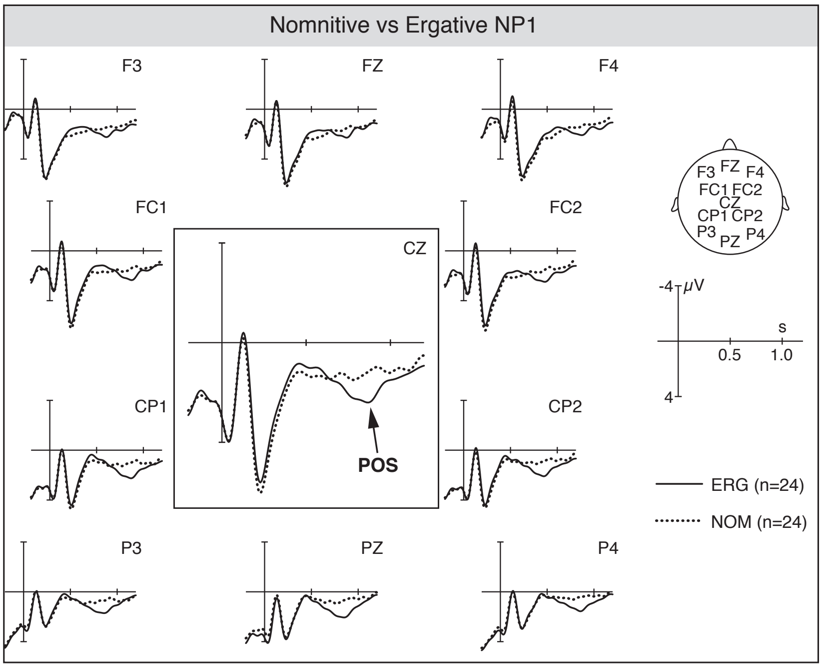

Figure 3.2. Grand average ERPs at the position of NP1 (n-24) comparing nominative and ergative arguments. The solid line is for ergative arguments and dotted line for nominative arguments.

The analysis revealed a significant main effect of CASE (midline: $F(1,23)=38.62$, $p<0.001$; lateral: $F(1,23)=18.13$, $p<0.001$) and a significant interaction of ROI x CASE (midline: $F(1,23)=6.63$, $p<0.002$; lateral: $F(1,23)=6.50$, $p<0.002$).

Resolving the interaction by ROI revealed a significant effects for CASE at all midline electrodes (max: CZ: $F(1,23)=41.74$, $p<0.001$; min: FZ: $F(1,23)=4.98$, $p<0.03$) and for the lateral electrodes sites at left posterior: $F(1,23)=18.22$, $p<0.001$; right anterior: $F(1,23)=10.62$, $p<0.003$; and right posterior: $F(1,23)=22.45$, $p<0.001$.

In sum, the results reveal a significant positivity for the ergative arguments in comparison to nominative arguments.

3.4.2.2 NP2

For the analysis at the position of NP2, we compared four conditions (INN/PNN (nom-nom-imperfective/nom-nom-perfective) vs. IKN/PKN (nom-acc-imperfective/nom-acc-perfective) and INE/PNE(erg-nom-imperfective/erg-nom-perfective) vs. IKE/PKE (erg-acc-imperfective/erg-acc-perfective). NP1(A-argument) was either nominative or ergative and NP2 was either nominative or accusative. Thus, the accusative case violations at NP2(O-argument) was tested in both when it was preceded by nominative and ergative arguments. Therefore, for the statistical analysis, there were two factors CASE-NP1 (nominative vs. ergative) and CASE-NP2 (nominative vs. accusative). The visual inspection showed an early effect in the time range of 100-250 ms but the effect seemed to be the continuation of the effect from NP1(mean duration of NP1: nominative arguments (513.25 ms) and ergative arguments (672.5 ms)). A negativity was observed between 600-800 ms, and a positivity in the time range of 850-1150 ms for the nominative arguments. Thus, for the accusative case violations, we observe a biphasic N400-late positivity pattern.

Time window 1 (100-250 ms) The analysis for the time range of 100-250 ms revealed a significant main effect of CASE-NP1 (midline: $F(1,23)=64.99$, $p<0.001$; lateral: $F(1,23)=42.26$, $p<0.001$), as well as an interaction of ROI x CASE-NP1 (midline: $F(1,23)= 6.99$, $p<0.002$; lateral: $F(1,23)=5.14$, $p<0.008$).

Resolving by ROI revealed a significant effect of CASE-NP1 at all the midline electrodes (max: CPZ: $F(1,23)=72.89$, $p<0.001$; min: FZ: $F(1,23)=13.28$, $p<0.001$) and also for lateral sites: (max: left posterior: $F(1,23)=62.87$, $p<0.001$; min: left anterior: $F(1,23)=10.98$, $p<003$).
As mentioned above, this effect is rather the continuity of the effect from NP1. This becomes clear when we take a look at the plot for NP2 depending on NP1, i.e whether NP2 was preceded by nominative or ergative arguments.

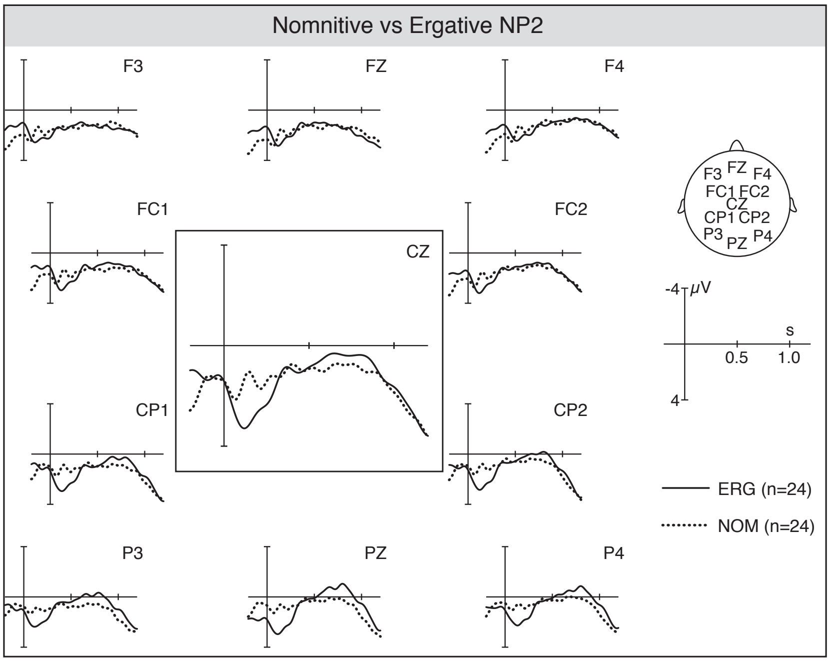

Figure 3.3. Grand average ERPs at the position of NP2 (n=24) comparing initial nominative and ergative arguments (NP1). The solid line is for ergative arguments and dotted line for nominative arguments.

Time window 2 (600-800 ms) A repeated measure Anova was performed for the factors CASE-NP1(nominative vs. ergative) and CASE-NP2 (nominative vs. accusative) for the time range of 600-800 ms. Significant main effects of CASE-NP2 (midline: $F(1,23)=53.38$, $p<0.001$; lateral: $F(1,23)=27.08$, $p<0.001$), and CASE-NP1 (midline: $F(1,23)=15.25$, $p<0.001$; lateral $F(1,23)=10.71$, $p<0.003$) were observed. The analysis also revealed interactions of ROI x CASE-NP2 (midline: $F(1,23)=12.77$, $p<0.001$; lateral: $F(1,23)=11.15$, $p<0.001$) and ROI x CASE-NP1 (midline: $F(1,23)=10.75$, $p<0.001$; lateral: $F(1,23)=7.50$, $p<0.001$).

Resolving these interactions by ROI, showed a significant effect of CASE-NP2 at all midline electrodes (max: CPZ: $F(1,23)=70.24$, $p<0.001$; min: FZ: $F(1,23)=6.90$, $p<0.01$) and CASE-NP1 at FCZ: $F(1,23)=4.55$, $p<0.04$; CZ: $F(1,23)=12.97$,$p<0.001$; CPZ: $F(1,23)=16.73$, $p<0.001$; PZ: $F(1,23)=23.23$, $p<0.001$; POZ: $F(1,23)=21.54$, $p<0.001$. For the lateral electrodes sites, a significant effect of CASE-NP2 was observed at all the electrodes (max: right posterior: $F(1,23)=50.68$, $p<0.001$; min: right anterior: $F(1,23)=5.59$,$p<0.05$) and an effect of CASE-NP1 at left posterior: $F(1,23)=31.38$, $p<0.001$ and right posterior: $F(1,23)=12.05$, $p<0.002$.

The statistical analysis supports the negativity for the nominative arguments in comparison to accusative arguments.

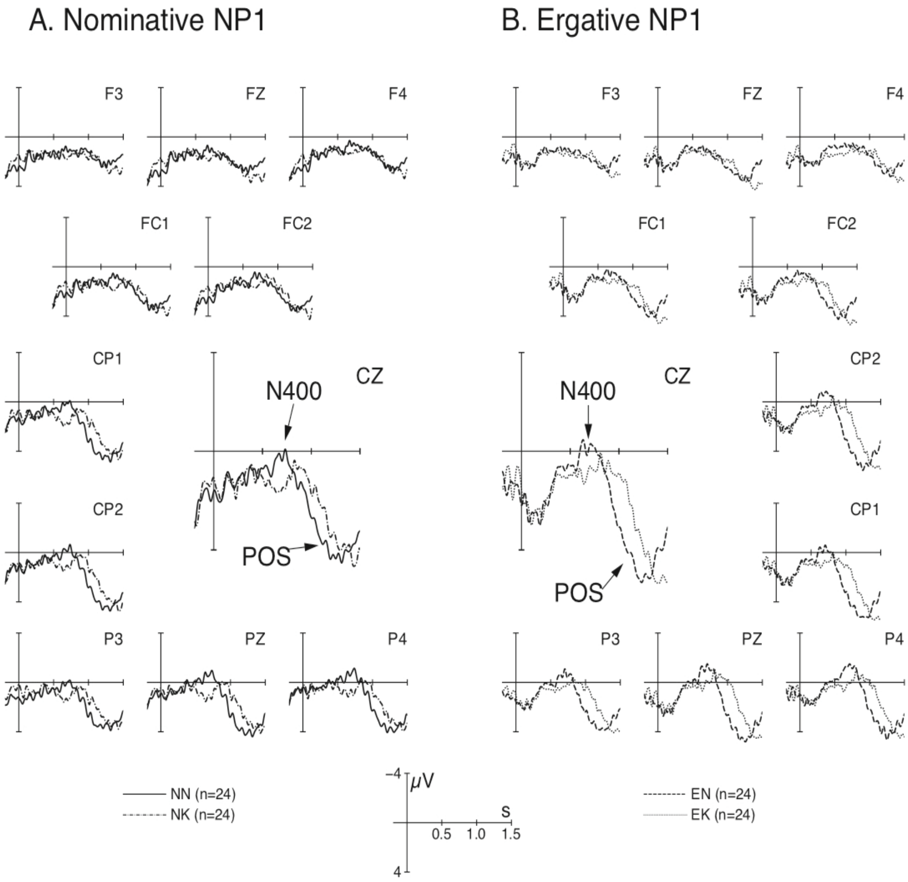

Figure 3.4. Grand average ERPs at the position of NP2 (n=24) comparing nominative and accusative arguments. Panel A for the initial nominative arguments and Panel B for the initial ergative arguments. The negativity is plotted upwards.

Time window 3 (850-1150 ms): For the time range of 850-1150 ms, a significant effect of CASE-NP2: (midline: $F(1,23)=31.17$, $p<0.001$; lateral: $F(1,23)=14.69$, $p<0.001$),as well as interactions of ROI x CASE-NP2 (midline: $F(1,23)=31.86$, $p<0.001$; lateral: $F(1,23)=36.14$, $p<0.001$) and ROI x CASE-NP1 (midline: $F(1,23)=6.15$, $p<0.003$; lateral: $F(1,23)=2.73$, $p<0.05$) were observed.

Resolving these interactions by ROI, revealed a significant effect of CASE-NP2 at FCZ: $F(1,23)=8.70$, $p<0.007$; CZ: $F(1,23)=30.65$, $p<0.001$; CPZ: $F(1,23)=44.25$, $p<0.001$; PZ: $F(1,23)=38.90$, $p<0.001$; POZ:($F(1,23)=48.61$, $p<0.001$ and an effect of CASE-NP1 at PZ:

$F(1,23)=4.34$, $p<0.05$. For the lateral electrodes sites, a main effect of CASE-NP2 at left posterior: $F(1,23)=29.57$, $p<0.001$ and right posterior: $F(1,23)=37.82$, $p<0.001$ was found.

Thus, the statistical analysis supports the positivity for the nominative arguments in comparison to accusative arguments in this time range.

3.4.2.3 Aspect

For the analysis at the position of the aspect marker, we compared four conditions. In this case NP1 was either nominative or ergative and aspect was either imperfective or perfective. All the conditions that had accusative case violations (nominative at NP2) were excluded in this analysis. Therefore, in this case, sentences were ungrammatical due to a mismatch of aspect and case marking at NP1, i.e when NP1 was ergative and the verb in imperfective aspect (ergative case violation) or NP1 was nominative and the verb in perfective aspect (nominative case violation), respectively. Since it does not become clear whether NP1 should bear nominative or ergative case until the aspect marker is processed, the ERPs were time-locked to the aspect marker. The visual inspection showed a negativity for both the nominative and ergative case violations in the time range of 100-300 ms, and a positivity for the ergative case violation in the time range of 400-700 ms. The negativity here is an N400 effect but the time range looks very early due to the fact that the ERPs were time-locked to the aspect marker. When we time-lock the ERPs to the onset of the verb, it is clear that this effect is an N400 (see Figure 3.5).

A repeated measure ANOVA was performed for the factors CASE-NP1(nominative vs. ergative) and ASPECT (imperfective vs. perfective). The statical analysis was also done for the verb, which is given in Appendix 1, and we also performed the statistical analysis for conditions that were ungrammatical due to the accusative case violations at NP2, which is given in Appendix 2.

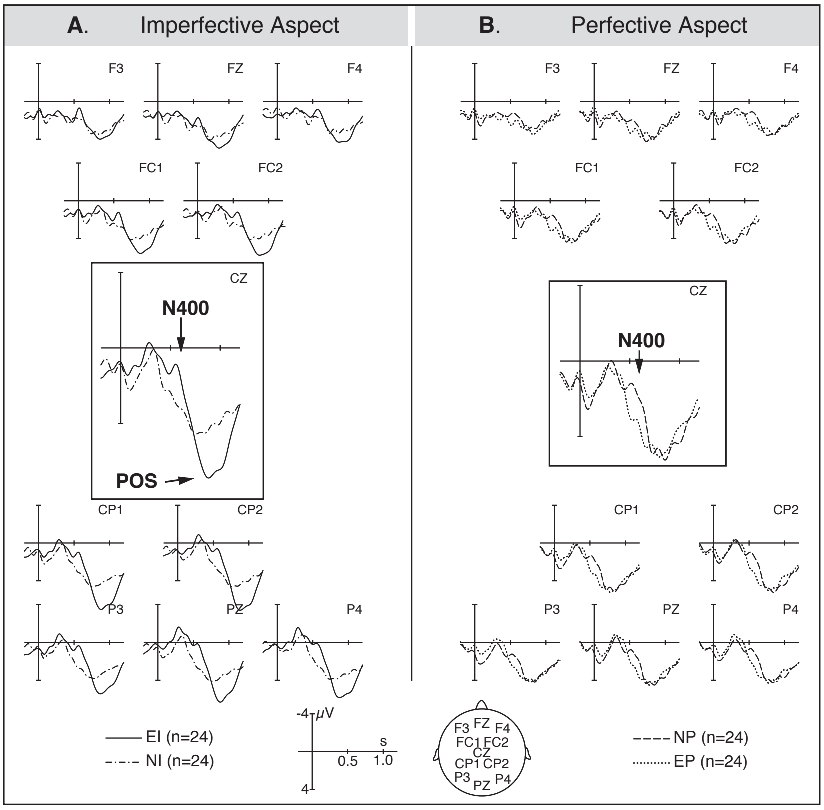

Figure 3.5. Grand average ERPs (n=24) at the position of the verb for all the critical conditions. Panel A shows the ergative case violation and panel B nominative case violation. Negativity is plotted upwards.

Visual inspection of the position of the aspect marker showed a negativity in the 100-300 ms time window and a late positivity in the time range of 400-700 ms. See Figure 3.6:

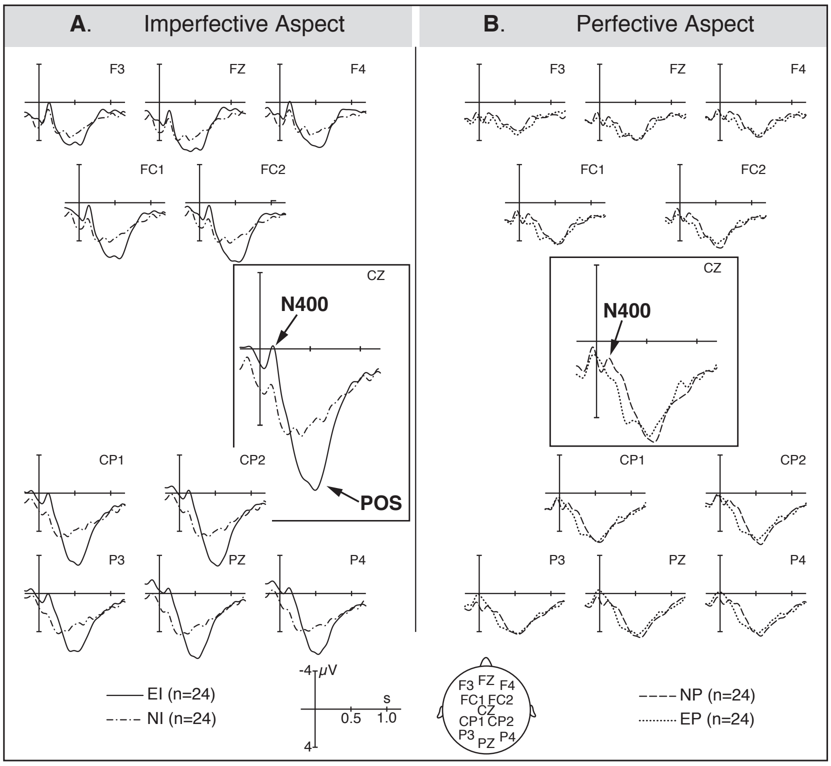

Figure 3.6. Grand average ERPs (n=24) at the position of the aspect marker for all conditions. Panel A shows the ergative case violation and panel B the nominative case violation. Negativity is plotted upwards.

Time window 1 (100-300 ms): A repeated measures ANOVA for the time range 100 to 300 ms post onset of the aspect marker revealed a main effect of ASPECT only for the midline electrodes ($F(1,23)=4.38$, $p<0.04$). Significant interactions of CASE-NP1x ASPECT (midline: $F(1,23)=14.47$, $p<0.001$; lateral: $F(1,23)=12.12$, $p<0.002$), ROI x CASE-NP1 (midline: $F(5,115)=6.46$, $p<0.002$; lateral: $F(5,115)=5.71$, $p<0.008$), and ROI x CASE-NP1 x ASPECT (midline: $F(5,115)=7.57$, $p<.001$; lateral: $F(5,115)=7.57$, $p<0.001$) were observed.

Resolving these interactions by ROI revealed interactions of CASE-NP1 x ASPECT at FCZ: $F(1,23)=6.40$, $p<0.01$; CZ: $F(1,23)=21.14$, $p<0.001$; CPZ: $F(1,23)=19.09$, $p<0.001$; PZ: $F(1,23)=16.69$, $p<0.001$; POZ: $F(1,23)=18.42$, $p<0.001$ at midline electrodes and for lateral electrodess ites at left posterior: $F(1,23)=17.08$, $p<0.001$; right anterior: $F(1,23)=5.27$, $p<0.03$; and right posterior: $F(1,23)=23.74$, $p<0.001$).

Further resolving the interaction of CASE-NP1 x ASPECT by ASPECT, a significant effect of CASE-NP1 was observed for imperfective aspect (ergative case violation) at CZ: $F(1,23)=16.10$, $p<0.001$; CPZ: $F(1,23)=15.47$, $p<.001$; PZ: $F(1,23)=18.09$, $p<0.001$; POZ: $F(1,23)=16.69$, $p<0.001$) for midline electrodes and for the lateral electrode sites at left posterior ($F(1,23)=22.69$, $p<0.001$), right anterior: ($F(1,23)=4.03$, $p<0.05$), right posterior: ($F(1,23)=26.33$, $p<0.001$).

For the perfective aspect (nominative case violation) a significant effect of CASE-NP1 was observed at FCZ: $F(1,23)=4.04$, $p<0.001$; CZ: $F(1,23)=9.07$, $p<0.006$; CPZ :$F(1,23)=9.96$, $p<0.004$ and right posterior ($F(1,23)=3.73$, $p<0.06$).

Thus, the statistical analysis supports the N400 effect observed for both the nominative and ergative case violations.

Time window 2 (400-700 ms): A repeated measures ANOVA for the time range 400 to 700 ms post onset of the aspect marker revealed a significant effect of ASPECT (midline: $F(1,23)=8.85$, $p<0.001$; lateral: $F(1,23)=11.92$, $p<0.002$) and CASE-NP1 (midline: $F(1,23)=32.37$, $p<0.001$; lateral: $F(1,23)= 20.84$, $p<0.001$), as well as interactions of CASE-NP1 x ASPECT (midline: $F(1,23)=25.48$, $p<0.001$; lateral: $F(1,23)=15.90$, $p<0.001$), ROI x CASE-NP1 (midline: $F(5,115)=5.66$, $p<0.002$), and ROI x CASE-NP1 x ASPECT (midline: $F(5,115)=7.60$, $p<.002$; lateral: $F(5,115)=9.24$, $p<.001$).

Resolving these interactions by ROIs for the midline electrodes revealed an interactions of CASE-NP1 x ASPECT at all midline electrodes (max: FZ : $F(1,23)=4.67$, $p<0.04$; min: POZ: $F(1,23)=18.76$, $p<0.001$) and for lateral electrodes sites in the left posterior ($F(1,23)=17.13$, $p<0.001$), right anterior ($F(1,23)=10.24$, $p<0.004$) and right posterior region($F(1,23)=21.48$, $p<0.001$).

Further resolving the interaction of CASE-NP1 x ASPECT by ASPECT revealed a significant effect of CASE-NP1 for the imperfective aspect (ergative case violations) at all midline electrodes (max: FZ: $F(1,23)=10.17$, $p<0.004$; min: POZ: $F(1,23)=41.90$, $p<0.001$) and at lateral electrodes sites at left posterior: $F(1,23)=48.42$, $p<0.001$; right anterior: $F(1,23)=21.03$, $p<0.001$; and right posterior : $F(1,23)=59.22$, $p<0.001$. There was no significant effect for the perfective aspect (nominative case violations).

Thus, the statistical analysis supports the late positivity effect for the ergative case violation, while there was no positivity effect observed for the nominative case violation.

3.5 Discussion

We observed a late positivity at the position of NP1 for the ergative-marked arguments in comparison to nominative arguments, whereas for NP2, we observed a biphasic N400-late positivity pattern for nominative in comparison to accusative-marked arguments (for accusative case violations). Both at the onset of the verb and the aspect marker we observed an N400-late positivity pattern for the condition IKE (erg-acc-imperfective, for ergative case violation), but only a N400 for the condition PKN (nom-acc-perfective, nominative case violation). So there was a crucial difference: while the ergative case violations in imperfective aspect shows the biphasic pattern N400-late positivity, for the nominative case violations in perfective aspect, we only found an N400 effect and no late positivity. In the following sections, we discuss the results in detail.

3.5.1 Effect at NP1

As mentioned above, Wolff et al. (2008) reported that in Japanese an initial accusative arguments showed a positivity and the authors interpreted it as reflecting a dependency formation. As stated above, Hindi is comparable to this nominative-accusative language as an ergative argument suggests a transitive reading. In Hindi, while a nominative argument is ambiguous between transitive and intransitive readings, an ergative argument suggests a transitive reading. As transitive events need two arguments, a second participant is expected. This dependency is different from Japanese and German, where an actor is expected, contrary to which, in Hindi, an ergative-marked argument is an actor and so, an undergoer is expected. Thus, this positivity for the ergative arguments is compatible with the previous result and we interpret it as dependency formation. It seems that dependency formation works universally and irrespective of the direction of expectation (i.e whether an actor is expected or undergoer). To make it more clear it seems that when it is clear with the case information that the event is transitive and either actor or undergoer is expected a dependency is formed for the expectation of the upcoming argument. Though one might argue that this effect in Hindi could be just a difference between a case-marked argument and a bare NP, results at NP2 speak against this argument, where we see the effect for a bare NP and not for the accusative-marked argument. If the effect at NP1 is observed because ergative is overtly marked and nominative is not marked overtly then we should expect an effect for the accusative case-marked argument at NP1 as accusative is overtly marked. But this is not the case and we see the effect for nominative argument at NP2 for the accusative case violations. Thus, it is unlikely that the effect observed at NP1 is due to the fact that ergative is overtly marked while nominative is not marked overtly. In brief, it can be stated that the dependency formation seems to work both in nominative-accusative and ergative-absolutive languages.

3.5.2 Effect at NP2

For NP2 we observed a biphasic N400-late positivity pattern similar to the double case violations in German (Frisch et al., 2005). Recall from the hypothesis that we proposed that the human nominative arguments at NP2 can not be assigned an undergoer role without accusative marking. Thus, there is a problem in the *compute prominence step (*according to eADM*)* and this evokes an N400 effect. The time range of the effects were different, but that could be due to the accusative marking which comes after the NP and hence the effect observed in a later time window. The hypothesis was well supported by the results as we observed a biphasic N400-late positivity pattern for the accusative case violations in both the cases whether it was preceded by the nominative or ergative arguments. Thus the N400 effect was observed due to the problem in compute prominence step and this result is different from problem observed due to the thematic hierarchising of the arguments. The late positivity is observed due to the problem in well-formedness check of the sentence (Bornkessel & Schlesewsky, 2006a).

3.5.3 Effect at Aspect

Both at the onset of verb and aspect marker we observed a biphasic pattern N400-late positivity. Thus, both for the ergative case violations and nominative case violations an N400 effect was observed. The N400 was more pronounced for the ergative case violations in comparison to the nominative case violations and late positivity was observed only for the ergative case violations and not for the nominative case violations.

The N400 effect looked very early at the position of the aspect marker thus it questioned whether the effect is an N400 effect or not. But this is due to the fact that ERPs were time-locked on the aspect marker. But the normal latency at the position of the verb supports the interpretation that this effect is an N400. The effect at the onset of the verb shows that the range of this effect is starting at around 400 ms, which is seen for the classic N400 effect.

As it clear that we are talking about ergative case violations in imperfective aspect (when NP1 is marked ergaitve and aspect is imperfective) and nominative case violations in perfective aspect(when NP1 is nominative and aspect is perfective). The nominative and ergative case violations can not be tested at the position of NP in Hindi since it does not become clear whether the A argument should bear the nominative or ergative case until the verb/aspect is processed. Therefore, it was tested at the position of the aspect marker. Thus, one might argue that the effects observed here is not because of the case violation but rather for the aspect violation. But there is reason to believe that this effect is observed due to the case marking at NP1. There was a difference between the results for imperfective and perfective aspects. If this result is due to the aspect violation, then we should not observe a difference for both aspects. Apart from that, the different strengths of the effects (for N400) in both the cases suggest that it is not just an aspect violation. Zawiszewski (2007) reported a similar N400-positivity effect for the ergative case violations in Basque, an ergative language. Thus, we interpret that this result which is observed at the position of aspect marker is due to the case marking at NP1.

Recall from the hypothesis, that we proposed that we should find a LAN if the case violation is treated as a formal mismatch (Friederici and Frisch, 2002), or an N400 effect if the problem arises due to a prominence mismatch (Frisch & Schlesewsky, 2005). We observed an N400 effect for both the nominative and ergative case violations. Thus, this finding goes well with results from German (Frisch & Schlesewsky, 2005), discussed above, and we interpret that the N400 in the present case is observed due to the prominence mismatch, in line with Bornkessel & Schlesewsky (2006a). Since the NP1 is already processed before the verb/aspect marker is encountered and it becomes clear only at the position of the aspect marker that the sentence is incorrect, there is a mismatch with the previously computed argument and aspect, which is reflected in the N400. Recall from Chapter 1 that according to eADM, the NPs are assigned actor or undergoer role in the *compute prominence* step and the previously computed arguments are matched with verb's LS in the *compute linking step.* In this case, we observed the effect at the aspect marker/verb, thus there is a problem in the *compute linking* step when the previously computed prominence information stands in conflict with the aspect of the verb. Recall that the N400 effect observed for the ergative case violation was more pronounced. This could be due to the fact that the ergative case is more restricted in Hindi than the nominative case. We discuss the differences for the ergative and nominative case in the next paragraph as this is also relevant for late positivity effect.

The late positivity observed for the ergative case violations is due to the well-formedness problems, while the fact that the positivity disappears for the nominative case violations is really surprising. For these findings, we do not have a clear explanation, and further investigation on this issue will be needed. But there are some possible interpretations for the disappearance of the positivity in the case of nominative case violations. We observed an N400-late positivity pattern for both ergative and accusative case violations, whereas for nominative case violations, we only found an N400. Meng & Bader (2000) argued that case exhibits processing properties distinct from those of other morphological features (e.g. number) as case errors are more difficult to detect than number errors. However, Schlesewsky & Frisch (2003) argued that this contrast is limited to nominative case only, while violations involving accusative and dative cases are judged more accurately. They argued that this difference could be due to the fact that in German and many other languages the nominative case has a specific status as a default case.

In Hindi, the ergative case is restricted to perfective aspect only, whereas nominative case has a very wider range, as it can occur in all the other cases: imperfective, progressive aspect, present, past and future tense. It is worth mentioning that there are some transitive verbs that are optionally assigned ergative case marking, like samajhana "understand", while laanaa "bring" and bolnaa "speak" do not take the ergative (Mohanan, 1994).

Furthermore, the verb agrees only with nominative arguments in person, number and gender in Hindi, whereas the verb does not agree with ergative and accusative marked arguments. Thus, there are there are several differences between nominative arguments and ergative arguments in Hindi. But it is still puzzling why we do not see a positivity in the PKN condition (for nominative case violation). The disappearance of late positivity can not be interpreted according to any existing literature on positivity effects. We propose that the positivity disappears in this case not only because of the differences between nominative and ergative arguments but rather because dialectal variation plays an important role in this case. There are several dialects of Hindi spoken, therefore there is a tendency that people might ignore a problem concerning the well-formedness of a sentence because they frequently hear such structures from other speakers. We present a speculative analysis in this line in the general discussion (Chapter 7).

We think one will need to further investigate this question. But this study at least suggests that, from a processing perspective, the nominative behaves differently from both accusative and ergative arguments in Hindi.

3.6 Summary

On the basis of ERP results, we observed that dependency formation appears to work similarly both in nominative-accusative and ergative-absolutive languages. Thus, whenever there is an expectation either from undergoer to actor or from actor to undergoer, a positivity is evoked. We observed an N400-late positivity for the violation of accusative case: the N400 is due to a problem in *compute prominence* and the late positivity due to problems in the well-formedness check. At the verb and aspect marker, we observed an N400-late positivity pattern for arguments marked with ergative case in the imperfective aspect, only, whereas nominative arguments in the perfective aspect did not elicit this late positivity. This suggests that the well-formedness check is silent in this case. But why is this so is the question one needs to investigate further.

3.7 Experiment 1a: Questionnaire Study

The accusative marking is obligatory only with animate arguments and it occurs with an inanimate argument only when it has a specific or definite meaning in Hindi (see Chapter 2). In the ERP experiment, we observed that there was a high acceptability for accusative case violations in some cases. We conducted a questionnaire study to find out be reason behind the high acceptability in such cases. As accusative marking is based on animacy in Hindi, we also included other arguments like inanimate arguments, animals and pronouns in order to have a general overview of the accusative case marking in Hindi.

3.7.1 Materials and Methods

3.7.1.1 Participants

Sixty-three Hindi native speakers participated in the questionnaire study. All the participants were staying in Delhi, India, when this questionnaire study took place. The mean age of the participants was 27.

3.7.1.2 Materials

Twenty items from Experiment 1 were selected for the questionnaire study to obtain an offline judgement of native speakers for the sentences, which were used in the main experiment, particularly for those with accusative case violation. Apart from that, we also included other sentences types. So while in the main experiment, there were only common nouns used both as a subject and object, in the questionnaire study, arguments at NP1 were always human common nouns and varied only in case (nominative and ergative), and NP2 was a mix of common nouns, proper nouns (names), animals, inanimate arguments and pronouns. The type of NP2 was implemented as a between-subjects factor. Apart from the critical conditions, we also included 80 filler items to balance the design. The filler conditions included relative clause constructions, ditransitive constructions, sentences with adjective-noun agreement violations, semantically incorrect sentences and clauses, in which the object was permuted in front of the subject. Each participants rated 100 sentences in total, 20 critical sentences and 80 fillers.

Conditions	NP1	NP2	Verb	Mean(sd)
AIK	NP1(CN)	np2(CN)-ko	verb-IPFV aux	2.95 (0.59)
*AIN	NP1(CN)	np2(CN)	verb-IPFV aux	3.35 (0.69)
APK	NP1(CN)-erg	np2(CN)-ko	Verb-PFV aux	2.71 (0.85)
*APN	NP1(CN)-erg	np2(CN)	Verb-PFV aux	3.25 (0.78)
BIK	NP1(CN)	np2(PR)-ko	verb-IPFV aux	2.49 (0.61)
*BIN	NP1(CN)	np2(PR)	Verb-IPFV aux	3.55 (0.60)
BPK	NP1(CN)-erg	np2(PR)-ko	verb-PFV aux	2.72 (0.47)
*BPN	NP1(CN)-erg	np2(PR)	Verb-PFV aux	3.35 (0.71)
CIK	NP1(CN)	np2(animal)-ko	verb-IPFV aux	3.03 (0.75)
CIN	NP1(CN)	np2(animal)	verb-IPFV aux	3.29 (0.61)
CPK	NP1(CN)-erg	np2(animal)-ko	verb-PFV aux	3.35 (0.58)
CPN	NP1(CN)-erg	np2(animal)	Verb-PFV aux	3.38 (0.47)
DIK	NP1(CN)	np2(ina)-ko	verb-IPFV aux	2.61 (0.64)
DIN	NP1(CN)	np2(ina)	verb-IPFV aux	2.69 (0.55)
DPK	NP1(CN)-erg	np2(ina)-ko	verb-PFV aux	2.85 (0.66)
DPN	NP1(CN)-erg	np2(ina)	verb-PFV aux	2.63 (0.68)
EIK	NP1(CN)	np2(pro)-ko	verb-IPFV aux	2.80 (0.51)
EIN	NP1(CN)	np2(pro)	verb-IPFV aux	2.67 (0.71)
EPK	NP1(CN)-erg	np2(pro)-ko	verb-PFV aux	2.63 (0.57)
EPN	NP1(CN)-erg	np2(pro)	Verb-PFV aux	2.43 (0.80)

Table 3.4. All the critical conditions used in the questionnaire study and also the mean values, standard deviations are given in parenthesis. The abbreviations are as follows: CN-common noun, PR-proper noun, ANI-animal, INA-inanimate arguments, PRO-pronoun, ERG-ergative, KO-accusative.

3.7.1.3 Method

The participants read the sentences offline and they were asked to rate them on a point scale of 1 to 4. Rating 1 was for the correct sentences, 4 for the incorrect sentences. Rating 2 for the sentences that people use in informal talking and rating 3 suggested that some people coming from different regions could use this sentences, while others may not (dialectal variations).

3.7.1.4 Data Analysis

A repeated measures ANOVA was performed for CASE-NP1 (nominative vs. ergative) and CASE-NP2 (nominative vs. accusative) as within factors and ANIMACY-NP2 as between factors. The ANOVA was computed both by subjects (F_1) and items (F_2).

3.7.2 Results

A repeated measure ANOVA revealed a significant main effect of CASE-NP2 ($F_1(1,62)=10.55$, $p<0.001$), ANIMACY-NP2 ($F_1(4,128)=9.71$, $p<0.001$; $F_2(4,76)=8.96$, $p<0.001$), as well as an interaction of CASE-NP2 x ANIMACY-NP2 ($F_1(4,128)=4.85$, $p<0.0009$; $F_2(4,76)= 5.34$, $p<0.0003$).

When the interaction of CASE-NP2 x ANIMACY-NP2 was resolved by ANIMACY- NP2, it revealed a significant effect of CASE for proper nouns ($F_1(1,62)=21.65$, $p<0.001$; $F_2(1,19)=10.68$, $p<0.002$) and common (human) nouns ($F_1(1,62)= 6.30$, $p<0.02$). For the items, a significant effect of CASE for pronouns ($F_2(1,19)=6.43$,$p<0.01$) was observed.

3.8 Summary

The acceptability ratings suggest the sentences that contained an accusative case violations had a very low acceptability. Surprisingly, the accusative case violations seemed to be more pronounced only in the case when NP2 was either a proper name or a human common noun. In the other conditions, when the second argument was an animal, the acceptability ratings were lower irrespective of the case marking. When the second argument was a pronoun or an inanimate noun, people liked these sentences, regardless of whether the argument was case-marked or not. In this case, the correct sentences did not have very high acceptability ratings, either,but they were still rated much more acceptable than the ungrammatical conditions. Thus, the mean values suggest that case marking is more prominent in the case of a proper name or a human common noun.

The statistical analysis also supported this result as a significant effect of CASE-NP2 was only observed for proper names and human common nouns. There was no effect of CASE-NP2 for the other argument types. The result of the questionnaire study supports the case violation effects found in the main experiment, in which only human common nouns were used. The result of the questionnaire study looks strange in the sense that it did not show rating 1 (grammatical) or 4 (ungrammatical). One reason for this could be that the rating 2 was used for sentences that people hear in informal talks and 3 was rated for the dialectal variations, but this is simply an speculation. Another strange result was with animals, as they had been rated as highly unacceptable, regardless of whether they were case-marked or not. This definitely needs to be investigated in future research.

Chapter 4

Experiment 2 Role of word order variation in argument interpretation in Hindi

4.1 Introduction

Recall from Chapter 1 that the languages of the world do not show only different case marking pattern but also exhibit different word order variations. While languages like English are rigid word order languages, others like German, Japanese, Turkish, Russian, Hindi and many other languages of the world allow word order permutations. This means that, for example, the object can be positioned before the subject. Bornkessel & Schlesewsky (2006a) proposed that a complete understanding of the human neurocognitive architecture of language comprehension cannot be attained without a close examination of how word order permutations are processed. Many languages of the world have been examined from this perspective (see Chapter 1, section 1.3.1). But again, the languages that have been investigated from this perspective have been mostly nominative-accusative languages. As Hindi is a split ergative language, in the present experiment, we explored the processing of word order permutations in such a language. So on the one hand, while this experiment gives information about the processing of word order variations in Hindi, on the other hand, it also examines whether the word order permutations are processed differently or similarly in nominative-accusative and ergative-absolutive languages. As this issue has not been investigated in any ergative languages, the experiment will give us a first indication about the processing of word order variations in an ergative language.

4.2 Present study

Recall from Chapter 2 that different results for the different types of word order variations have been observed. Results from German showed a sustained LAN for the objects permuted to the pre-field (e.g. Felser, Clahsen & Münte, 2003; Fiebach et al.,2002; Matzke et al., 2002), while objects permuted to the middle-field revealed a negativity between 300 and 500 ms after the onset of the object (Bornkessel & Schlesewsky, 2006a, Bornkessel, Schlesewsky and Friederici, 2002, 2003; Rösler et al., 1998; Schlesewsky, Bornkessel, and Frisch, 2003). This effect was earlier considered to be a LAN (Rösler et al., 1998) but later termed "scrambling negativity" by Schlesewsky et al.

(2003). Though, the scrambling negativity has been observed when permuted object is unambiguously identified if it is not the case scrambling negativity is not observed (Wolff, et al., 2008; Demiral et al., 2008).

Recall from the discussion in Chapter 1 that in German an initial accusative argument causes a prediction for an prototypical actor (Roehm et al., 2004). Wolf et al. (2008) reported a late positivity effect at the position of NP1 when an initial argument was an accusative-marked in Japanese and proposed that this effect is observed due to dependency formation. Recall from Experiment 1 that we observed a similar result for an initial ergative argument in comparison to nominative arguments. This suggested that the dependency formation works similarly for ergative arguments in Hindi than for accusative arguments in accusative languages. In this experiment, we explore the dependency formation in more detail. In Experiment 1, we used initial nominative and ergative arguments. In this experiment, the object was permuted, hence leading to three comparisons at NP1(NOM/ACC/ERG). As we already observed a late positivity effect in Experiment 1 for initial ergative arguments, the question here was whether we could find a comparable result for ergative arguments in a visual experiment, and further, if accusative arguments also show a similar kind of dependency formation. An accusative argument is ambiguous in Hindi due to the same case marking for both accusative and dative arguments (-*ko*). Note that dative subject constructions are possible in Hindi (with psych verbs). So an initial NP with any of the possible case markings, namely ergative, nominative or accusative/dative can occur in the first position. To investigate how an accusative argument in the initial position is treated is the main focus at this point. An accusative argument is ambiguous in several ways, as it could be the object of a sentence with pro-dropp, an object moved to first position or a dative subject. A nominative-marked argument is ambiguous between an intransitive and transitive event. An ergative NP can only be interpreted as subject of transitive verbs that take two arguments. We hypothesise that we should see a positivity for both accusative and ergative arguments in comparison to nominative arguments at NP1, because both ergative and accusative arguments will form some kind of dependency relations.

It should be noted that whether an initial *ko* (accusative) marked argument is treated as an accusative or dative experiencer the dependency formation is expected. This is because, if it is treated as an accusative, an actor is expected in the event. If it is treated as a dative-marked argument, an undergoer is predicted to follow. According to Narasimhan (1998), dative subject constructions are M-intransitive[11] and they are polyadic constructions, i.e. there are two or more

[11] M-intransitive: 1 Macrorole (verbs such as run, fall etc.)

nominals in the sentence (see Narsimhan, 1998 for the detail). Therefore, at the positon of NP1, it does not make any difference in terms of dependency formation whether *ko* is assumed to be accusative or dative, as there is always an expectation for a second participant in the event.

For NP2, we expect an N400 for the canonical imperfective sentences (nom-acc-imp), i.e when NP1 is nominative and the following second argument is an accusative. Initially, the nominative argument will be treated as an S argument but when the second argument is encountered in the sentence, the structure has to be reanalysed from an intransitive event to a transitive event. Such a reanalysis was reflected by an N400 effect in previous studies both in German (Bornkessel et. al., 2004) and Japanese (Wolff et al., 2008). Thus, we expect to see a similar effect at NP2. If accusative arguments in the first position are initially considered to be a dative subject (because of the *ko*-syncretism) and if they are interpreted as an actor, then at NP2, there will be the need for a thematic reanalysis when the following argument is ergative. Thus, we propose that an early positivity will be observed at the position of NP2 for the thematic reanalysis (cf. Bornkessel at el., 2003).

4.3 Material and Methods

4.3.1 Participants

Twenty four right handed native speakers of Hindi participated in the experiment (seven women, mean age 26.83. years, range 23-37). At the time of the experiment, all participants were residing in Berlin. Six additional participants were excluded from the final analysis because of EEG artefacts.

4.3.2 Materials

Eighty sets of the four sentence conditions, shown in Table 4.1, were constructed. All arguments were human masculine proper nouns. The 320 sentences thus resulting were subdivided into two lists, each containing 160 sentences, 40 per condition.

Condition	Critical sentences
EK	NP-ERG NP-Ko V- perfective Aux Kishore-ne mohan -ko maar-aa hai. Kishore.m-Erg Mohan.m-acc beat-PFV.3sg.m aux "Kishore has hit Mohan."
KE	NP-Ko NP-ERG V-perfective Aux Kishore-ko mohan-ne maar-aa hai. Kishore.m-acc Mohan.m-Erg beat-PFV.3sg.m aux "Mohan has hit Kishore."
NK	NP-nom NP- ko V-imperfective Aux Kishore mohan-ko maar-taa hai. Kishore.m(nom) Mohan-acc beat-IPFV.3sg.m aux "Kishore hits Mohan."
KN	NP- ko NP- nom V-imperfective Aux Kishore-ko mohan maar-taa hai. Kishor.m-acc Mohan.m(nom) beat-IPFV.3sg.m aux "Mohan hits Kishore."

Table 4.1. Example sentences for each of the critical conditions in Experiment 2 (abbreviations: E-ergative, K-accusative, N-nominative).

4.3.3 Procedure

The sentences were presented visually, word-by-word (word and case markers were presented together) in the centre of the screen with a presentation time of 600 ms per word and an inter-stimulus-interval (ISI) of 100 ms. Each trial began with the presentation of an asterisk (1000 ms plus 200 ms ISI) and ended with a 1000 ms pause, followed by a comprehension question. Participants judged whether the question was right or wrong by pushing the buttons for *yes* or *no*. The questions were asked on the basis of the sentence that the participants had read. In each set, half of the questions were right and half were wrong. In the wrong questions, either NP1, NP2 or verbs were changed. The response time for this task was 4000 ms.

The participants were told to avoid movements and blinking while reading the sentence but were allowed to blink while reading the comprehension questions. An additional practice session (20 sentences) was conducted for each participant before the main experiment started. The main experiment consisted of 160 sentences that were presented in the four blocks of 40 sentences. There was a very short break after each block.

4.3.4 EEG recordings

The EEG recording was the same as in Experiment 1.

Average ERPs were calculated per condition per participant from the onset of the critical stimulus items to 1000 ms post onset. The critical positions were NP1, NP2 and VERB. Trials, for which the comprehension task was not performed correctly, were excluded from the averaging procedure.

4.3.5 Data Analysis

Data analysis was done in the same way as in Experiment 1.
The analysis of NP1 and NP2 were different. For the analysis of NP1, there was only one factor, CASE (nominative-accusative and ergative). For the analysis of NP2, there were two factors: ASPECT (perfective vs. imperfective) and WORD ORDER (canonical vs. non-canonical).
The topographical factors were the same as in Experiment 1.

4.4 Results

4.4.1 Behavioural results

Condition	Comprehension Question	
	Correct (%)	Reaction time (ms)
EK	84(8)	1315 (240)
KE	87(7)	1369 (251)
NK	90(4)	1323 (235)
KN	89(6)	1324 (221)

Table 4.2. The mean percentage of correctness in the comprehension tasks and reaction times. Standard deviations are given in parenthesis.

For the error rates, a repeated measures ANOVAs (for participant *(F_1)* and item *(F_2)*) was performed for the factors ASPECT (perfective vs. imperfective) and WORD ORDER (canonical vs. non-canonical). The ANOVA revealed a main effect of ASPECT ($F_1(1,23)= 16.06$, $p<0.0006$; $F_2(1,79)=3.48$, $p<0.07$), and further, a marginally significant interaction of ASPECT x WORD ORDER ($F_1(1,23)= 3.57$, $p<0.07$) was observed for subjects, only. There was no interaction of ASPECT and WORD ORDER for the items and since the interaction for the participants was only marginal, it was not resolved further.

For the reaction time, statistical analysis revealed a marginal effect of WORD ORDER ($F_1(1,23)= 3.26$, $p<0.08$.

4.4.2 ERP Results

4.4.2.1 NP1

Visual inspection showed a positivity for ergative and accusative arguments at the position of NP1 (Figure 4.1) between 500-750 ms.

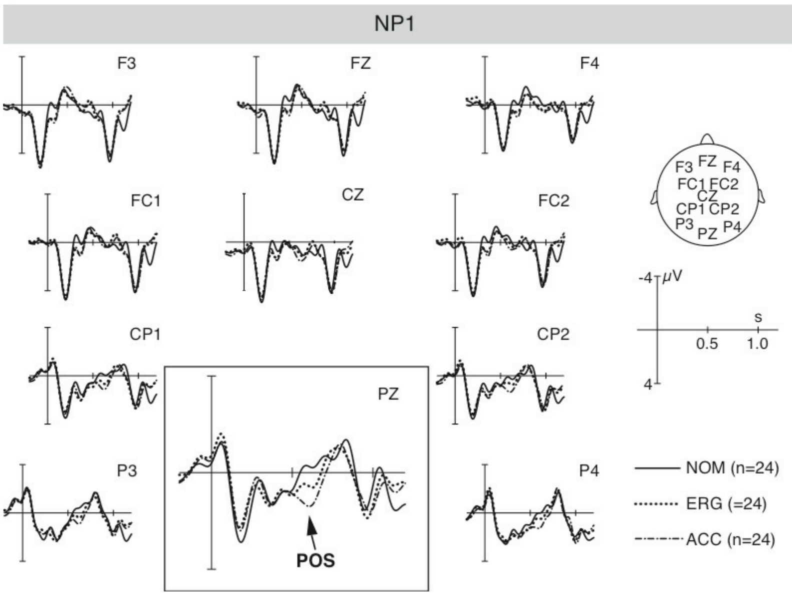

Figure 4.1. Grand average ERPs (n=24) at the position of NP1, comparing all three conditions: ergative, accusative and nominative. Negativity is plotted upwards.

Time window 1 (500-750 ms): On the basis of visual inspection, a repeated measures ANOVA was performed for the factor CASE (nominative vs. accusative vs. ergative) in the time window of 500-750 ms. A significant main effect of CASE was observed at midline electrodes, only (midline: $F(2,23)=3.09$, $p<0.05$) and an interaction of ROI x CASE was observed both at midline and lateral sites: (midline: $F(10,115)=11.87$, $p<0.001$; lateral: $F(6,69)=13.26$, $p<0.001$).

Resolving by ROI showed a main effect of CASE at CPZ: $F(2,23)=3.92$, $p<0.03$; PZ: $F(2,23)=11.15$, $p<0.001$; POZ: $F(2,23)=16.22$, $p<0.001$ and for the lateral electrodes sites at all electrode regions (max: left anterior: $F(2,23)=4.44$, $p<0.02$; min: right posterior: $F(2,23)=10.85$, p<0.001). This analysis was followed by a pairwise comparisons of the cases for the ROIS showing a main effect of case.

The pairwise comparison of nominative and accusative case reached the Bonferroni-corrected significance threshold for the midline electrodes at CPZ: $F(1,23)=6.26$, $p<0.02$; PZ: $F(1,23)=15.54,0.001$; POZ: $F(1,23)=23.67$, $p<0.001$, and for all the lateral electrodes sites (max: left posterior: $F(1,23)=7.11$, $p<0.01$; min: right posterior: $F(1,23)=19.51$, $p<0.001$).

The pairwise comparison of nominative and ergative case reached the Bonferroni-corrected significance threshold for the midline electrodes at PZ: $F(1,23)=5.72$, $p<0.03$; and POZ: $F(1,23)=6.73$, $p<0.02$, and a marginal effect was observed for the lateral electrode sites at left anterior: $F(1,23)=4.33$, $p<0.05$; right anterior: $F(1,23)=4.13$, $p<0.05$; right posterior: $F(1,23)=4.12$, $p<0.05$.

The pairwise comparison of accusative and ergative case reached the Bonferroni-corrected significance threshold for the midline electrodes at CPZ: $F(1,23)=9.17$, $p<0.006$; POZ: $F(1,23)=15.35$, $p<0.001$, and a marginal effect at PZ: $F(1,23)=4.96$, $p<0.04$; while for the lateral electrodes sites, it revealed a significant effect in the right posterior region: $F(1,23)=7.58$, $p<0.01$.

Summary:
A broadly distributed positivity with a right posterior maximum was observed for both ergative and accusative arguments. The effect was more pronounced for the accusative than the ergative ones. The comparison of ergative vs. accusative did not look much pronounced but the effect was statistically significant.

4.4.2.2 NP2

Visual inspection showed an early positivity at NP2 when NP1 was accusative and NP2 was nominative. A positivity was also observed for the canonical (nom-acc) imperfective sentences at NP2.

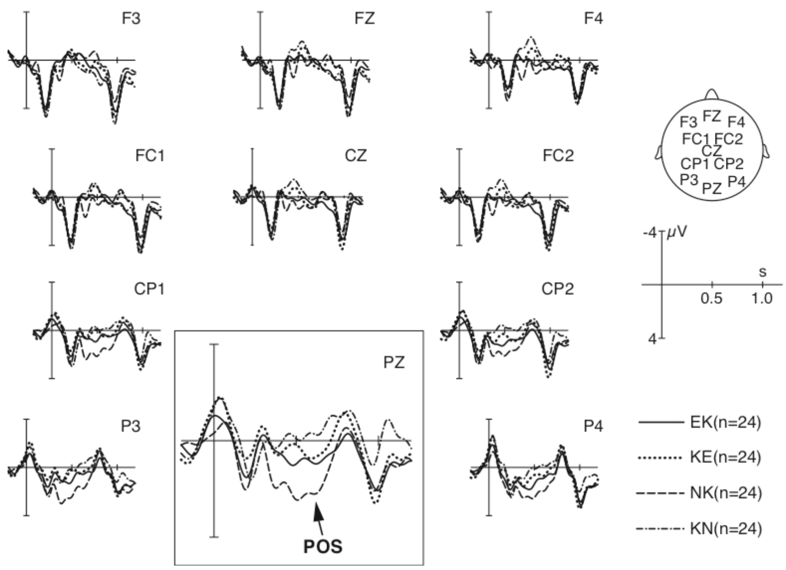

Figure 4.2. Grand average of the ERPs (n=24) at the position of NP2 comparing all four conditions. Negativity is plotted upwards.

Time window 1 (200-350 ms): The early positivity was observed in a time range of 200-350 ms (for acc-nom-imperfective sentence) and a positivity in the time range of 350-650 ms (for nom-acc-imperfective sentences). The analysis for the time window of 200-350 ms revealed a significant main effect of ASPECT (midline: $F(1,23)=5.27$, $p<0.03$; lateral: $F(1,23)=8.77$, $p<0.007$) and interactions of ROI x WORD ORDER (lateral: $F(3,69)=2.74$, $p<0.05$), ASPECT x WORD ORDER (midline: $F(1,23)=7.93$, $p<0.009$) and ROI x ASPECT x WORD ORDER (midline: $F(5,115)=9.69$, $p<0.001$; lateral: $F(3,69)=5.10$, $p<0.003$).

Resolving these interaction by ROIs revealed an interaction of ASPECT x WORD ORDER at CZ: $F(1,23)=7.61$, $p<0.01$; CPZ: $F(1,23)=13.72$, $p<0.001$; PZ: $F(1,23)=17.71$, $p<0.001$; POZ: $F(1,23)=20.60$, $p<0.001$ for the midline electrodes. For the lateral electrodes sites, an interaction of ASPECT x WORD ORDER was observed in the left posterior ($F(1,23)=6.31$, $p<0.02$) and right posterior regions ($F(1,23)=8.41$, $p<0.008$).

When the interaction of ASPECT and WORD-ORDER was resolved by ASPECT, it revealed a main effect of WORD ORDER for the imperfective aspect at CZ: $F(1,23)=5.41$, $p<0.03$; CPZ:

$F(1,23)=12.95$, $p<0.002$; PZ: $F(1,23)=15.66$, $p<0.001$; and POZ: $F(1,23)=19.63$, $p<0.001$ for the midline electrodes.

For the lateral electrodes sites, a main effect of WORD ORDER was observed for the imperfective aspect at left posterior ($F(1,23)=4.70$, $p<0.04$) and right posterior ($F(1,23)=4.47$, $p<0.05$). For the lateral sites, the effect of WORD ORDER was also observed for the perfective aspect at right posterior ($F(1,23)=4.96$, $p<0.04$).

In summary, the early positivity observed for accusative-nominative conditions is well supported by statistical analysis.

Time window 2 (350-650 ms): For the time range of 350-650 ms, the statistical analysis revealed a main effect of ASPECT (midline: $F(1,23)=7.009$, $p<.001$; lateral: $F(1,23)=6.93$, $p<0.01$) and WORD ORDER (midline: $F(1,23)=12.07$, $p<0.002$; lateral: $F(1,23)=12.04$, $p<.002$). Further, it also revealed an interaction of ASPECT x WORD ORDER: (midline: $F(1,23)=8.65$, $p<0.007$; Lateral: $F(1,23)=8.10$, $p<0.009$) for both midline and lateral sites. At the same time, the interactions of ROI x ASPECT: ($F(3,69)=4.61$, $p<0.009$), ROI x WORD ORDER: ($F(3,69)=7.94$, $p<0.001$), and ROI x ASPECT x WORD ORDER: ($F(3,69)=3.67$, $p<0.02$) were observed for the lateral sites, only.

When the interaction of ASPECT x WORD ORDER was resolved by ASPECT, for midline electrodes, it revealed a main effect of WORD ORDER for imperfective aspect: $F(1,23)=16.46$, $p<0.001$.

Resolving by ROI for the lateral electrodes sites revealed a main effect of ASPECT at left anterior: $F(1,23)=15.52$, $p<0.001$ and left posterior: $F(1,23)=18.06$, $p<0.001$ and an effect of WORD ORDER at left posterior: $F(1,23)=13.85$, $p<0.001$, right anterior: $F(1,23)=17.35$, $p<0.001$ and right posterior: $F(1,23)=15.34$, $p<0.001$ as well as an interaction of ASPECT and WORD ORDER at left posterior: $F(1,23)=8.80$, $p<0.006$, right anterior: $F(1,23)=10.63$, $p<0.003$ and right posterior: $F(1,23)=8.26$, $p<0.008$.

While resolving by ASPECT did not reveal any effect of WORD ORDER for the perfective aspect, for the imperfective aspect it revealed a main effect of WORD ORDER at left posterior: $F(1,23)=18.32$, $p<0.001$, right anterior: $F(1,23)=25.87$, $p<0.001$ and right posterior: $F(1,23)=19.63$, $p<0.001$.

In summary, the statistical analysis of the later time window supports the observation of a positivity for the canonical imperfective sentences. We could not analyses the data for the verb as the effect from NP2 continued until the verb and thus making it was difficult to analyse the verb. This can be observed in the figures below:

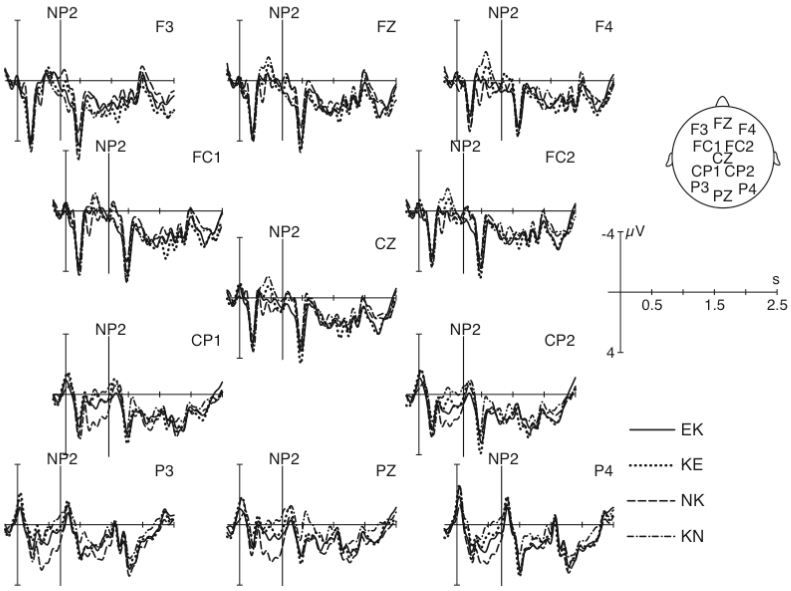

Figure 4.3. Grand average ERPs at the position of NP2 and verb together (n=24), comparing all four conditions. The vertical bar (written NP2 on top) shows the offset of NP2. Negativity is plotted upwards.

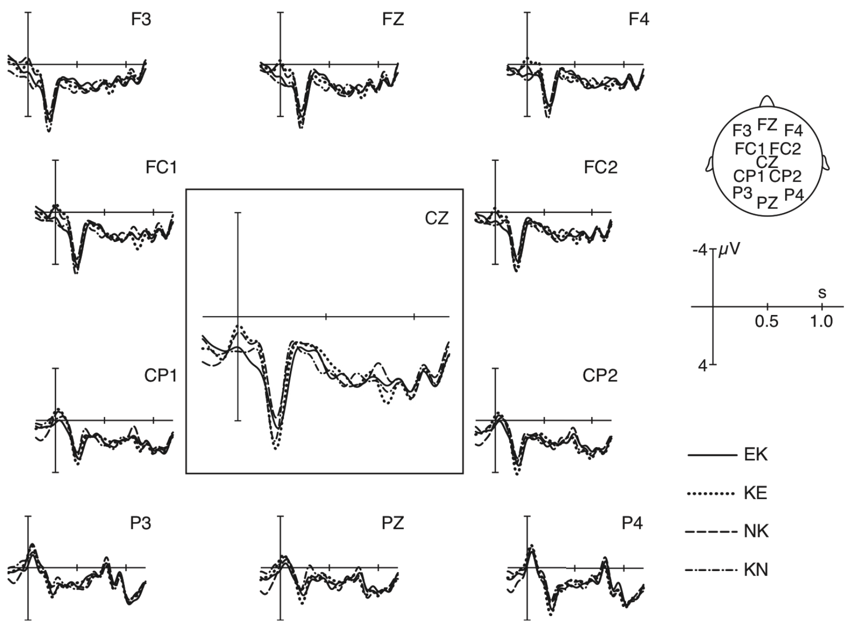

Figure 4.4. Grand average ERPs (n=24) for the position of the verb, comparing all four conditions.

4.5 Discussion

We observed a late positivity effect for both accusative and ergative arguments at NP1(see Figure 4.1). The effect for the accusative arguments was more pronounced than for the ergative arguments. At the position of NP2, we observed an early positivity for acc-nom sentences and a positivity for canonical imperfective sentence (nom-acc). There was no effect observed for canonical and non-canonical perfective sentences at NP2. In the following, we present the interpretation of the effects at NP1 and NP2. As mentioned above, filler sentences were not used in this experiment, therefore, we divided the block into two parts and analyis was done on the basis of taking part as a factor to find out whether reading similar sentences had some influence. But it did not show any difference[12].

4.5.1 Effect at NP1

A late positivity was observed for both ergative and accusative arguments at NP1. Recall from Chapter 1 that we observed a late positivity for ergative arguments at NP1 in comparison to nominative arguments and that we interpreted that this positivity as reflecting the formation of

[12] Since there were no filler sentences in this experiment, we divided the blocks into two parts (first and second half) and statistics were computed taking part as a factor. This was done to judge whether reading similar sentences had some influence towards the end of the experiment. But the statistical analysis did not show an interaction of first or second half with other factors.

dependency relations. Similar to Experiment 1, we observed a late positivity effect at NP1 for both ergative and accusative arguments in comparison to nominative arguments. The effect for the accusative arguments was more pronounced than for the ergative arguments. This could be due to the fact that while an ergative argument has only one prediction, namely the expectation for a transitive event, and since the ergative argument is an actor, an undergoer is predicted in the event. An initial accusative argument, on the other hand, can have several predictions. For instance, in Hindi, an initial accusative argument could be the O-argument when the A-argument is dropped, it could be the A-argument of an experiencer verb, and it could also be the O-argument moved in front of the A-argument, as Hindi is a free word order language. As mentioned above, in terms of dependency formation, it does not make a difference whether a *ko*-marked argument at NP1 is treated as accusative or dative. Hence, the question arises of why there is a stronger effect for the accusative argument in comparison to ergative one? One possible explanation lies in the fact that an accusative argument is ambiguous. It should be note that ambiguity is referred to in terms of dependency formation. Thus, an accusative argument is ambiguous in the sense of what kind of argument is predicted after an initial accusative argument. A nominative argument is also ambiguous between being interpreted as S or A-argument as it could be the S-argument of intransitive verbs and A- argument of transitive verbs. Since nominative arguments can also be the S-arguments of intransitive verbs, in this case, no dependency formation is predicted. But for both ergative and accusative arguments a dependency formation is predicted. The accusative argument is ambiguous in terms of dependency formation, while an ergative argument is not. There are two possible interpretations of the stronger effect for the accusative arguments. Firstly, the interpretation can be in terms of ambiguity as in the case of ergative arguments, it is clearly an actor and an undergoer is expected. Although the object can be dropped in Hindi, the argument is still expected in the event. In the case of accusative arguments, there are different expectations possible. If it is treated as an accusative argument, an actor will be expected in the event. If it is considered to be a dative argument, then an overt argument is expected. Thus, the important issue in the case of an initial accusative argument is that it is ambiguous in terms of dependency formation. Therefore, this could be the reason behind the stronger positivity for the initial accusative arguments. Frisch et al. (2002) argued that when the NP1 is ambiguous between a subject and object reading, it evokes a P600. Thus, one can argue that in this case the more pronounced positivity is evoked because an initial accusative argument is ambiguous in terms of dependency formation. An alternative interpretation for the more pronounced positivity for the accusative arguments comes lies in the analysis of NP2. When we analyse the data at NP2, it becomes clear that an initial accusative argument is only treated as an accusative argument not as a dative argument (see section 4.5.2).

Thus, in this case, there is an expectation of an actor. The expectation of an actor shows a more pronounced positivity than the expectation of an undergoer. Thus, the positivity for the accusative argument is more pronounced than that for ergative arguments.

In sum, this experiment suggests that dependency formation takes place in the case of accusative as well as ergative arguments because a late positivity was observed for both the arguments and we also found the same result in Experiment 1 for the ergative arguments.

4.5.2 Effect at NP2

There were two effects observed at NP2: an early positivity (200-350 ms), when the first argument was accusative and the second argument was nominative, and a late positivity (350-650 ms) for the initial argument bearing nominative case-marking while the second argument was accusative-marked. Bornkessel et al. (2003) observed an early positivity at NP2 when comparing subject-object vs. object-subject sentences with dative case in German. They interpret this effect as a reflection of a thematic reanalysis. The authors suggest that the dative arguments can be a proto-agent in German. However,when second nominative argument occurs in the sentence, and it is an animate argument, it is assigned the proto-agent role. Hence, there is a need of thematic reanalysis in this case.

The early positivity for the acc-nom sentences at NP2 in this experiment at least suggests that dative experiencer preference is ruled out in Hindi when one sees/hears the accusative sentences at NP1. Rather, they are treated as the accusative argument. If it was treated as dative experiencer we should see some effect at NP2 when the ergative argument is encountered. This is not the case as we do not see any effect for the ergative argument at NP2. However, we only find an early positivity for the nominative argument when preceded by an accusative argument.

The question arises of whether this early positivity is analogous to that of German. One might argue that the early positivity observed in Hindi is reflecting a thematic reanalysis similar to that of German. This means that there is a thematic reanalysis in the acc-nom sentences. At a first glance, one might think that this is the case and that there is a reanalysis from an actor reading for the ko-argument (ACC) to an actor reading for the nominative argument.

However, the results of the ergative conditions speak against this interpretation because, if this was the case, the thematic reanalysis should be stronger in the case of ergative. This, however, is not the case as the effect is observed for nominative conditions.

Alternatively, if the initial *ko*-marked argument is analysed as an accusative, then there is no effect expected at NP2 in the case of ergative argument. This is because the initial *ko*-marked argument is an undergoer and ergative argument is the actor. However, in the case of the nominative conditions, the ACC-NOM structure could also be a dative experiencer structure. Let us consider the following examples:

(4.1)	a.	Raam-ko	mohan	pasand	hai.
		Ram.m-dat	Mohan.m(nom)	like	aux
		"Ram likes Mohan."			
	b.	Raam-ko	mohan	mar-taa	hai.
		Ram-acc	Mohan.m(nom)	hit-IPFV.3sg.m	aux
		"Mohan hits Ram."			

As we can see from above sentences (4.1a/b), it is not clear at the position of NP2 (*Mohan*) whether it is a dative constructions or an active one. As mentioned above, Narshiman (1998) argued that a dative argument does not get a macro role. So in this case (4.1a), *Mohan* will get the undergoer role. The undergoer role assigned to *Raam* can be assigned to *Mohan* if it is a dative construction. In the sentence (4.1b), *Mohan* will get the actor role, while *Raam* will remain an undergoer. But this becomes clear only at the position of verb. At the position of NP2, this is not clear. Hence, it can be said that some kind of thematic reanalysis is needed in this case and we therefore observe an early positivity. But it should not be forgotten that at the position of NP2, (acc-nom) structures are ambiguous. Therefore, it can be predicted that if the result is due to ambiguity, we should observe an effect for the nominative argument at NP1. Nominative argument at NP1 is ambiguous because it could be a S or A argument.

For the canonical imperfective (nominative-accusative) sentences, a positivity was observed in the time range of 350-650 ms. As stated above, the nominative argument will be treated as a subject of an intransitive verb (Gibson, 1998; Demiral et al., 2008). It has been reported in several studies that when an initial argument can be treated as a subject of intransitive verb and a second argument is observed, an N400 effect is evoked for the unexpected argument. In such cases, an intransitive event is reanalysed as a transitive event when the second argument is encountered and an N400 is evoked (Wolff et al., 2008; Bornkessel, et al., 2004).

But in the case of Hindi we observed a positivity and not an N400 effect. Thus, this result is very surprising. In order to examine the stability of this positivity, we reexamined the data from Experiment 1 in order to see whether the comparison of nominative-accusative and ergative-accusative sentences at NP2 would show a similar result. As is apparent from Figure 4.5, this is indeed the case.

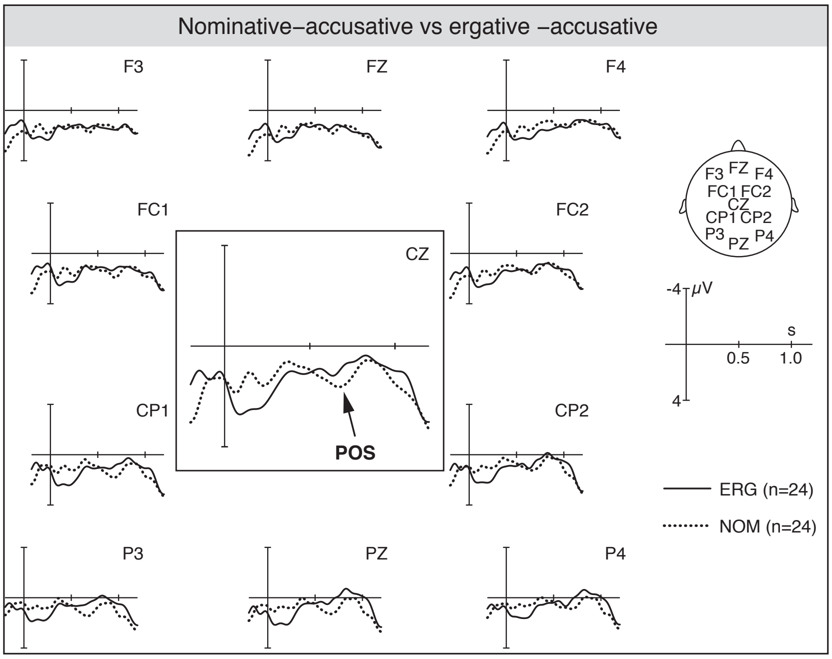

Figure 4.5. Grand average ERPs at the position of NP2 from Experiment 1, comparing nominative-accusative and ergative-accusative condition at NP2. The early positivity in the figure is the positivity for ERG vs. NOM at the position of NP1.

Thus, the positivity in this case is really surprising. In German and Japanese,an N400 was observed for a similar event. If we compare Hindi with German/Japanese, the constructions under consideration seems similar: the nominative NP1 can initially be analysed as an S argument, but must then be reanalysed to an A argument. Thus, there appear to be three possible scenarios that could explain this discrepancy: (a) the process is similar, but the neurophysiological correlate differs between Hindi and German/Japanese; (b) the assumption of an intransitivity preference is incorrect; (c) the difference is to be sought in the properties of the languages under consideration, perhaps in the split ergative properties of Hindi.

The first option, even if it can not be ruled out completely, is not preferred. The second option also can not explain this as there is an effect for NOM-ACC sentence in Hindi but only of a different kind to that observed in German and Japanese. If the third option is taken into consideration, the crucial difference between the German/Japanese pattern and the Hindi pattern is to be found in Hindi's split ergativity pattern. The critical issue is that, in Hindi, an initial nominative is ambiguous between an S, an A and an O reading, whereas in German and Japanese, the ambiguity is only between S and A. Therefore, it could be possible that the difference observed in the case of Hindi and German/Japanese is due to this fact. This definitively needs to be investigated further.

4.6 Summary

Thus, the results of the experiment suggest that dependency formation works similarly for ergative and accusative arguments. It suggests that when a prediction of a further argument is possible, dependency formation takes place. Moreover, it also suggest that the positivity for dependency formation is observed in both independent of whether an undergoer or an actor is expected. Still, the effect is larger for the expectation of an actor. The results from NP2 are surprising since we found a positivity for nom-acc sentences where others have observed an N400 effect. Again, this will require further investigation in future research.

Chapter 5

Experiment 3: The role of animacy in argument interpretation in Hindi

5.1 Introduction

Animacy plays an important role in argument interpretation. Bornkessel & Schlesewsky (2006a) proposed that animacy modulates the establishment of the dependency relations between arguments (see Chapter 1). These relations determine argument interpretation even in the absence of verb information, and actor and undergoer role are assigned on the basis of a small set of cross-linguistically valid information types like morphological case and linear order.

Animacy effects and the interaction of animacy with features like case have been much explored in nominative-accusative languages. However, it has not yet been explored in ergative languages, so that the role of animacy can be generalised to both nominative and ergative languages from the processing perspective. We observed some similarities between ergative and nominative-accusative languages for the use of case in Experiment 1 and 2, but there were also some crucial differences. Hence, in this experiment, we explored the role of animacy in a split ergative language (Hindi) to find out whether the results are different in this case or if they are similar to those results observed for accusative languages.

5.2 Present study

Both Experiment 1 and Experiment 2 suggest that, just as an accusative argument leads to the prediction of an actor in German, an ergative argument appears to engender a prediction for an undergoer in Hindi. In this experiment, we explore the nature of this prediction in more detail, specifically whether it entails a prediction for animacy-based prototypicality or not.

Recall from Chapter 1 that in German, when an initial accusative argument is processed, a prediction of a nominative animate argument (actor) is made: When this prediction is not met, and instead an inanimate actor is encountered, it shows an N400 effect (Roehm et al., 2004). A similar effect was observed for Chinese when an inanimate actor follows an initial animate undergoer (Philipp et al., 2008). As discussed earlier, Comrie (1989) suggests that an unmarked transitive construction consists of an animate actor and an inanimate undergoer. It has already been shown that in accusative languages, an initial accusative argument predicts a prototypical actor (animate). In Hindi, after seeing an ergative argument, an inanimate undergoer should be predicted. However, the difference between Hindi and languages like German, Chinese and Tamil is that, in these languages, the data were interpreted by semantic dependency relations, i.e. between undergoers and actors, rather than formal dependency between accusative and nominative case. Therefore, this study can be seen as a contrast to earlier studies. Another issue that must be kept in mind is that undergoers are defined in opposition to the actor, i.e. undergoers are dependent on actors but not vice versa (Primus, 1999). In this respect, Bornkessel-Schlesewsky & Schlesewsky (2009c) proposed that the apparent prototypicality effects involving undergoers should be attributed to the increased competition for the actor role. Thus, the basic idea is that the system could not predict a prototypical undergoer in the same way as it can predict a prototypical actor.

The aim of Experiment 3 was to test this prediction. In addition, we also wanted to test if the accusative case interacts with animacy. Recall from Chapter 2, that accusative marking is optional in Hindi. While accusative marking is obligatory with human nouns, it does not occur with inanimate nouns unless the object is definite or specific. Therefor, it is interesting to see how case and animacy interact at NP2. In Experiment 1, we observed a biphasic N400-late positivity effect when human common nouns were not marked with accusative case. Therefore, we should expect a similar result for the comparison of human vs. inanimate nouns in this experiment. A further question is how the processing of NP1 (inanimate or animate arguments) influences NP2, i.e whether the animacy of NP1 influences the processing of the case violation for the undergoer. Is a violation of *ko*-marking easier to process when the actor is prototypical (animate) as opposed to when it is low in prototypicality (inanimate)?

5.3 Materials and Methods

5.3.1 Participants

Twenty four right handed native speakers of Hindi participated in the experiment (eight women, mean age 26.83 years, range 23-37). At the time of the experiment, all participants were residing in Berlin.

5.3.2 Materials

Eighty sets of the eight sentence conditions shown in Table 5.1 were constructed. Arguments were human proper nouns and inanimate objects. The 640 sentences thus resulting were subdivided into two lists, each containing 320 sentences. The A-arguments in set 1-40 were changed as O-arguments in set 41-80 and O-arguments in set 1-40 were changed as A-arguments in set 41-80. Thus, the items which were NP1 in 1-40 were NP2 in 41-80 and the items which were NP2 in 1-40 were NP1 in 41-80. This was done in order to avoid any lexical effect. Though, there was an error for the conditions animate -inanimate(nom) (AIN) and inanimate-inanimate (nom) (IIN) when NP2 was inanimate feminine. The verbs used in this experiment were always 3rd person singular masculine, so when NP2 was inanimate feminine these sentences were ungrammatical. So those sets that had this problem were removed from the final analysis. In the final analysis, there were only 56 sets, as 24 sets were removed due to this problem.

Condition	Sentences
AIN	NPanim-ERG NP-inaim V-perfective aux saroj-ne rath khiiMc-aa hai. Saroj.m-erg chariot.m(Nom) pull-PFV.3sg.m aux "Saroj has pulled the chariot."
AIK	NPanim-ERG NPinaim-ko V-perfective aux saroj-ne rath-ko khiiMc-aa hai. Saroj-erg chariot.m-acc pull-PFV.3sg.m aux "Saroj has pulled the chariot"
IIN	NPinanim-ERG NPinaim V-perfective aux taaNgaa[13]-ne rath khiiMc-aa hai tonga.m-Erg chariot.m(Nom) pull-PFV.3sg.m aux "Tonga has pulled the chariot."
IIK	NPinanim-ERG NPinaim-ko V-perfective aux taaNga-ne rath-ko khiiMc-aa hai tonga.m-Erg chariot.m-acc pull-PFV.3sg.m aux "Tonga has pulled the chariot."
*AAN	NPanim-ERG NPanim V-perfective aux saroj-ne ramesh khiiMc-aa hai Saroj.m-Erg Ramesh.m(Nom) pull-PFV.3sg.m aux "Saroj has pulled Ramesh."
AAK	NPanim-ERG NPanim-ko V-perfective aux saroj-ne ramesh-ko khiiMc-aa hai Saroj.m-Erg Ramesh.m-acc pull-PFV.3sg.m aux "Saroj has pulled Ramesh."
*IAN	NPinanim-ERG NPanim V-perfective aux taaNgaa-ne ramesh khiiMc-aa hai tonga.m-Erg Ramesh.m(NOM) pull-PFV.3sg.m aux "Tonga has pulled Ramesh."
IAK	Npinanim-ERG NPanim -ko V-perfective aux taaNgaa-ne ramesh-ko khiiMc-aa hai tonga.m-Erg Ramesh.m-acc pull-PFV.3sg.m aux "Tonga has pulled Ramesh."

Table 5.1. Example sentences for each of the critical conditions in Experiment 3 (Abbreviations: A-Animate, I-Inanimate, N-Nominative, K-accusative).

[13] Horse-drawn carriage.

5.3.3 Procedure

The procedure was the same as in the previous experiment.

5.3.4 EEG Recordings

The EEG recoding was done in an identical manner to that of Experiment 1.

5.3.5 Data Analysis

Data analysis was same as Experiment 1. The factors were ANIMACY-NP1 (animate vs. inanimate), ANIMACY-NP2 (animate vs. inanimate) and CASE-NP2 (nominative vs. accusative).
As mentioned above, there was an error in the material for the conditions AIN and IIN. So we excluded those sets (n=24) that were problematic, both in the analysis of behavioural data and the analysis of the verb in ERP data. As it only became was at the position of verb that these sentences were ungrammatical, there was no problem at the position of NP1 and NP2. After analysing the mean values for the acceptability judgement task, we observed that there were two groups of participants: one group, which had a tendency to rate the non case-marked argument at NP2 as acceptable, and another group, which accepted the case-marked argument at NP2. Hence, for the following analysis (for both behavioural and ERP data) GROUP was included as a between participant factor. The topographical factors were same as in Experiment 1.

5.4 Results

5.4.1 Behavioural

Table 5.2 shows the mean acceptability ratings and reaction times for the acceptability judgement task and comprehension question.

Condition	Acceptability Judgement		Comprehension Question	
	Acceptance (%)	Reaction time (ms)	Correct (%)	Reaction time (ms)
AIN	69 (18)	582 (185)	88 (6)	1853 (341)
AIK	88 (6)	521 (185)	91 (6)	1769 (357)
IIN	60 (19)	642 (208)	87 (10)	1929 (358)
IIK	83 (7)	549 (193)	89 (7)	1842 (370)
*AAN	24 (27)	520 (147)	79 (7)	1863 (352)
AAK	89 (5)	495 (152)	86 (7)	1770 (349)
*IAN	26 (24)	552 (184)	84 (9)	1847 (356)
IAK	82 (10)	548 (188)	89 (6)	1772 (320)

Table 5.2. The mean percentage for the acceptability judgement task and comprehension question, and reaction times for both the tasks, the standard deviations are given in the parenthesis.

Due to the surprisingly low acceptability of condition AIN, we undertook a median split. Results showed a difference between two groups, one with a general tendency to accept sentences without *ko*-marking (AIN/IIN/AAN/IAN) and another with a general tendency to reject sentences without *ko*-marking. For two participants, the rating was identical to the median, so they were excluded from the final analysis. Finally, there were 11 participants in each group. The mean values for both groups are given in Table 5.3 and 5.4:

Condition	Acceptability Judgement		Comprehension Question	
	Acceptance (%)	Reaction time (ms)	Correct (%)	Reaction time (ms)
AIN	86(6)	558(180)	88(6)	1850(421)
AIK	91(5)	551(197)	91(5)	1745(383)
IIN	75(12)	640(212)	90(9)	1912(443)
IIK	84(9)	564(213)	90(6)	1836(447)
*AAN	33(34)	491(163)	76(6)	1856(409)
AAK	91(5)	472(139)	87(9)	1744(389)
*IAN	33(33)	545(187)	85(9)	1825(402)
IAK	82(13)	544(177)	88(6)	1732(380)

Table 5.3. The mean percentage for the acceptability judgement task and comprehension question, and the reaction times for the High Group, the standard deviations are given in the parenthesis.

Condition	Acceptability Judgement		Comprehension Question	
	Acceptance (%)	Reaction time (ms)	Correct (%)	Reaction time (ms)
AIN	52(10)	630(199)	88(6)	1872(271)
AIK	84(5)	550(192)	89(7)	1799(353)
IIN	47(15)	660(226)	85(10)	1962(299)
IIK	82(5)	549(191)	88(8)	1852(339)
*AAN	10(6)	552(142)	81(6)	1891(325)
AAK	87(5)	531(175)	83(5)	1808(334)
*IAN	17(9)	548(193)	84(8)	1877(349)
IAK	82(6)	566(216)	89(6)	1821(280)

Table 5.4. The mean percentage for the acceptability judgement task and comprehension question, and the reaction times for the Low Group, the standard deviations are given in the parenthesis.

As a result of this difference in the judgement patterns, all further analysis includes the factor GROUP as a between participants factor.

A repeated measures ANOVA taking GROUP as a between factor for the acceptability judgement task revealed significant main effects of ANIMACY-NP1: $F_2(1,55)=11.92$, $p<0.0006$), ANIMACY-NP2: ($F_1(1,20)=15.72$, $p<0.001$; $F_2(1,55)=59.47$, $p<0.001$) CASE-NP2: ($F_1(1,20)=52.21$, $p<0.001$; $F_2(1,55)=103.57$, $p<0.001$) and the interactions of ANIMACY-NP2 x CASE-NP2: ($F_1(1,20)=11.82$, $p<0.0008$; $F_2(1,55)=33.89$, $p<0.001$), CASE-NP2 x GROUP: ($F_1(1,20)=23.29$, $p<0.001$; $F_2(1,55)=38.66$, $p<0.001$) and ANIMACY-NP2 x GROUP: ($F_2(1,55)=4.13$, $p<0.04$) .

Resolving the interaction of CASE-NP2 and GROUP by GROUP revealed a main effect of CASE both for the High: ($F_1(1,10)= 4.13$, $p<0.06$; $F_2(1,55)=28.32$, $p<0.001$) and the Low Group: ($F_1(1,10)=33.46$, $p<0.001$; $F_2(1,55)=41.87$, $p<0.001$).

Resolving by GROUP for the items further revealed an effect of ANIMACY-NP2 for both the High Group: $F_2(1,55)=21.42$, $p<0.001$ and the Low Group: $F_2(1,55)=17.01$, $p<0.001$.

Resolving the interaction of ANIMACY-NP2 and CASE- NP2 by CASE showed a main effect of ANIMACY-NP2 ($F_1(1,20)=5.66$, $p<0.02$; $F_2(1,55)=53.03$, $p<0.001$), only for the nominat- ive, non case-marked objects.

For the comprehension question, the statistics revealed a main effect of CASE-NP2: $F_1(1,20)=4.10$, $p<0.04$ by participant, only, and for the items, it showed the interactions of ANIMCY-NP2 x CASE-NP2: $F_2(1,879)=4.08$, $p<0.04$), and ANIMACY-NP1 x ANIMACY-NP2: $F_2(1,55)= 3.20$, $p<0.07$;

and ANIMACY-NP1 x CASE-NP2: $F_2(1,879)=3.25$, $p<0.07$. The interactions of ANIMACY-NP1 x ANIMACY-NP2 and ANIMACY-NP1 x CASE-NP2 were only marginally significant and there for they were not resolved further.

Resolving the interaction of ANIMCY-NP2 x CASE-NP2 by CASE-NP2 showed a main effect of ANIMACY-NP2: $F_2(1,55)=3.63$, $p<0.06$ only for the nominative case.

The reaction times for both the acceptability task and comprehension question did not show any significant effect for the subjects, while for items, it revealed an interaction of ANIMACY-NP1 x GROUP: $F_2(1,55)=3.90$, $p<0.05$ for the acceptability judgement task.

Resolving by GROUP did not show any effect of ANIMACY-NP1 neither for the High nor the Low Group.

For the comprehension questions it showed the interaction of ANIMACY-NP1 x ANIMACY- NP2 x CASE-NP: $F_2(1,55)=4.56$, $p<0.04$). Resolving by ANIMACY-NP1 did not show any effect as well.

Summary:
Similar to the mean values of the two groups, the statistical analysis of the acceptability judgement task showed an interaction of GROUP with CASE-NP2 for participants, only. The presence of this interaction shows that the effect was larger for the Low Group. So while both groups judged the structures with an accusative (*ko*-marked) object more acceptable, the acceptability drop for the non case-marked structure was more pronounced for the Low Group.

Further, the effect of case was observed for both the High and Low Group. The interaction of ANIMCY-NP2 and CASE-NP2 (independent of group), when resolved, showed the effect of ANIMYCY-NP2 only for the nominative case. Thus, for both the groups, inanimate nominative objects were more acceptable than animate nominative objects.

5.4.2 ERP Results

Visual inspection showed a negativity for the inanimate arguments at NP1 in comparison to the animate arguments. See Figure 5.1:

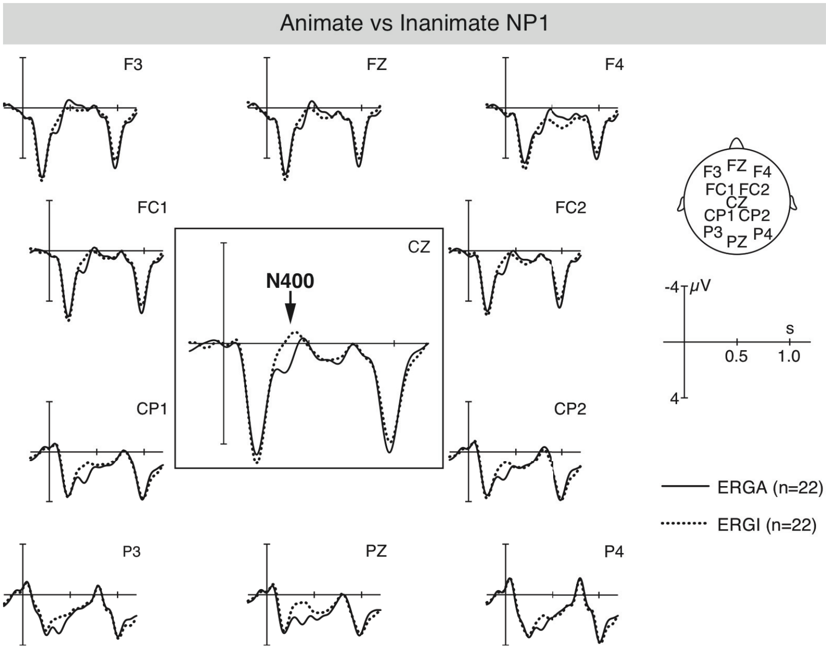

Figure 5.1. Grand average ERPs at the position of NP1(N=22). Solid line for the animate and dotted line for inanimate argument. The negativity is plotted upwards.

5.4.2.1 NP1

Time window 1 (300-500 ms): On the basis of visual inspection, a repeated measures ANOVA was performed for the 300-500 ms time window. The analysis revealed a significant main effect of ANIMACY (midline: $F(1,21)=12.88$, $p<0.002$; lateral: $F(1,21)=4.20$, $p<0.05$) and an interaction of ROI x ANIMACY (midline: $F(5,105)=3.28$, $p<0.04$; lateral: $F(3,63)=5.71$, $p<0.009$).

Resolving by ROI, a main effect of ANIMACY was observed at midline electrodes on the following sites: CZ: $F(1,21)=10.82$, $p<0.004$; CPZ: $F(1,21)=13.02$, $p<0.002$; PZ: $F(1,21)=12.57$, $p<0.002$ and POZ: $F(1,21)=19.04$, $p<0.001$. The lateral electrodes sites revealed a main effect of ANIMACY at left posterior: $F(1,21)=18.40$, $p<0.001$ and right posterior sites: $F(1,21)=6.04$, $p<0.02$.

Summary:

The statistical analysis supports the N400 effect for inanimate arguments. As the Anova shows, this effect was independent of the group factor, since there was no interaction of GROUP and ANIMACY.

5.4.2.2 NP2

On the basis of visual inspection, a repeated measures ANOVA was performed for NP2 for the two time windows 250-450 ms and 550-800 ms. We observed a negativity for the case-marked inanimate argument in the earlier time window. The latter time window showed a negativity for the animate nominative argument for the Low Group.

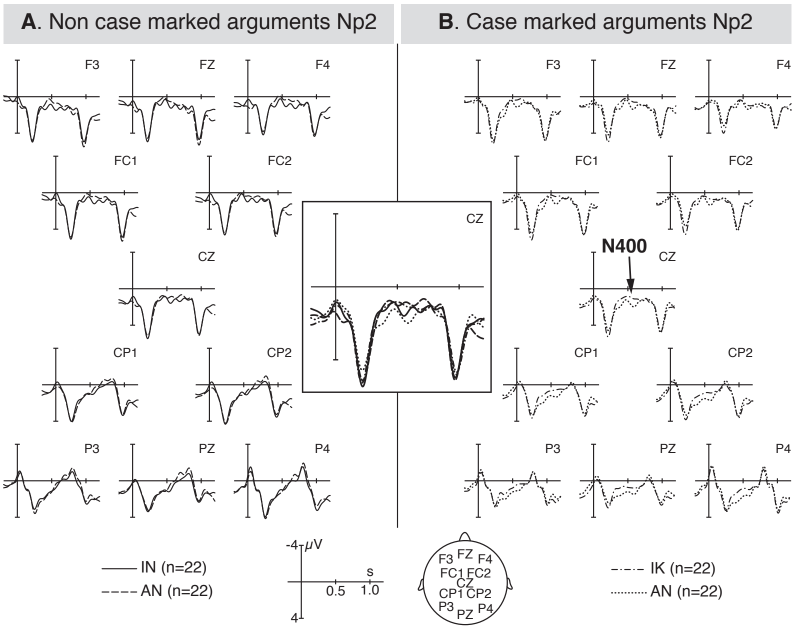

Figure 5.2. Grand average ERPs at the position of NP2 (n=22) comparing nominative (animate vs. inanimate) left panel and accusative (animate vs. inanimate) right panel. Negativity is plotted upwards.

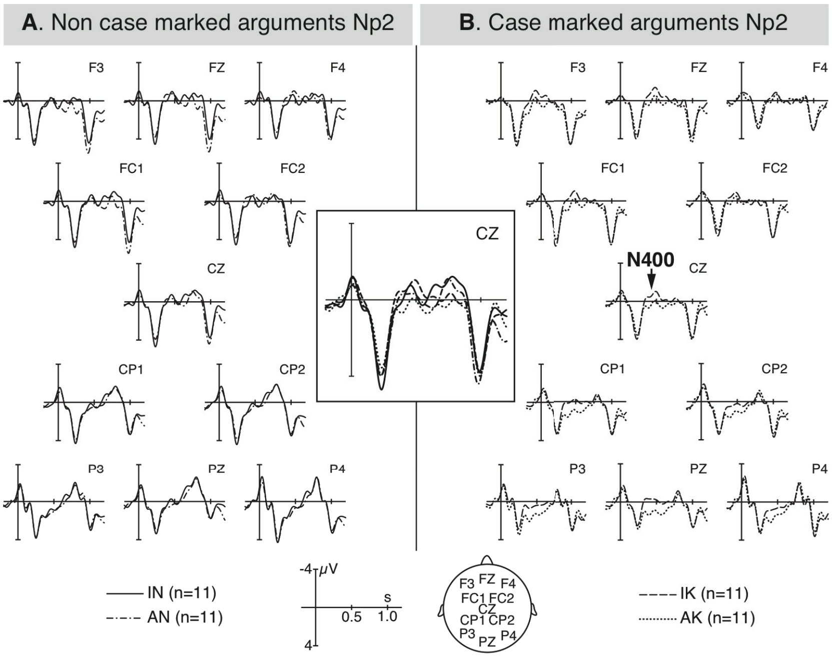

Figure 5.3. Grand average ERPs at the position of NP2 (n=11) for the High Group, comparing nominative (inanimate vs. animate) left panel and accusative (animate vs. inanimate) right panel. Negativity is plotted upwards.

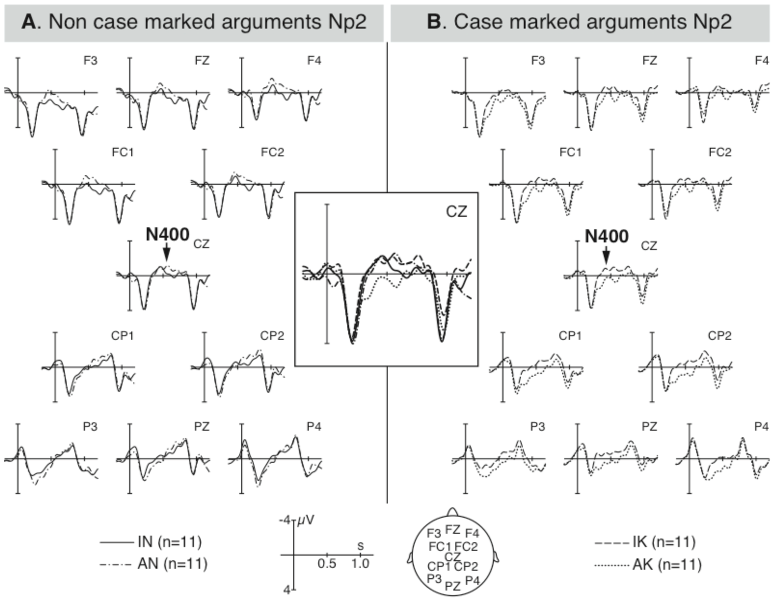

Figure 5.4. Grand average ERPs at the position of NP2 (n=11) for the Low Group, comparing nominative (inanimate vs. animate) in the left panel and accusative (animate vs. inanimate) in the right panel.

Time window 1 (250-450 ms): The statistical analysis for the time window 250-450 ms revealed a main effect of ANIMCY-NP2 (midline: $F(1,20)=25.53$, $p<0.001$; lateral: $F(1,20)=6.44$, $p<0.02$) and ANIMCY-NP1 (midline: $F(1,20)=3.55$, $p<0.07$). The effect of ANIMACY-NP1 was observed for the midline electrodes, only. Further, it revealed the interactions of ROI x CASE-NP2 (midline: $F(5,100)=13.79$, $p<0.001$; lateral: $F(3,60)=6.59$, $p<0.001$), ROI x ANIMACY-NP2 (midline: $F(5,100)=6.33$, $p<0.004$; lateral: $F(3,60)=13.58$, $p<0.001$), CASE-NP2 x ANIMCY-NP2 (midline: $F(1,20)=5.64$, $p<0.03$; lateral: $F(1,20)=7.03$, $p<0.02$), and ROI x ANIMYC-NP1 (midline: $F(5,100)=8.29$, $p<0.004$; lateral: $F(3,60)=10.45$, $p<0.001$).

Resolving by ROI for the midline electrodes revealed a main effect of CASE-NP2 at PZ: $F(1,20)=3.96$, $p<0.06$ and POZ: $F(1,20)=7.78$, $p<0.01$. An effect of ANIMCY-NP2 was found at FCZ: $F(1,20)=13.05$, $p<0.002$; CZ: $F(1,20)=15.95$, $p<0.001$; CPZ: $F(1,20)=24.24$, $p<0.001$; PZ: $F(1,20)=26.61$,$p<0.001$; and POZ: $F(1,20)=53.07$, $p<0.001$ and an effect of ANIMACY-NP1 at CZ: $F(1,20)=4.18$, $p<0.05$; CPZ: $F(1,20)=7.39$, $p<0.01$; PZ: $F(1,20)=8.87$, $p<0.007$; POZ: $F(1,20)=6.74$, $p<0.02$.

Resolving by ROI for the lateral sites showed a main effect of CASE-NP2 at left anterior $F(1,20)=3.64, p<0.07$, a main effect of ANIMACY-NP2 at left anterior: $F(1,20)=7.10$, $p<0.01$; left posterior: $F(1,20)= 17.10$, $p<0.001$; and right posterior: $F(1,20)= 13.21$, $p<0.002$ and an effect of ANIMACY-NP1 at left posterior: $F(1,20)=8.51$, $p<0.008$; and right anterior: $F(1,20)=7.76$, $p<0.01$.

Resolving the interaction of CASE-NP2 x ANIMACY-NP2 by CASE for midline electrodes showed an effect of ANIMYC-NP2 for both the nominative: $F(1,20)=3.69$,0.07 and accusative case: $F(1,20)=25.53$, $p<0.001$.

The interaction of CASE-NP2 x ANIMCY-NP2 by CASE for the lateral electrodes sites revealed a main effect of ANIMACY-NP2 only for the accusative case: $F(1,20)=14.47$, $p<0.001$.
In sum, this effect (N400) was observed when NP2 was an inanimate accusative.

Time window 2 (550-800 ms): The analysis revealed the interactions of ROI x CASE-NP2 (midline: $F(5,100)=5.52$, $p<0.009$; lateral: $F(3,60)=16.09$, $p<0.001$), CASE-NP2 x ANIMACY-NP2 (midline: $F(1,20)=3.69$, $p<0.07$; lateral: $F(1,20)=7.21$, $p<0.01$), while the interactions of ROI x ANIMCY-NP2: (lateral: $F(3,60)=8.39$, $p<0.002$), ROI x ANIMCY-NP1: (lateral: $F(3,60)=4.97$, $p<0.006$), ROI x CASE-NP2 x GROUP: (lateral: $F(3,60)=3.04$, $p<0.05$) and CASE-NP2 x ANIMACY-NP2 x GROUP: (lateral: $F(1,20)=9.27$, $p<0.006$) were observed for the lateral sites, only.

Resolving by ROI for midline electrodes revealed a main effect of CASE-NP2 at PZ: $F(1,20)=7.39$, $p<0.01$ and POZ: $F(1,20)= 4.20$, $p<0.05$.

Resolving interactions for lateral sites by ROI showed a main effect of CASE-NP2 at left anterior: $F(1,20)= 8.81$, $p<0.007$ and right posterior: $F(1,20)=5.90$, $p<0.02$; an effect of ANIMACY-NP2 at left posterior: $F(1,20)=5.50$, $p<0.03$, and an effect of ANIMACY-NP1 at left posterior: $F(1,20)=7.62$, $p<0.01$.

Resolving the interaction of CASE-NP2 x ANIMACY-NP2 for midline electrodes by CASE-NP2 revealed a main effect of ANIMACY-NP2: $F(1,20)=7.36$, $p<0.01$ for the accusative case, only. The negativity effect for the accusative inanimate arguments.

The interaction of ROI x CASE-NP2 x GROUP , when resolved by ROI for the lateral sites, did not show an interaction of CASE-NP2 x GROUP for any of the ROIs.

Resolving the interaction of CASE-NP2 x ANIMACY-NP2 x GROUP by GROUP for the lateral sites revealed an interaction of CASE-NP2 and ANIMACY-NP2 only for the Low Group: ($F(1,10)=10.11$, $p<0.009$).

Further resolving the interaction by CASE-NP2 showed a main effect of ANIMACY-NP2 for the nominative case: ($F(1,10)=4.18$, $p<0.07$, the negativity effect for the animate nominative in comparison to inanimate nominative arguments, for the lower group.

Summary:

In the early time window, an N400 effect was observed for the inanimate arguments that were case-marked (accusative *ko*). As the statistics show, this effect was independent of GROUP, since there was no interaction of GROUP with any of the other factors. In the later time window, an N400 effect was observed for the Low Group for nominative animate arguments. But in this case, there was an interaction of GROUP with other factors for the lateral electrode sites, while there was no interaction of GROUP with any other factors for the midline electrodes. For the midline electrodes, the effect was rather the continuity of the effect from the early time window. Thus, the N400 effect in the later time window for animate nominative argument was only observed for the Low Group.

5.4.3.3 Verb

Visual inspection showed a positivity effect (400-800 ms) at the position of the verb when NP2 was non case-marked (nominative), and an early positivity (150-300 ms) for the animate nominative arguments. A repeated measures ANOVA was performed for both the time windows.

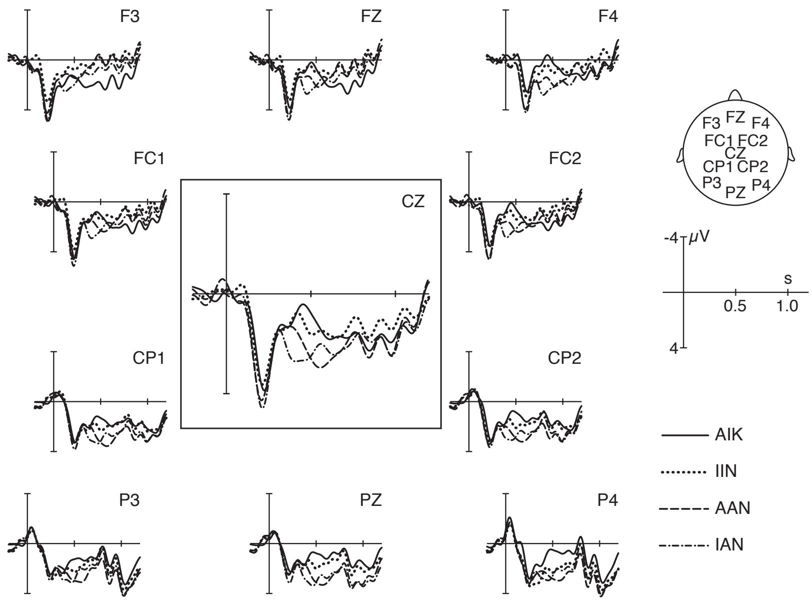

Figure 5.5. Grand average ERPS at the position of the verb for all participants (n=22), comparing case-marked and non case-marked NP2.

Time window 1 (150-300 ms): The statistical analysis revealed a significant main effect of CASE-NP2 (midline: $F(1,20)=6.68$, $p<0.02$; lateral: $F(1,20)=7.59$, $p<0.01$) and the interactions of ROI x ANIMACY-NP2 (midline: $F(5,100)=8.83$, $p<0.001$; lateral: $F(1,20)=7.59$, $p<0.01$), CASE-NP2 x ANIMACY-NP2 x ANIMACY-NP1 (midline: $F(1,20)=3.99$, $p<0.06$; lateral: $F(1,20)=5.66$, $p<0.03$), and ROI x ANIMACY- NP1 x GROUP (lateral: $F(3,60)=2.65$, $p<0.06$).

Resolving by ROI for the midline electrodes showed a main effect of ANIMACY-NP2 only at POZ: $F(1,20)=5.77$, $p<0.03$.

Resolving by ROI for the lateral sites showed a main effect of CASE-NP2 in the right anterior: $F(1,20)=22.19$, $p<0.001$ and right posterior regions: $F(1,20)= 19.77$, $p<0.001$, and the effect of ANIMACY-NP2 at left posterior: $F(1,20)=7.24$, $p<0.01$ and right anterior sites: $F(1,20)= 5.97$, $p<0.02$.

Resolving the interaction of CASE-NP2 x ANIMACY-NP2 x ANIMACY-NP1 by ANIMACY-NP1 for the midline electrodes showed an interaction of CASE-NP2 x ANIMACY-NP2 only for the inanimate arguments: $F(1,20)=5.44$, $p<0.03$. Thus, this interaction of CASE-NP2 and ANIMACY-NP2 occurred when NP1 was inanimate. There was no interaction for an animate NP1.

Further resolving the interaction of CASE-NP2 x ANIMACY-NP2 by CASE-NP2 showed a marginal effect of ANIMACY-NP2: (F(1,20)= 3.57, p<0.07) for the nominative case, only.

When the interaction of ROI x ANIMCY-NP1 x GROUP was resolved by ROI for the lateral sites, it did not reveal an effect for the any ROIs.

When the interaction of CASE-NP2 x ANIMACY-NP2 x ANIMACY-NP1 for the lateral sites was resolved by ANIMACY-NP1, it only revealed an interaction of CASE-NP2 x ANIMACY-NP2 for the inanimate first arguments: (F(1,20)=4.08, p<0.06.

Further resolving the interaction of CASE-NP2 x ANIMACY-NP2 by CASE-NP2 did not show any effect for neither nominative nor accusative case.

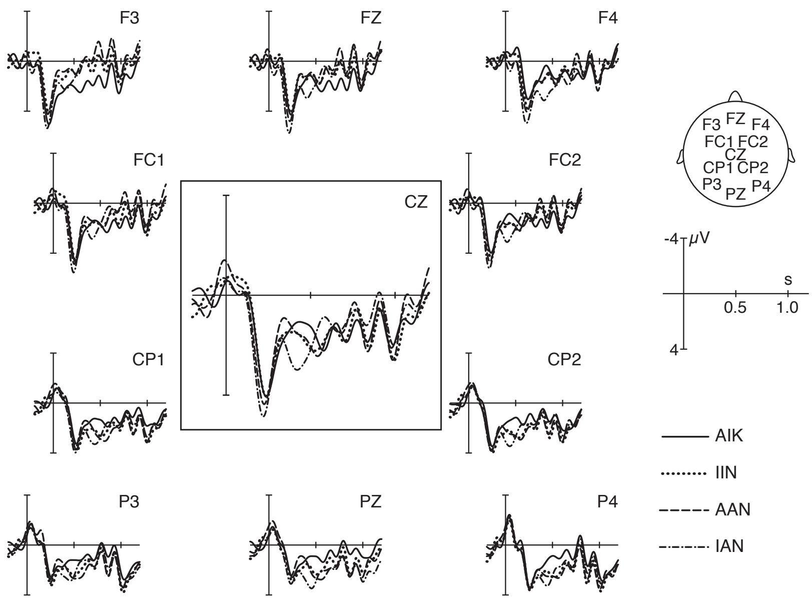

Figure 5.6. Grand average ERPs (n=11) at the verb for the High Group comparing case-marked NP2 and non case-marked NP2. The solid line for the case-marked condition and rest for non case-marked condition.

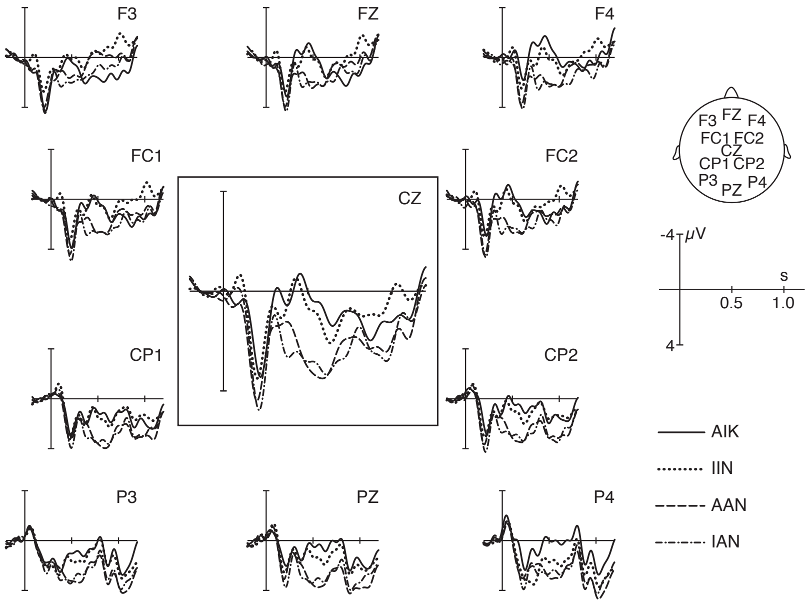

Figure 5.7. Grand average ERPs (n=11) at the position of the verb for the Low Group comparing case-marked NP2 and non case-marked NP2. The solid line is for the case-marked condition and rest for the non case-marked condition.

Time window 2 (400-800 ms): In this time window, the analysis revealed a main effect of CASE-NP2 (midline: $F(1,20)=13.61$, $p<0.002$; lateral: $F(1,20)=5.57$, $p<0.03$). Further, it revealed the interactions of ROI x CASE-NP2 (midline: $F(5,100)=7.46$, $p<0.004$; lateral: $F(3,60)=19.36$, $p<0.001$), CASE-NP2 x ANIMACY-NP2 (midline: $F(1,20)=5.32$, $p<0.03$; lateral: $F(1,20)= 4.26$,$p<0.05$), CASE-NP2 x ANIMACY-NP2 x ANIMACY-NP1 (lateral: $F(1,20)=4.39$, $p<0.05$) and CASE-NP2 x ANIMACY-NP2 x GROUP (midline: $F(1,20)=3.65$, $p<0.07$; lateral: $F(1,20)=5.95$, $p<0.02$).

Resolving by GROUP for the midline electrodes showed an interaction of CASE-NP2 x ANIMACY-NP2 for the Low Group: $F(1,20)=6.49$, $p<0.03$.

Further resolving the interaction of CASE-NP2 x ANIMCY-NP2 by CASE-NP2 showed the main effect of ANIMACY-NP2 for the nominative case: $F(1,20)=6.46$, $p<0.03$.

Resolving by GROUP for the lateral electrodes sites showed the interaction of CASE-NP2 x ANIMACY- NP2 for the Low Group: $F(1,20)=6.97$,$p<0.02$.

Further resolving the interaction of CASE-NP2 x ANIMACY-NP2 by CASE-NP2 showed a main effect of ANIMACY-NP2 for the nominative case: $F(1,20)=4.77$, $p<0.05$.

Resolving by ROI for the midline electrodes revealed a significant main effect of CASE-NP2 at CZ: $F(1,20)= 8.96$, $p<0.007$; CPZ: $F(1,20)= 22.83$, $p<0.001$; PZ: $F(1,20)= 30.97$, $p<0.001$; and POZ: $F(1,20)= 21.56$, $p<0.001$.

Resolving the interactions by ROI for the lateral electrodes sites showed a main effect of CASE-NP2 at left posterior: $F(1,20)=11.31$, $p<0.003$; right anterior: $F(1,20)=7.96$, $p<0.01$ and right posterior sited: $F(1,20)=23.92$, $p<0.001$ and the effect of ANIMACY-NP2 in the left anterior region: $F(1,20)=5.68$, $p<0.03$.

When the interaction of CASE-NP2 x ANIMACY-NP2 x ANIMACY-NP1 was resolved by ANIMACY-NP1, it only revealed an interaction of CASE-NP2 x ANIMACY-NP2 for the inanimate NP1: $F(1,20)=6.80$,$p<0.02$.

Further resolving the interaction of CASE-NP2 x ANIMACY-NP2 by CASE-NP2 showed a main effect of ANIMACY-NP2 ($F(1,20)=4.45$, $p<0.05$) for the nominative case, only.

In sum, the positivity was observed when the first argument was inanimate and second NP was nominative (both inanimate and animate).

Summary:

In the early time window of 150-300 ms, the effects at the midline electrodes were independent of the group factor. For sentences with an inanimate first argument, we observed a marginally significant positivity for sentences with an animate nominative NP2. The later positivity was observed for both the groups when the first argument was inanimate and second argument was nominative (both inanimate and animate). This effect was more pronounced when the NP2 was animate.

5.6 Discussion

We observed an N400 at NP1 for inanimate arguments in comparison to animate arguments. For NP2, we observed an N400 for the inanimate accusative-marked arguments. The negativity was also observed for the animate nominative argument but this effect was found only for the low acceptability group in the time range of 400-800 ms. However, this negativity effect was mainly observed for the lateral sites; at midline electrodes it seems to be the continuity of the negativity effect from an early time window. For the verb, we found a positivity when NP1 was inanimate and NP2 was nominative. A marginally significant early positivity was observed when the first argument was inanimate and the second argument was an animate nominative.

5.6.1 Effect at NP1

We observed an N400 effect for the inanimate arguments at NP1. This effect was expected as inanimate arguments are not a prototypical actor as animate arguments. Since inanimate arguments are not prototypical actors, an N400 in this case is evoked due to a problem in the *compute prominence* step (Bornkessel & Schlesewsky 2006a). It is unlikely that the N400 for inanimate ergative NPs at the position of NP1 is lexical in nature (i.e. due to lexical differences between animate and inanimate nouns), since the same nouns were used at the position of NP2 (see materials section), for which no general animacy effect was observed. Recall that this effect was also independent of the group factor. Thus, this result suggests that the animacy effect for an initial ergative contrasts with the absence of animacy effects for initial nominatives in languages such as German and Tamil (and also for initial arguments in Chinese). Therefore, it suggests that the unambiguous actor reading required by the ergative allows for an assessment of actor prototypicality already at the position of NP1 in Hindi, whereas in other languages, there is still the possibility of an S reading at NP1 and actor prototypicality is therefore not yet an issue.

5.6.2 Effect at NP2

At NP2, we observed a negativity for the inanimate case-marked arguments. There was no general effect for animate nominatives (non-case-marked argument) in comparison to inanimate nominative arguments. However, a negativity was observed for animate nominative argument for the Low Group. Recall from Chapter 2 that inanimate arguments only take accusative marking when there is a specific/definite meaning. Hence, both the negativity observed at NP1 and NP2 seems to be due to the interaction of case and animacy. Thus, at NP2, this effect is observed due to the prominence mismatch between the animacy and case marking dimensions. In accordance to eADM, there will be a problem in *compute prominence* and hence, this N400 effect is evoked. Recall from Chapter 2 (section 2.7) that Vasishth (2003) explored the effect of case marking in centre-embedding constructions in Hindi and reported that *ko*-marked objects were more difficult to process than non *ko*-marked arguments. Thus, this N400 effect for accusative inanimate arguments suggests that *ko*-

marked inanimate arguments are difficult to process in both simple sentences and centre-embedding constructions.

While there was no general animacy effect observed for the earlier time window, we did find a negativity in the latter time window for the animate nominative in comparison to the inanimate nominative. But this effect was only observed for the Low Group participants. This result is not surprising as animate arguments that are not case-marked are ungrammatical. Hence, this problem is also due to a conflict in *compute prominence,* but the interesting issue in this case is the group factor. Recall from Experiment 1 that we observed a biphasic N400-late positivity effect for accusative case violations (for a human nominative argument at NP2). But in the present experiment, there was no general effect observed for human nouns in comparison to inanimate nominates but the effect was only observed for the Low Group participants. It suggest that the case marking effect may vary depending on the group. It is important to note that the High Group also judged the animate nominative sentences significantly less acceptable. So it is not a problem of not recognising the violation. The participants could not be grouped on the basis of region and the languages they spoke. Hence, it becomes important to investigate the reason for such a difference. Finally, recall from our hypothesis, we proposed that the undergoer can not be predicted from and actor in the same way as an actor can be predicted from an undergoer (Bornkessel-Schlesewsky & Schlesewsky, 2009c). This hypothesis is well taken into account.

5.6.3 Effect at position of the verb

At the position of verb, we observed two effects a positivity when NP2 was nominative, and an early positivity when NP2 was animate nominative. The early positivity seems to be like a P200, which was observed for animate non case-marked arguments. A P200 has been observed for semantic incongruity in some studies (Landi et al., 2006) but this is not the case here. Other cases where a P200 effect has been reported are for the modulation of the P200 for semantic associates (Coulson, Federmeier, Van Petten, and Kutas, 2005) and early sensitivity to semantic manipulations (Martin-Loeches, Hinojosa, Gomez-Jarabo, & Rubia, 2001). Since this effect was marginally significant and only observed at midline electrodes, we will not discuss it any further.

There were only two conditions with ungrammatical animate nominative arguments at NP2. This indicates that the positivity does not seem to be caused by the ungrammaticality of NP2. Furthermore, this effect was based on the animacy of NP1. When NP1 was inanimate and NP2 was nominative (both animate and inanimate), the effect was stronger. The positivity also seemed to be more pronounced for the Low Group. Recall from the discussion of the behavioural data that for the condition IIN (when the first argument was inanimate and the second argument an inanimate nominative), the acceptability rating was only around 60%, while is was around 80% when second argument was an accusative. This suggests that when the first argument was inanimate and second argument was nominative, people had a tendency to reject these sentences. Thus, it can be argued that there is problem in the well-formedness of the sentences. This positivity evoked due the problems in well-formedness check (Bornkessel & Schlesewsky, 2006a). Recall from Chapter 1, in accordance with eADM core informations and other informations like plausibility etc. interacts in *generalised mapping step* and the problem in this case evokes a P600 effect. Thus, we provide an speculative analysis of this result in terms of pragmatic properties of argument realisation (see Chapter 7). This effects seems to be like the P200 observed for animate non case-marked arguments.

Chapter 6

Experiment 4: Processing of long distance agreement in Hindi

6.1 Introduction

In this experiment, the agreement pattern of Hindi was put to test. It is well-known that the agreement pattern in Hindi is dependent on the case marking of the argument as only nominative case-marked arguments agree with the verb (for details, see Chapter 2). In general, agreement violations engender a biphasic LAN-positivity or simply a positivity effect. Kutas and Hillyard (1983) showed that for the agreement violation in the sentence **Some shells is even soft* a LAN is elicited at the position of *is*. Since then, several studies have reported a either a LAN-positivity or a positivity for agreement violations (Coulson, King, and Kutas 1998; de Vincenzi et. Al 2003; Hagoort and Brown 2000). Nevins (et al., 2007) showed a positivity for the all types (gender, person) of agreement violations in Hindi. However, the difference between earlier studies and the present study lies in the fact that all the earlier studies took simple clauses into account. In this study, we tried to see if the agreement mismatch showed a similar effect for agreement across clause boundaries. Hence, for this purpose, we investigate the phenomena called long distance agreement (LDA) in Hindi, which is also crucially dependent on ergative case marking. Therefore, in this case, it is also important to observe if the processing of the agreement differs depending on case marking. We observed in the first experiment that nominative and ergative case showed different results. As the agreement in Hindi is dependent on the case marking, one goal of this experiment was to test if the results vary on the basis of the case marking of the first argument. In so far, this study can also be related to the earlier experiments.

6.2 Present study

The critical sentence conditions for the present study (see Table 6. 1) involve a manipulation of the following factors: the case marking of the matrix subject (nominative vs. ergative), the agreement properties of the infinitival verb (masculine vs. feminine) and the agreement properties of the control verb (masculine vs. feminine).

Conditions	Sentences
NMM	Raam$_i$ [ø$_i$ saikal calaa-naa] caah-taa hai. R.(M)[NOM] [NOM cycle(F)[NOM] ride-INF.M] want-IPFV.m AUX 'Ram wants to ride a bicycle.'
NFM	Raam$_i$ [ø$_i$ saikal calaa-nii] caah-taa hai. R.(M)[NOM] [NOM cycle(F)[NOM] ride-INF.F] want-IPFV.m AUX 'Ram wants to ride a bicycle.'
NFF	*Raam$_i$ [ø$_i$ saikal calaa-nii] caah-tii hai. R.(M)[NOM] [NOM cycle(F)[NOM] ride-INF.F] want-IPFV.f AUX 'Ram wants to ride a bicycle.'
EMM	Raam-ne$_i$ [ø$_i$ saikal calaa-naa] caah-aa hai. R.(M)-ERG [NOM cycle(F)[NOM] ride-INF.M] want-PFV.m AUX 'Ram wanted to ride a bicycle.'
EFM	*Raam-ne$_i$ [ø$_i$ saikal calaa-nii] caah-aa hai. R.(M)-ERG [NOM cycle(F)[NOM] ride-INF.F] want-PFV.m AUX 'Ram wanted to ride a bicycle.'
EFF	Raam-ne$_i$ [ø$_i$ saikal calaa-nii] caah-ii hai. R.(M)-ERG [NOM cycle(F)[NOM] ride-INF.F] want-PFV.f AUX 'Ram wanted to ride a bicycle.'.

Table 6.1. Example sentences for each of the critical conditions in Experiment 4.

In Hindi, as discussed earlier, verbs agree with the highest-ranking nominative argument in terms of number, gender and person (Mohanan, 1994). Thus, when there is a nominative S or an A argument, it triggers verb agreement (cf. the agreement between the matrix subject *Raam* and the verb *caahtaa* in conditions NMM/NFM in Table 6.1 and the ungrammaticality of condition NFF). By contrast, when the A argument bears non-nominative case marking (e.g. ergative or dative), agreement is with the nominative O argument. When there is no nominative argument in the clause, the verb typically bears default (3rd person, masculine, singular) agreement (cf. condition EMM). Under certain circumstances, however, it may also agree with an argument in an embedded infinitival clause (Mahajan, 1990; Butt, 1995). This type of long distance agreement is illustrated by condition EFF in Table 6.1: here, the matrix verb (*caahii*) agrees with the feminine object in the control clause (*saikal*). However, while both default and long distance agreement are possible when the matrix subject bears ergative case marking, there must be a correspondence between whatever agreement it bears and the agreement of the infinitival verb. Hence, conditions EMM and EFF are possible, while condition EFM is ungrammatical. Finally, for embedded infinitival clauses with a shared argument, Hindi allows either a nominative or an ergative agreement pattern. As is apparent from Table 6.1, the infinitival verb in the control clause agrees with either the shared (and covert) argument (when it bears masculine agreement features; conditions NMM/EMM) or with the O-argument in the control clause (when it bears feminine agreement features; conditions NFM/NFF/EFM/EFF). In the first of these patterns, the shared argument is associated with nominative case. In the second, it is identified as ergative-bearing via the object agreement pattern (see Bickel & Yadava, 2000).

With this background in mind, we can now turn to a closer description of the experimental design of the present study, focusing on the three critical manipulations related to a possible preference: case marking of NP1, agreement of the infinitive, and agreement of the control verb.

Case marking of the first NP As described above, only nominative arguments agree with the verb in Hindi. LDA is possible with ergative and dative arguments. When there is a nominative subject, the agreement with the control verb should be highly predictable, while this prediction should not be equally strong in the case of an ergative.

Agreement properties of the infinitive It has been shown in literature on the control verb that LDA is dependent on the infinitive because LDA is only possible when the infinitive agrees with its O-argument in the embedded clause. Hence, it will be interesting to see how infinitive influences the agreement of the control verb.

Agreement properties of the control verb. The control verb constitutes the critical position of interest in the present study. As shown above, for the component reported for agreement violations are either a biphasic pattern LAN–P600 or only a P600 and we expect similar results for the violations of the agreement in the present study. One thing that must be kept in mind is that, in this study, the violation is only for gender.

In order to examine these issues empirically, we analysed the ERPs at the position of the control verb in terms of two factors: case marking of the matrix subject (CASE: nominative vs. ergative) and gender agreement of both the infinitive and the control verb (GENDER: masculine infinitive – masculine control verb: MM; feminine infinitive – masculine control verb: FM; feminine infinitive – feminine control verb: FF).

6.3 Materials and methods

6.3.1 Participants

Twenty-four native speakers of Hindi participated in the experiment (five women; mean age 27.58 years, range 23-39). All were right-handed as assessed by an adapted Hindi version of the Edinburgh handedness inventory (Oldfield, 1971). At the time of their participation in the experiment, all participants were residing in Berlin, Germany. A further four participants were excluded from the final data analysis due to excessive EEG artefacts.

6.3.2 Materials

Eighty sets of the six sentence conditions shown in Table 6.1 were constructed. The matrix subject was always a masculine proper name and the argument in the infinitival clause was always an inanimate argument of feminine gender. The 480 sentences thus resulting were subdivided into two lists, each containing forty sentences per critical condition (240 in total) and three sentences with similar lexical materials. Each list was combined with 160 additional filler sentences. The fillers were acceptable and unacceptable simple main clauses, thereby serving to ensure that participants would not invariably expect to encounter an embedded control clause in every sentence presented to them. List presentation was counterbalanced across participants.

6.3.3 Procedure

Sentences were presented visually in the centre of a computer screen in a word-by-word manner (nouns and case markers were presented together). Each word was presented for 600 ms, followed by an inter-stimulus-interval (ISI) of 100 ms. Each trial began with the presentation of an asterisk (1000 ms plus 200 ms ISI) and ended with a 1000 ms pause, after which participants completed two behavioural tasks. Firstly, they judged whether the sentence that they had just read was an acceptable sentence of Hindi or not. As a cue for the judgement task, three question marks appeared in the centre of the computer screen. After a participant's response or after the maximal response time of 3000 ms had expired, a comprehension question appeared in the centre of the screen (see 5 for an example). Participants were required to judge whether this question was correct with respect to the preceding sentence or not.

(6.1) kya mohan saikal calaa-naa caah-taa hai ?
Q Mohan.m(nom) bicycle.f(nom) ride-Inf.m want-IPFV.PTCP AUX.
'Does Mohan want to ride a bicycle?'

The comprehension task required the answers 'yes' and 'no' equally often, with 'no' responses required in the case of an exchanged content word. The maximal response time for the comprehension task was 4500 ms. After both tasks had been completed, there was a 2000 ms pause before the beginning of the next trial.

The experimental session was subdivided into ten blocks of 40 sentences each and lasted approximately three hours including electrode preparation.

6.3.3 EEG recording

The EEG recording was the same as in Experiment 1.

6.3.4 Data Analysis

Data analysis was same as in Experiment 1. For the acceptability judgement task, mean acceptability ratings and reaction times were calculated for each condition. For the comprehension task, error rates and reaction times were calculated for each condition. Incorrectly answered trials were excluded from the reaction time analysis for the comprehension task. In all cases, we computed repeated-measures analyses of variance (ANOVA) involving the condition factors CASE (unmarked first NP (nominative) vs. ergative first NP), and GENDER (masculine infinitive – masculine control verb: MM; feminine infinitive – masculine control verb: FM; feminine infinitive – feminine control verb: FF) and the random factors participants (F_1) and items (F_2).

6.4. Results

6.4.1 Behavioural data

Table 6.2 shows mean acceptability ratings and reaction times for the acceptability judgement task and mean percentages of correct answers and reaction times for the comprehension task. The standard deviations are given in parenthesis.

Conditions	Acceptability Judgement		Comprehension Question	
	Acceptance (%)	Reaction time (ms)	Correct (%)	Reaction time (ms)
NMM	95 (4)	496 (195)	89 (6)	1981 (402)
NFM	67 (29)	601 (232)	88 (6)	2082 (432)
NFF	15 (16)	565 (243)	83 (12)	2077 (382)
EMM	78 (24)	607 (258)	89 (7)	2073 (418)
EFM	27 (25)	709 (253)	83 (9)	2215 (450)
EFF	88 (8)	558 (207)	87 (6)	2033 (425)

Table 6.2. Mean values for the acceptability judgement task and comprehension question. The standard deviations are given in parenthesis.

For the acceptability ratings, a repeated measures ANOVA revealed a main effect of GENDER ($F_1(2,46)=61.78$, $p<0.001$; $F_2(2,158)=351.38$, $p<0.001$), and an interaction of CASE x GENDER: ($F_1(2,46)=136.56$, $p<0.001$; $F_2(2,158)=756.69$, $p<0.001$). The main effect of CASE only reached significance in the analysis by items ($F_1(1,23)=0.88$, $p<0.36$; $F_2(1,79)= 32.73$, $p<0.001$).

Resolving the interaction CASE x GENDER by CASE revealed an effect of GENDER for sentences with a nominative matrix subject ($F_1(2,46)=119.49$, $p<0.001$; $F_2(2,158)=814.18$, p<0.001) and for sentences with an ergative matrix subject ($F_1(2,46)=74.12$, $p<0.09$; $F_2(2,158)=357.74$, $p<0.001$). Pairwise comparisons between the three levels of the factor GENDER revealed significant differences between all three conditions for sentences with nominative subjects (all F_1s > 23.50, ps < 0.001; all F_2s > 192.50, ps < 0.001). For sentences with ergative subjects, the difference between MM and FF only reached marginal significance in the analysis by participants ($F_1(1,23)=3.42$, $p<0.08$), while all other comparisons were significant (all F_1s > 118.50, ps < 0.001; all F_2s > 9.40, ps < 0.01).

The reaction times for the acceptability judgement task showed main effects of CASE: ($F_1(1,23)=13.19$, $p<0.001$; $F_2(1,79)=30.92$, $p<0.001$) and GENDER: ($F_1(2,46)=14.16$, $p<0.001$; $F_2(2,158)=42.40$, $p<0.001$), as well as an interaction CASE x GENDER ($F_1(2,46)=6.15$, $p<0.004$; $F_2(2,158)=13.24$, $p<0.001$). Resolving the interaction by CASE showed main effects of GENDER for sentences with nominative matrix subjects ($F_1(2,46)=10.17$, $p<0.001$; $F_2(2,158)=18.30$, $p<0.001$) and for sentences with ergative matrix subjects ($F_1(2,46)=10.79$, p<0.001; $F_2(2,158)=35.30$, $p<0.001$). For sentences with a nominative subject, pairwise comparisons between conditions showed a significant difference between conditions MM and FF ($F_1(1,23)=7.59$, $p<0.01$; $F_2(1,79)=19.13$, $p<0.001$) and between conditions MM and FM ($F_1(1,23)=17.23$, $p<0.001$; $F_2(1,79)=31.27$, $p<0.001$), while the difference between conditions FF and FM only reached marginal significance in the analysis by items ($F_1(1,23)=3.11$, $p<0.09$; $F_2(1,79)=3.71$, $p<0.06$). For the pairwise comparisons between the conditions with ergative subjects, only the difference between conditions MM and FF failed to reach significance in the analysis by participants ($F1(1,23)=2.08$, $p<0.16$), while all other comparisons showed significant differences (all F_1s > 8.60, ps < 0.01; all F_2s > 8.20, ps < 0.01).

For the comprehension question it showed a main effect of GENDER ($F_1(2,46)=6.55$, $p<.001$; $F_2(2,158)=3.16$, $p<0.05$) and an interaction of CASE x GENDER ($F_1(2,46)=6.28$, $p<.003$; $F_2(2,158)=3.16$, $p<0.04$). Separate analyses for the two levels of CASE revealed an effect of GENDER for sentences with nominative matrix subjects ($F_1(2,46)=5.77$, $p<0.006$; $F_2(2,158)=4.77$,$p<0.009$), while this effect was only significant in the analysis by participants for sentences with ergative matrix subjects ($F_1(2,46)=7.60$, $p<0.001$; $F_2(2,158)=2.13$,$p<0.12$). Pairwise comparisons for the nominative conditions showed a significant difference between FF and FM ($F_1(1,23)=5.08$, $p<0.03$; $F_2(1,79)= 4.85$, $p<0.03$) and between FF and MM ($F_1(1,23)=8.12$, $p<0.01$; $F_2(1,79)=9.75$, $p<0.01$), while conditions FM and MM did not differ from one another ($F_1/F_2 < 1$). For the ergative conditions, the difference between conditions MM and FM was significant ($F_1(1,23)=11.17$, $p<0.01$; $F_2(1,79)=3.82$, $p<0.05$), whereas the comparison between FF and FM only yielded a significant difference in the analysis by participants ($F_1(1,23)=7.60$, $p<0.01$; $F_2(1,79)=2.08$, $p<0.15$) and the comparison between MM and FF was not significant in either analysis ($F_1(1,23)=1.17$, $p<0.29$; $F_2 < 1$).

The reaction times for the comprehension task showed main effects of CASE ($F_1(1,23)=11.20$, $p<.002$; $F_2(1,79)=5.79$, $p<0.02$) and GENDER ($F_1(2,46)=11.88$, $p<.001$; $F_2(2,158)=10.47$, $p<0.001$) and an interaction CASE x GENDER ($F_1(2,46)=7.42$, $p<.001$; $F_2(2,158)=3.13$, $p<0.05$). Resolving the interaction by CASE showed main effects of GENDER for sentences with nominative matrix subjects ($F_1(2,46)=5.01$, $p<0.01$; $F_2(2,158)=3.52$, $p<0.03$) and for sentences with ergative matrix subjects ($F_1(2,46)=14.97$, $p<0.001$; $F_2(2,158)=8.09$, $p<0.001$). Pairwise comparisons for the nominative conditions revealed a significant difference between MM and FM ($F_1(1,23)=7.05$, $p<0.01$; $F_2(1,79)=5.94$, $p<0.02$) and between MM and FF ($F_1(1,23)=8.84$, $p<0.01$; $F_2(1,79)=5.39$, $p<0.02$), but not between FM and FF ($F_1/F_2 < 1$). For the ergative conditions, condition FM differed from MM ($F_1(1,23)= 14.24$, $p<0.001$; $F_2(1,79)=7.38$, $p<0.01$) and from FF ($F_1(1,23)=23.61$, $p<0.001$; $F_2(1,79)=19.67$, $p<0.001$), while there was no difference between MM and FF ($F_1(1,23)=1.87$, $p<0.18$; $F_2<1$).

Summary:

The acceptability judgement task revealed acceptability differences between all three conditions with nominative subjects and all three conditions with ergative subjects. Crucially, the precise nature of the acceptability pattern differed depending on the case marking of NP1 (nominative: MM > FM > FF; ergative: FF > MM > FM). The acceptability differences between conditions were mirrored by the reaction times. For sentences with nominative subjects, responses were significantly faster for condition MM than for the other two conditions, with an additional trend for FF to be faster than FM. For sentences with ergative subjects, condition FM gave rise to slower reaction times in comparison to both FF and MM, here with an additional trend for FF to be faster than MM.

For the comprehension task, participants made more errors for condition FF as opposed to conditions MM and FM in the nominative sentences; for the ergative sentences, condition FM yielded higher error rates than MM and (by participants) than FF. With regard to the reaction times, condition MM showed the faster responses than both FM and FF in the nominative conditions, whereas reaction times were slower for condition FM as opposed to MM and FF in the ergative sentences.

6.4.2 ERP data

6.4.2.1 Control verb

Grand average ERPs for the position of the control verb are shown in Figure 1. Visual inspection of the figure suggests that the ERP responses for the critical conditions differ between approximately 350 and 600 ms post onset of the control verb. The sentences with nominative matrix subjects appear to show a three-way distinction in this time window, with the masculine-masculine (MM) condition showing a positivity in comparison to the other two conditions, of which the feminine-masculine (FM) condition in turn shows a negativity in comparison to the feminine-feminine (FF) condition. By contrast, sentences with ergative matrix subjects only show a two-way distinction between conditions: here, a negativity is apparent for the FM condition in comparison to both the MM and the FF condition. Finally, the nominative subject FF condition appears to show an additional late positivity between approximately 700 and 900 ms post verb onset. In accordance with the visual inspection of the data, statistical analyses were performed in two time windows: 350-600 ms and 700-900 ms.

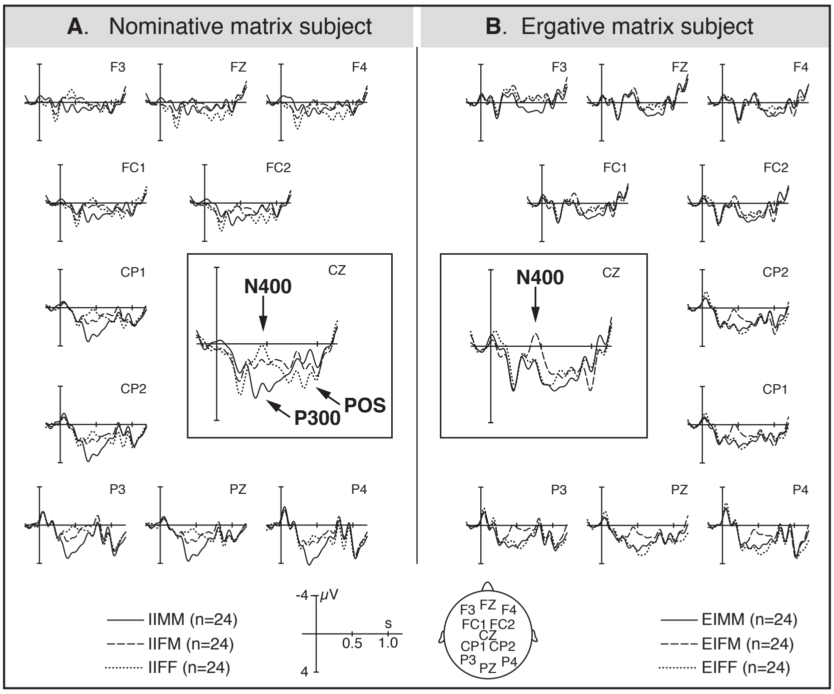

*Figure 6.1:*Grand average ERPs (N=24) at the position of the critical control verb (onset at the vertical bar). The figure compares conditions MM, FM and FF for sentences with a nominative matrix subject (Panel A) and sentences with an ergative matrix subject (Panel B). Negativity is plotted upwards.

Time window 1 (350-600 ms): In the time window 350-600 ms, repeated measures ANOVAs revealed a main effect of GENDER: (midline: $F(2,46)=8.03$, $p<0.002$; lateral: $F(2,46)=8.03$, $p<0.002$), as well as interactions ROI x CASE (midline: $F(4,115)=4.87$, $p<0.001$; lateral: $F(3,69)=3.03$, $p<0.05$), ROI x GENDER (midline: $F(8,184)=3.51$, $p<0.02$; lateral: $F(6,138)=6.99$, $p<0.001$), CASE x GENDER (midline: $F(2,46)=5.91$, $p<0.007$; lateral: $F(2,46)=6.91$, $p<0.003$) and ROI x CASE x GENDER (midline: $F(8,184)=9.85$, $p<0.001$; lateral: $F(6,138)=5.41$, $p<0.001$).
Separate analyses within each region of interest showed an interaction of CASE x GENDER at central and posterior midline sites (CZ: $F(2,46)=3.83$, $p<0.03$; CPZ: $F(2,46)=5.82$, $p<0.01$); PZ: $F(2,46)=10.68$, $p<0.001$; POZ: $F(2,46)=17.35$, $p<0.001$) and in both posterior lateral ROIs (left: $F(2,46)=11.87$, $p<0.001$; right: $F(2,46)=10.74$, $p<0.001$).

When these interactions were resolved by CASE, all of the regions showing an interaction also showed an effect of GENDER both for sentences with nominative matrix subjects (all $F\text{s}\geq 7.77$; all $p\text{s}<0.001$) and for sentences with ergative matrix subjects (all $F\text{s}\geq 4.30$; all $p\text{s}<0.02$). Pairwise comparisons between the three levels of the factor GENDER are presented in Table 6.3a and Table 6.3b for sentences with nominative and ergative subjects, respectively. As is apparent from the table, for sentences with nominative subjects, condition MM engendered a centro-parietal positivity in comparison to both FM and FF, and FM elicited an additional left-posterior negativity in comparison to FF. Thus, the analysis confirmed the three-way distinction between these condition that was indicated by visual inspection. Sentences with ergative subjects, by contrast, only showed a two-way distinction between conditions: here, FM engendered a negativity in comparison to both FF and MM.

a. Nominative Matrix Subject			
ROI	MM-FF	MM-FM	FM-FF
CZ	*F*(1,23)=13.21,p<0.01	*F*(1,23)=8.38, *p*<0.01	
CPZ	*F*(1,23)=19.39,p<0.001	*F*(1,23)=11.33, *p*<0.01	
PZ	*F*(1,23)=26.38,p<0.001	*F*(1,23)=11.22, *p*<0.01	
POZ	*F*(1,23)=26.06,p<0.001	*F*(1,23)=10.73, *p*<0.01	
Left-Posterior	*F*(1,23)=33.19,p<0.001	*F*(1,23)=15.05,*p*<0.001	*F*(1,23)=7.31, *p*<0.02
Right-Posterior	*F*(1,23)=22.02,p<0.001	*F*(1,23)=13.41, *p*<0.01	
b. Ergative Matrix subject			
ROI	MM-FF	MM-FM	FM-FF
CZ	----	*F*(1,23)=8.98, *p*<0.01	*F*(1,23)=5.57, *p*<0.03
CPZ	----	*F*(1,23)=7.54, *p*<0.02	*F*(1,23)=6.94, *p*<0.02
PZ	----	*F*(1,23)=10.15, *p*<0.01	*F*(1,23)=12.64, *p*<0.01
POZ	----	*F*(1,23)=14.46,*p*<0.001	*F*(1,23)=22.39,*p*<0.001
Left-Posterior	----	*F*(1,23)=28.41,*p*<0.001	*F*(1,23)=9.65, *p*<0.01
Right-Posterior	----	*F*(1,23)=11.10, *p*<0.01	*F*(1,23)=20.95,*p*<0.001

*Table 6.3:*Pairwise comparisons between the three levels of the factor GENDER for sentences with nominative (A) and ergative matrix subjects (B). Comparisons are shown for all regions of interest (ROIs) that showed an interaction CASE x GENDER. All of these regions also showed effects of GENDER for both nominative and ergative conditions. For the pairwise comparisons, alpha-levels were corrected according to a modified Bonferroni procedure (Keppel, 1991), i.e. only effects that reached the corrected probability level of $p<0.033$ were considered significant (with $p<0.04$ amounting to a marginally significant effect). In the table, we report uncorrected probability levels for all effects meeting the significance criterion. Abbreviations: MM (masculine agreement on infinitive – masculine agreement on control verb); FM (feminine agreement on infinitive – masculine agreement on control verb); FF (feminine agreement on infinitive – feminine agreement on control verb).

Time window 2 (700-900 ms): In the time window 700-900 ms, we observed an interaction of ROI x CASE (midline: $F(5,115)=3.51$, $p<0.06$; lateral: $F(3,69)=5.44$, $p<0.02$) and, for the lateral electrodes, an interaction of ROI x GENDER ($F(6,138)=5.02$, $p<0.001$). The interaction ROI x CASE x GENDER reached significance for the midline electrodes ($F(8,184)=3.23$, $p<0.02$) and showed a trend towards significance at lateral sites ($F(6,138)=1.97$, $p=0.09$). Separate analyses in each ROI showed interactions of CASE x GENDER at FZ ($F(2,46)=3.37$, $p<0.05$) and in the right-anterior ROI ($F(2,46)=3.49$, $p<0.04$). Resolving these interactions by CASE showed a trend towards an effect of GENDER for nominative conditions at FZ ($F(2,46)=2.52$, $p=0.09$) and a significant effect of GENDER in the right-anterior ROI ($F(2,46)=4.79$, $p<0.02$), while neither of these regions showed an effect of GENDER for the ergative conditions. For the nominative conditions, pairwise comparisons between the three levels of GENDER for the regions showing a main effect revealed significant differences between FF and MM (right-anterior: $F(1,23)=13.47$, $p<0.001$; FZ: $F(1,23)=5.42$, $p<0.03$) and between FF and FM (right- anterior: $F(1,23)=5.58$, $p<0.03$). These differences were due to the fact that condition NFF showed a right frontal positivity in comparison to the other two conditions with nominative matrix subjects.

6.4.2.2 Infinitive

In general, the infinitive did not show any effect. But as shown above in the behavioural data, condition NFM was assumed to be the case of dialectal variations hence a median split was done. We observed that there were two groups: one which had high acceptability ratings for this condition and one that had low acceptability ratings. This effect was also observed in the ERP data. The Lower Group showed an N400 for the feminine infinitive both in the case of nominative and ergative, while the High Group did not show any effect.

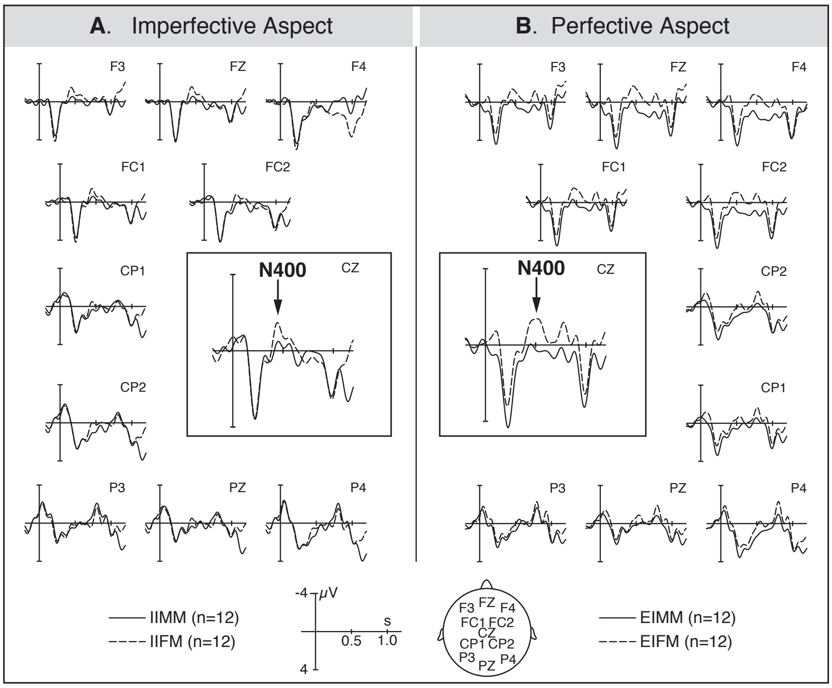

Figure 6.2. Grand average ERPs for the infinitive (n=12) for the low acceptability group.

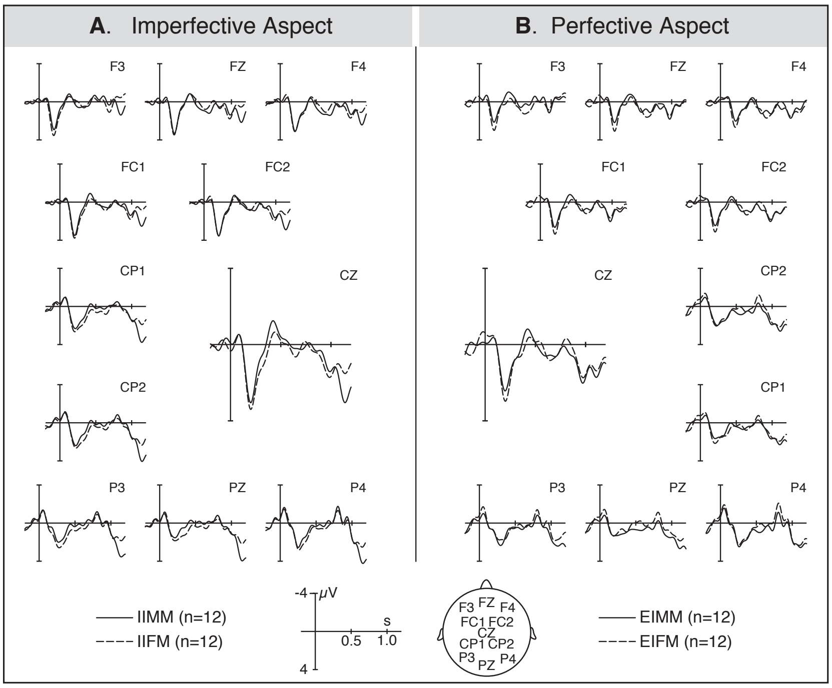

Figure 6.3. Grand average for the infinitive (n=12) for the high acceptability group.

Figure 6.2 suggests that the low acceptability group shows an N400 for feminine vs. masculine agreement at the position of the infinitive, whereas no such difference is observable in the high acceptability group. Interestingly, the effect for the low acceptability group is not restricted to the nominative conditions, but is also observable for the ergative conditions. These impressions were confirmed by a statistical analysis involving the between-participants factor GROUP, which was conducted in a time window from 350-550 ms post onset of the infinitive. The analysis revealed interactions GROUP x GENDER (midline: $F(1,22)=9.32$, $p<0.01$; lateral: $F(1,22)=6.88$, $p<0.02$) and GROUP x ROI x CASE x GENDER (midline: $F(5,110)=7.37$, $p<0.01$; lateral: $F(3,66)=2.90$, $p<0.06$). Resolving these interactions by GROUP showed a main effect of GENDER for the low acceptability group (midline: $F(1,11)=36.30$, $p<0.0001$; lateral: $F(1,11)=27.85$, $p<0.001$), which was due to a negativity for feminine vs. masculine agreement. The high acceptability group showed an interaction ROI x CASE x GENDER for the midline electrodes only ($F(5,55)=5.12$, $p<0.02$), but no significant interaction CASE x GENDER for any individual ROI.

6.4.2.3 Filler verbs

The above results showed that a gender mismatch elicited an N400 effect for both the nominative and ergative case. The results are surprising as they did not show any LAN and positivity. Effects. As mentioned above, earlier studies on Hindi showed only a positivity but no negativity. Hence, to test whether this is because of the embedded clause structure, we also analysed the filler sentences. We used filler sentences with both nominative and ergative case, which had a gender mismatch in the simple clause. We had only 20 sentences for each condition but the result might still provide useful insights.

For the filler verbs, the time windows were chosen depending on visual inspection. the filler Matching the results for the critical sentences, we also observed an N400 effect in the analysis of the filler sentences. Though visual inspection showed an effect in early time window 150-300 ms but it did not show any significance in the statistics. For the positivity effect the time window 700-900 ms was chosen. This time range is same as it was in the case of the control verb.

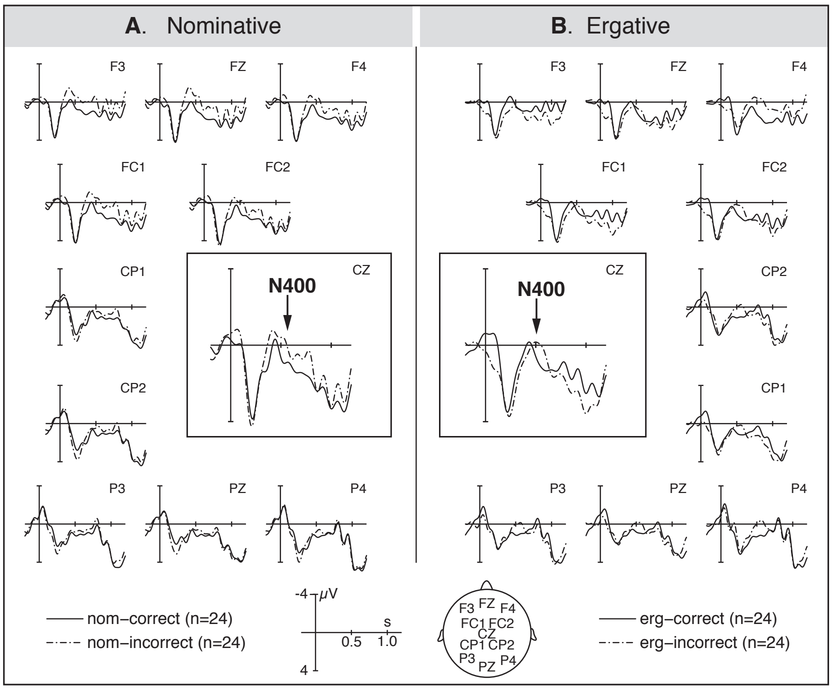

Figure 6.4. Grand average for the filler verb (n=24) for both nominative and ergative arguments. Negativity is plotted upwards.

6.4.2.3.1 Imperfective sentences

In the imperfective sentences, all the sentences had a gender violations consisting of the verb not matching with the NP1(nominative). The early time window 150-300 ms did not reveal any effect for neither midline nor lateral sites.

Time window 1 (350-600 ms): The time range 350-600 ms showed an interaction of ROI x GENDER at midline ($F(5,115)=5.66$, $p<0.001$) and a main effect of GENDER at lateral sites ($F(1,23)=3.54$, $p<0.07$.

Resolving the interaction by ROI showed a main effect of GENDER at FZ: ($F(1,23)=7.19$, $p<0.01$ and at FCZ: ($F(1,23)=4.87$, $p<0.04$. This effect was due to the negativity observed for the agreement violation condition in imperfective sentence. Since the effect is widespread over the electrodes, we conclude it to be an N400 effect.

Time window 2 (700-900 ms): For the time range of 700-900 ms, the midline electrodes showed an interaction of ROI x GENDER ($F(5,115)=2.65$, $p<0.06$. Lateral sites did not show any effect. Resolving by ROI did not reveal an effect for any of the electrodes.

6.4.2.3.2 Perfective sentences

For the perfective sentences, there was also a gender violations on the verb, but different from imperfective sentences, both the arguments were case marked, NP1-ergative and NP2- accusative. The verb, which should have a default agreement (i.e masculine) was feminine and therefore inducing a gender violation. Similar to the imperfective sentences, the ANOVA was performed for the three time windows 150-300, 350-600 and 700-900 ms.

Time window 1 (150-300): There was no effect for the midline electrodes, while the lateral sites revealed an interaction of ROI x GENDER ($F(3,69)=2.66$,$p<0.06$), while further resolved by ROI, there was no effect.

Time window 2 (350-600): The time window 350-600 ms did not show any effect for the midline electrodes. For lateral sites, it showed an interaction of ROI x GENDER ($F(3,69)=2.95$, $p<0.07$). Further resolving by ROI showed an effect of GENDER in the right posterior region: ($F(1,23)=3.50$, $p<0.07$).

Time window 3 (700-900 ms): For the time range 700-900 ms, there was no effect for the midline electrodes, while lateral sites showed an interaction of ROI x GENDER (F(3,69)=5.72, p<0.005). Resolving by ROI revealed an effect of GENDER for the left anterior sites (F(1,23)=3.51, p<0.07). This effect was observed for gender violations when the first argument was ergative.

In brief, we observed both an N400 and a marginally significant positivity for gender violations when NP1 was ergative, the positivity was more anterior. For the nominative arguments, we only observed an N400 effect and no positivity.

6.5 Discussion

As the results showed, for the control verbs with a nominative subject, we observed a three-way distinction between the conditions: in a time window from 350-600 ms, condition MM engendered a centro-parietal positivity (P300), whereas both FF and FM elicited a centro-parietal negativity (N400), which was larger for condition FF. In addition, FF elicited a late positivity. By contrast, the sentence conditions with an ergative subject only gave rise to a two-way ERP distinction, namely to an N400 effect (350-600 ms) for FM in comparison to FF and MM. These findings indicate that the establishment of an agreement relation at the position of the control verb is subject to modulation by information at all three of the critical positions described above. For the infinitive, we observed an N400 both for the nominative and ergative conditions only for the lower group. There was no main effect at the position of infinitive verb.

The filler sentences, we observed similar results to those for the control verb as both the nominative and ergative conditions showed an N400 effect. However, a further surprising result was that the ergative conditions also showed a positivity, while there was no positivity for the nominative arguments.

6.5.1 Agreement of the control verb

Firstly, and rather unsurprisingly, the pattern of ERPs at the control verb is influenced by the case marking of NP1. When this argument is nominative-marked, the system exhibits a clear preference for agreement between NP1 and the matrix verb. This is shown by the fact that the only condition that leads to a violation of this expectation, namely FF, differs from both MM and FM, engendering the largest N400 and a late positivity. When NP1 is ergative-marked, by contrast, the pattern at the control verb depends entirely on the agreement of the infinitive, i.e. there is a preference for the agreement in the matrix clause to match that of the infinitive. This is evidenced by the N400 distinction for FM vs. MM/FF, with no difference between the latter two conditions. Apart from that, we analyse the P300 effect observed for the MM condition as a target related P300. It seems that when the matrix subject is nominative(masculine), people are expecting a masculine agreement with the matrix verb and when this target is met, we see this effect. There was no such effect in any other case.

These observations precisely reflect theoretical descriptions of the agreement system in Hindi (see section 6.1): agreement is always with the highest-ranked nominative argument; when there is no nominative argument in the sentence, the matrix verb either exhibits default agreement or long distance agreement. Whichever of the two options for a non-nominative subject is chosen, there must be a match between the agreement of the embedded verb and that of the matrix verb. Even though the behavioural results point to a final acceptability advantage for long distance agreement as opposed to default agreement, the ERP data suggest that both types of agreement are equally easy to process online.

This overall data pattern shows that agreement mismatches between NP1 and the control verb engender N400 effects in sentences of the type examined here. In the ERP literature on sentence processing, agreement mismatches are typically associated with late positivities (P600 effects) and, under certain circumstances, with left-anterior negativities (LAN effects) (see Kutas et al., 2006). The observation of an N400 effect in the present study thus appears somewhat surprising. Possibly, the nature of this effect could be attributable to the manipulation of gender agreement.

In an experiment on adjective-noun agreement in Spanish, Barber and Carreiras (2005) observed an N400 for gender agreement violations when the nouns and adjectives were presented as word pairs. Furthermore, in a previous ERP examination of subject-verb agreement in Hindi, Nevins, Dillon, Malhotra, and Phillips (2007) observed an effect, which could be classified as an N400 for gender violation. While the authors themselves interpreted this effect as the beginning of a late positivity, visual inspection of their ERP figures suggests that it is in fact a negativity for the violation condition. In the study of Nevins et al. (2007), all the sentences were in future tense as in the future tense all the agreement features (person, number, and gender) are available on the verb in Hindi. Hence, it could be really interesting to test whether the agreement violations in Hindi show different results in different tenses. As we saw for the filler sentences, in simple sentences also an N400 effect for the agreement vioaltions. However, it is hard to conclude from the results of the filler sentences because there were not many trials. But at least this result also supports the findings for the control verbs in this experiment.

Thus, the finding of N400 effects for gender agreement violations is not unprecedented. However, the precise conditions under which agreement processing correlates with one or the other type of ERP components clearly requires further investigation in future research. But this experiment shows that the results vary depending on the case marking of NP1 because we found different result in the case of nominative and ergative arguments. The difference for the nominative and ergative case has been observed throughout the thesis. In Experiment 1, different results were observed for ergative and nominative case violation, as the latter did not show any positivity. Such variation was also observed at NP2 in the second experiment where we tested the role of word order variations. The present experiment also showed different result for nominative and ergative arguments.

6.5.2 Agreement of the infinitive

We did not see any general effect for the infinitive, we rather observed that the effect for the infinitive was affected by the group factor. As mentioned earlier, the condition NFM was influenced by dialectal variations. However, we could not group the participants on the basis of the region they come from or the languages they speak. Hence, a median split was done on the basis of the behavioural data. We observed that the lower group showed an N400 effect for the feminine agreement in comparison to the masculine one. This effect was observed for both the arguments with nominative and ergative case. This finding suggests that the lower group always preferred masculine infinitive. Thus, one thing that becomes clear from the results from control verb, filler conditions and infinitive that gender violations mainly shows an N400 effect in Hindi.

III GENERAL DISCUSSION

Chapter 7

General Discussion

The goal of this thesis was to investigate whether factors such as case, word order and animacy influence the argument interpretation in Hindi in the same way as it has been reported for nominative-accusative languages or if Hindi, being a split ergative language, shows different results. In general, it seems that these factors are really important from the perspective of argument interpretation in both types of languages (the languages that show an accusative case marking pattern and language with a split in the case marking pattern, like Hindi). Even though these factors are really important, we also observed crucial differences to the previously reported results for other languages. In general, throughout the thesis, there seems to be a general pattern, which consists of the ergative and accusative case showing similar patterns, while the nominative case differs from it. Crucial differences were also observed for the role of animacy and word order. In the following, we summarise the results from each experiment briefly and give a general analysis for all the results, particularly for those results that were surprising and for which a detailed analysis was not given the related chapters.

7.1 Role of case

In Experiment 1, we tested how ergative, nominative and accusative case are processed in Hindi. The result revealed a positivity for initial ergative arguments in comparison to nominative arguments. We interpret that the positivity effect for initial ergative arguments is evoked due to dependency formation. Recall from Chapter 3 and 4 that Wolff et al. (2008) reported a positivity effect for an initial accusative argument in Japanese and they argued that this positivity effect was reflecting the dependency formation. In Japanese, an initial accusative argument suggests that the sentence is transitive and that therefore an actor is expected in the event and a positivity is observed. The positivity for the ergative arguments in Hindi suggests that dependency formation works in both accusative and ergative languages irrespective of the direction of the expectation, i.e. whether actor is expected or an undergoer, but when there is any prediction for an upcoming argument in the event, this effect is observed. Thus, we interpret that the positivity effect for ergative arguments is for the formation of dependency relations.

For the accusative case violations at NP2, we observed a biphasic N400- late positivity effect. When human nouns were not marked with accusative case (*ko*) at NP2(O-arguments), which leads to an accusative case violations in Hindi, this biphasic effect was observed. The effects were observed for the accusative case violations for both nominative and ergative arguments at NP1. This effect can be interpreted in accordance to the eADM. Human nouns can not be assigned the undergoer role unless they are case marked (accusative ko) in Hindi. Thus, the N400 effect observed here is due to a problem in the *compute prominence* step (Bornkessel & Schlesewsky, 2006a) and the late positivity indicates a problem in the well-formedness check.

Finally, at the position of the aspect marker and the verb, we observed an N400 effect for both the nominative and ergative case violations when there was a mismatch of case and aspect. The late positivity effect was only observed for the ergative case violations and not for the nominative case violations. The N400 effect was more pronounced for the ergative case violations than the nominative case violations. Firstly, we will interpret the N400 effect and will come the positivity effect later. The N400 effect observed in this case is due to the prominence mismatch. Thus, this result is similar to the result at NP2 but with some crucial differences. Recall from Chapter 1 and 3 that double case violations in German revealed similar results (Frisch & Schlesewsky, 2005) and that an N400 effect in this case has been interpreted to be reflecting a prominence mismatch (Bornkessel & Schlesewsky, 2006a). Though, the N400 effect observed in Hindi for the ergative and nominative case violations are due to the prominence mismatch but the prominence mismatch is in *compute linking step*. In this case, there is a prominence mismatch in the *compute linking* step (in accordance to eADM). The ergative and nominative case violations were not tested at the position of the nominal phrases but at the aspect marker/verb. When the previously computed argument does not mach with the aspect of the verb, there is a problem in the *compute linking* step. Recall from Chapter 1 that according to the eADM, the NPs are assigned actor or undergoer role in the *compute prominence* step and the previously computed argument are matched with verb's LS in the *compute linking* step. Since in this case, we observed the effect at the aspect marker/verb, there is a problem in the *compute linking* step when the previously computed prominence information mismatch with the aspect of the verb and therefore, an N400 effect is observed. Thus, this N400 effect is observed for both nominative and ergative case violations due to the prominence mismatch in *compute linking step* different from accusative case violations at the position of NP2 where there is problem in *compute prominence step*. Therefore, both the accusative (at NP2) and the ergative case violations show similar results suggesting that both the cases behave similarly from the processing perspective. But we observed two differences for nominative case violations. Firstly, the N400 effect was less pronounced for the ergative case violations and secondly, it did not reveal any positivity effect in this case. The less pronounced N400 can be accounted for by the fact that the ergative case is very restricted in Hindi, while the nominative has a very wide scope as it can occur in all the tenses. A late positivity effect observed for the ergative case violation is due to problems in the *well-formedness check*.

Now, the main question here is why the positivity disappears in the case of nominative case violations. This result suggests that the well-formedness check is silent in this case. Why should this be the case? The P600 effect has been described as a marker of syntactic processing (Ullman, 2004; Hagoort, 2003), of reanalysis/repair (Friederici, 2002), of well-formedness problems (Bornkessel & Schlesewsky, 2006a,) or of more general conflict detection (van Herten et al., 2006). The absence of a late positivity in this case does not follow straightforwardly from any of these approaches, thereby suggesting that a more fine-grained functional differentiation may be required. Even though is difficult to answer why there is no positivity effect observed for nominative case violations, we present a speculative analysis for this result. Before coming to the speculative analysis, let us consider the status of the nominative case. It has been shown that the nominative has a default status as a case in many languages. Recall from Chapter 1 that Fodor & Inoue (2000) and Meng and Bader (2000) argued that case exhibits processing properties distinct from those of other morphological features such as number, and Schlesewsky & Frisch (2003) contradicted this point with the fact that this contrast is limited to the nominative case only and that accusative and dative case violations are judged more quickly (see Chapter 1). Next, let us consider the status of nominative and ergative case in Hindi. It is clear that the ergative case unambiguously assigns the actor role to an argument and also indicates that the sentence is transitive and that verb should be in perfective aspect. Thus, the use of the ergative is limited and when there is a violation in this condition, the processing system should quickly recognise this. On the other hand, a nominative argument is ambiguous as it can be a S- argument of intransitive verb, an A-argument of the transitive verb and also the O-arguments in a dative construction if the A-argument is dropped. Another difference between the ergative and nominative case is that it is the nominative argument that controls agreement in Hindi and apart from the perfective aspect, it can occur with all aspects (habitual, and progressive) and the tenses present, past and future. In the case of compound (verb + verb) and conjunct constructions (noun / adjective + verb) when the V2(vector verb) is intransitive, an A- argument does not bear ergative but nominative case marking. Due to this reason when other perfective aspect marker (cukaa/ cukii/cuke), apart from *aa/ii,* there are also some other perfective marker in Hindi (*cukaa/cukii/cuke),* are used with verbs the A-arguments do not take ergative case In Hindi. See the following examples:

(7.1) a. Raam khaa cukaa hai.
Ram.m(nom) eat PFV.3sg.m aux
"Ram has eaten."

b. Raam khaanaa khaa gay-aa hai.
Ram.m(nom) food eat go-PFV.3sg.m aux
"Ram ate food."

Thus, while the ergative case is very restricted in Hindi, the nominative has very wide scope. Also recall from Chapter 3 that there are some transitive verbs like (laanaa - to bring, samjhanaa - to understand), which optionally take the ergative in Hindi. However, there only very few of these verbs. All the above mentioned variations suggest that there are many expectations for a nominative argument in comparison to an ergative one. It could be suggested that due to so many expectations, people do not care for the well-formedness of the sentences and no positivity effect is observed. The N400 effect for the nominative case violations suggests that people recognize the case violations but they do not care for well-formedness of the sentence in this case. Nevertheless, we argue that it is not only too many expectations for the nominative case which causes the disappearance of the positivity in this case but rather the influence of dialectal variations of Hindi. There are several varieties of Hindi spoken in India and in some varieties of Hindi, nominative A arguments can be used even when verb is in perfective aspect, while the use of ergative A arguments with a verb in imperfective aspect is rare.

Thus, we propose that people also take this dialectal variations into account in the well-formedness step. We propose a speculative analysis for this in section 7.5.2.

In summary, the ergative and accusative revealed similar results in this experiment, while the nominative differed from it. Experiment 2 also suggested that the nominative behaves differently from the ergative in the case of word order variations. Thus, it suggests that it is not only in the case of violations that the nominative differs from accusative and ergative but also in other cases. We discuss this in the next section.

7.2 Role of word order

In Experiment 2, we explored word order variations of Hindi. We tested whether word order permutations across nominative and ergative arguments behave similarly or not. The first question of this experiment also concerned dependency formation. We already observed a positivity effect for an initial ergative argument in Experiment 1, which suggested that dependency formation works similarly for the ergative argument in Hindi as for the accusative arguments in languages like Japanese (Wolff et. al., 2008). Different from Experiment 1, in this experiment, we had three types of arguments at NP1: nominative, ergative and accusative/dative arguments. We observed a positivity effect for both the ergative and accusative/dative initial arguments but the positivity was stronger in the case of accusative/dative arguments. This could be due to several reasons, recall from Chapter 4 that an initial accusative is ambiguous in terms of dependency formation. Thus, this stronger positivity could be due to the fact the accusative argument is ambiguous. It was already argued in Chapter 4 that whether people treat an initial accusative argument as an accusative or a dative does not make a difference in terms of dependency formation. But the result from NP2 suggested that people treat an initial accusative argument as a accusative and not a dative arguments. Therefore, in this case, an actor is expected and not an undergoer. The expectation for the actor shows a more pronounced positivity. In sum, both ergative and accusative arguments show dependency formation in Hindi. Thus, once again, ergative and accusative arguments seem to behave similarly.

At the position of NP2, we observed two results. We observed an early positivity for ACC-NOM sentences and a positivity for NOM-ACC sentences. We argued that the early positivity is observed due to thematic reanalysis (Bornkessel et al., 2003). Since we already gave a detailed analysis of this result in Chapter 4, we will mainly talk about the positivity observed for canonical nominative sentences (NOM-ACC). The positivity observed for accusative arguments at NP2 following a nominative argument is really surprising. As mentioned above, in the other studes for this phenomena an N400 has been observed and not a positivity effect. In Hindi, an initial nominative will initially be taken as a S argument of an intransitive construction until a second argument occurs in the sentence and it becomes clear that it is a transitive event. Recall from Chapter 4 that Bornkessel et al. (2004) and Wolff et al. (2008) reported an N400 effect in such cases for German and Japanese, respectively. Hence, the expected component in this case for Hindi is also an N400 effect not a positivity. It has been argued that when a subject is ambiguous between transitive and intransitive reading, an intransitive reading is preferred (Bornkessel & Schlesewsky, 2006; Gibson, 1998; Schlesewsky & Friederici, 2003). So when an unexpected second argument occurs it engenders an N400 effect. This N400 effect is taken to be the interpretive revision from an intransitive to a transitive event (Wolff et al., 2008).

Thus, the positivity in the case of Hindi is surprising. Recall from Chapter 1 that a positivity has been observed for different conditions and that a so-called semantic P600 (see Bornkessel–Schlesewsky & Schlesewsky, 2008) has also been reported. Yet, the positivity observed in this case is different from all the previous cases and can therefore not be accounted for by previous interpretations of positivity effects available in the research literature. The positivity is also quite early for a P600. Therefore, we leave this question for future research. Since some additional work is needed, we propose a further experiment in the next chapter, which might be able to provide an answer to this question.

7.3 Role of animacy

In Experiment 3, we explored the role of animacy in argument interpretation in Hindi. In all the sentences, NP1 was marked with ergative case. Thus, at NP1 we compared animate ergative vs. inanimate ergative arguments. The result revealed an N400 effect for the inanimate arguments in comparison to the animate arguments. We interpreted that this N400 effect is observed due to a problem in *compute prominence* (in accordance to eADM), since inanimate arguments are not prototypical actors.

At NP2, we compared both case-marked animate and inanimate arguments and non case- marked inanimate and animate arguments. The non case-marked animate arguments were ungrammatical as human nouns obligatory need accusative case marking in Hindi. The result revealed an N400 effect for case-marked inanimate arguments. The N400 observed for inanimate accusative arguments is also due to the problem in *compute prominence*. Recall from Chapter 2 that only human nouns are obligatorily marked with accusative case while inanimate arguments generally do not need accusative marking. Inanimate arguments are marked with the accusative case when they are specific/definite. Thus**,** this effect was observed when there was a prominence mismatch between case marking and animacy.

Recall from Chapter 5 that there were two groups: one, which had high percentage for the animate-inanimate(nom) structures and another, which had a low percentage. Only the lower group showed a negativity effect for animate nominative arguments in comparison to inanimate nominative arguments. What could be the reasons behind this divergence between the two groups? As discussed in Chapter 5, this group difference could not be categorised depending on the region and the languages people spoke. Therefore, this really need to be further investigated in future research. De Swart (2007) proposed that the object case marking differs from speaker's and hearer's perspective. If this is the case, it could be the case that in this case group differed as to how they interpreted the sentences. Since there was no context provided in the experiment, this issue will definitely need further investigation in future research.

One general observation that follows from this experiment is that erg-nom sentences are harder to process than erg-acc sentences. This seems to be surprising even from the theoretical perspective. Accusative case marking has been assumed to be used to distinguish the arguments. If this is the case, why two case marked arguments (erg-acc) would be easier to process than the erg-nom ? This question needs to be investigated further.

At the position of verb, we observed a positivity when NP2 was nominative. This positivity was observed when the first argument was inanimate and the second argument nominative. Still, this effect was more pronounced when the first argument was an inanimate and NP2 was an animate nominative. The positivity effect for the nominative NP2 was more pronounced for the Low Group in comparison to Higher Group. Though this positivity is also surprising as the effect was observed at the position of verb. When first argument was inanimate ergative and second argument was not case marked people did not like the sentences. The behavioural data also showed similar results. At the same time, it also suggests that the animacy of NP1 and NP2, and the case marking of NP2 are all taken into account for the proper processing. In sum, the animacy of NP1 effects accusative case violations. We argued in Chapter 5 that this positivity is due to a problem in well-formedness check.

Another speculative analysis of this result can be made in terms of pragmatic properties of argument realisation. This result can interpreted in terms of a mismatch between the syntactic transitivity of the construction and the interpretive distinctness of the arguments. In general, accusative marking has been defined in terms of distinctness of the arguments. In Hindi, only human nouns obligatorily take accusative case. According to Mohanan (1994), a non case-marked direct object can be incorporated in Hindi even when it is animate, while this is not possible when a direct object is marked with accusative (ko). Thus, the presence of -ko signals a transitive construction, while its absence signals a reduction in syntactic transitivity. When argument distinctness is maximally fulfilled (i.e. two arguments are of completely different types), the undergoer can be backgrounded via argument incorporation. In this case, the P600 was more pronounced when the actor was inanimate and the undergoer was animate. Thus, this provides the opposite scenario to one that would call for a backgrounding of the undergoer via incorporation. Under these circumstances, the pragmatic requirements for a syntactically intransitive construction are not met. Schumacher (to appear) proposed that the P600 reflects the process of semantic/pragmatic enrichment. Thus, it could be assumed that the additional enrichment process required by particular syntactic argument realisation options are reflected in increased P600 amplitudes. The eADM interprets the monophasic late positivities (P600) as correlates of the *generalised mapping* step in stage 3 of processing (see Chapter 1, Figure 1.7). In this stage, the out put of stage 2 (argument prominence computation /argument linking) is integrated with a variety of additional sources such as world knowledge and discourse context. Thus, it can be assumed that the monophasic P600 observed here is due to a problem in *generalised mapping* rather than in the *well-formedness check*.

The differences observed for the accusative case violations in Experiment 1 and Experiment 3 may be due to the fact that Experiment 1 was auditory and it might have been clear that an incorporated reading is not possible in this case.

7.4 Agreement

In Experiment 4, we explored the long distance agreement phenomena (LDA) in Hindi. The LDA is possible when the matrix subject is marked with ergative case, and clause internal agreement when the matrix subject was nominative. At the position of the control verb (want), an N400 effect was observed for both nominative and ergative arguments. In addition, we also observed a positivity for the nominative argument when both infinitive and control verb were feminine. When the infinitive verb was feminine and the control verb was masculine, we only observed an N400 effect for in this case. For the ergative arguments, the N400 effect was observed when infinitive argument was feminine and control verb was masculine. While for the nominative argument, the MM (nom(marix-subj)-inf(M)-control-verb(M)) condition also showed a P300. So this three-way distinction for the nominative shows the predictions process. A distinction for the nominative and ergative argument was expected because the ergative argument does not agree with the verb. The nominative argument clearly suggest that there is a very high prediction for the agreement of the nominative argument. We observed a P300 effect in MM condition. A P300 effect has been observed in cases where a prediction is met. Roehm et al. (2007) reported a P300 effect at the position of *white* for the sentences: *Opposite of black is white.* Thus the P300 effect in the present case suggests that there is a very high expectation for the agreement with nominative arguments and when this is met a P300 effect is observed.

For the N400 effect, we also analysed the filler sentences, which were simple sentences with argreement violations for nominative and ergative arguments. In this case, we observed an N400 effect for both the nominative and ergative arguments. As we mentioned in Chapter 2, Zawiszewski

(2007) observed an N400-P600 pattern for object agreement violations and interpreted that the direct object agreement violations differ from subject agreement violations. But the present study shows that it is not the case. In Hindi, agreement violations show an N400 effect for subject-verb agreement violations. Recently, Zawiszewski conducted an experiment with subject agreement violations and observed a N400-P600 patterm (personal communication with Adam Zawiszewski, this work is in progress). Other differences between both works lie in the fact that while we observed an N400 effect for gender violations in Hindi, in Basques, it was observed for person and number violations. Thus, it can be stated that for all kinds of violations (person, number and gender), an N400 effect can be revealed. Recall from the discussion about agreement that most of the research has shown a LAN-positivity or only a positivity for agreement violations. For Spanish, however, Bareber & Carries (2005) reported an N400 effect for gender violations. In Hindi, the critical sentences only contained a gender violation, thus, we can claim that this effect is observed because of the gender violation. Recall from earlier discussions that Nevins et al.(2007) did not find any negativity for the gender violations in Hindi but rather observed a positivity for all types of violations. The difference between Nevins et al. (2007) and the present work is that while they used sentences in future tense, we used control constructions and sentences in present tense. Nevins et al. (2007) observed only a positivity but no negative effects. In the present study, while an N400 was observed for gender violations for both cases (nominative and ergative), the positivity was only observed for the nominative.

At the position of infinitive verb, there was no general effect. After a median split, the Low Group showed an N400 effect for both the nominative and ergative arguments when infinitive was feminine, and again, there was no positivity observed in this case.

In general, this suggest that whenever there was an agreement mismatch (gender in this case), it revealed an N400 effect. This result is different from previous studies where people have reported a biphasic LAN-positivity effect or only a positivity. The result varied depending on the conditions as we observed a three-way distinction for the nominative case. In general, the agreement mismatch showed different results in the case of ergative and nominative, as only the latter showed a positivity, while an N400 was observed for both cases. This suggested that there was a general difference between clause-internal and long-distance agreement. As mentioned in the discussion (in Chapter 6), this result lines up with previous experiments as the result varied depending on the case marking. Experiment 1 revealed different results for the nominative and ergative case as the former did not show any positivity. In Experiment 2 also the results varied for the different cases. Thus, there seems to be a pattern that accusaitve and ergative case behave differently from nominative in Hindi.

7.5 Consequences for the model of language comprehension (eADM)

We already discussed in previous sections the results that can be interpreted in accordance with the eADM and we also discussed results that were difficult to analyse. The idea was to test if the findings from Hindi can be analysed in this model as it aims to be applicable to ergative languages as well. In the following, we discuss the results that can be captured within eADM and also propose that eADM can capture disappearance of positivity for nominative case violation if dialectal variations are taken into account in the well-formedness step.

7.5.1 Compute Prominence / Compute Linking

In previous sections, we already argued that several results can be well captured in accordance with the eADM. In this section, we briefly summaries the results arising due to a problem in *compute prominence* and *compute linking* and then turn to the *well-formedness* check. In Experiment 1, we proposed that the N400 effect observed for the accusative case violations is due to a problem in the *compute prominence* step. The N400 effect observed at the position of aspect for the nominative and ergative case violations was due to a prominence mismatch recognised in the *compute linking* step.

In Experiment 3, the N400 effect observed for initial inanimate ergative arguments and inanimate accusative argument (at NP2) was due to a problem in the *compute prominence* step. Thus, in brief, the aim of eADM to be applicable to ergative languages is well supported from these results.

7.5.2 Well-formedness

The late positivity effects observed for the case violations were due to a problem in the well-formedness check. One surprising result found in the case of Hindi was the disappearance of the positivity in several cases. In Experiment 1, we did not see any late positivities for the nominative case violations. We gave a description of the wide range of possibilities that the nominative has in Hindi but this still does not answer the question completely. We also saw in the last experiment (on long distance agreement) that a positivity was only observed for the nominative case (gender agreement violation). For ergative arguments, an N400 effect was observed but it was not followed by a positivity. The eADM (Bornkessel & Schlesewsky 2006a) in its present form does not state anything about the absence of the positivity in ungrammatical sentences even though it does better than other approaches as the well-formedness concept covers it better than reanalysis. For the well-formedness check, discourse and context are taken into account while in reanalysis, the ungrammatical sentences must be reanalysed. We propose that the well-formedness check of the eADM can capture this result if dialectal variations are taken into account. Considering the case of Hindi, even in India it is difficult to find a monolingual native speaker as people speak several other languages. In addition, there are also several varieties of Hindi spoken in India. Even in theoretical linguistics, it has been observed that there are structures which are used in some varieties and not in others. We think that, so far, the role of dialectal variations in language processing has not been taken into account. We do not mean the studies on bilingualism and etc. Rather, the question here is whether the dialectal variation has an influence on procesiing. There are several varieties of Hindi spoken. Thus, even the native speakers hear some structures that they themselves may not use. Does this has an effect on the processing mechanisms?

Now let us consider the cases where we did not find any positivity. In Experiment 1 in the case of nominative case violations (when nominative was used in perfective), we did not see any positivity effect but only observed an N400. We already showed that there are different possibilities for the nominative case.

In some varieties it is possible that people use the perfective aspect without the ergative, while the ergative in combination with imperfective sentences seems to be really rare. In Experiment 4, we showed that sentences like those of condition NFM (Nom(matrix subject)-Inf(F)-control verb(M) an example is repeated here below) are treated as correct in some varieties of Hindi, while they are judged as incorrect in other varieties (Bickel & Yadav, 2000) .

(7.2)	Raami	[øi	saikal	calaa-nii]	caah-taa	hai.
	Raam.m(nom)	[NOM	cycle.f(nom)	ride-INF.F]	want-IPFV.M	aux
	'Raam wants to ride a bicycle.'					

This observation might need to be tested in more detail in future research to check whether the well-formedness check can be silent in other languages, too. But the present work really supports this proposal. Recall from previous discussions that we also saw that, in the cases without a positivity, the acceptability ratings were higher than in the conditions, for which we observed the positivity. Hence, it seems that when people have a tendency to hear the structures (from other varieties) even if they do not use them themselves, they consider the sentences to be well-formed and no positivity effect is observed in these cases. This is still a speculative proposal, which will definitely need further investigations.

Note that this was an exploratory work, since there were no previous systematic neurolinguistic studies on Hindi.

7.6 Summary

This chapter presented a general analysis of all the results. We proposed that most of the results can be analysed in accordance with the eADM and we further proposed that the absence of a positivity effect can be captured in accordance with the well-formedness step if dialectal variations are taken into account.

Chapter 8

Conclusions and directions for the future research

This chapter provides a summary of the thesis and indicates directions for future research.

8.1 General observations

Firstly, we will give brief conclusions from all the chapters and then directions for future research. In the following, we briefly describe what indications the results from Hindi provide. The study suggested that information types like case, word order and animacy play an important role in argument interpretation in Hindi similar to what has been shown for accusative languages. However, which information is more prominent, may depend on the language under consideration. For Hindi, throughout the thesis, we observed that ergative and accusative case behave similarly and nominative differs from them. We also observed that ergative and accusative arguments show dependency formation similar to accusative arguments in nominative-accusative languages. In the following, we summarise the results from each chapter and show which results were surprising. In next section, we then propose how these unexpected results can be investigated in the future.

In Experiment 1, Chapter 3, we observed a positivity for initial ergative arguments and interpreted that this result is observed due to dependency formation. For accusative case violations at NP2, we observed a biphasic N400-late positivity effect. We interpreted that the N400 effect for the accusative case violations is observed due to a problem in *compute prominence* and that the late positivity is engendered by a problem in the *well-formedness check.* For ergative and nominative case violations, which were tested at the position of the aspect marker, we observed a biphasic N400-late positivity effect for the ergative case violations and only an N400 effect for the nominative case violations. We showed that the N400 effect is observed for both the case violations due to a prominence mismatch in *compute linking*. We provided a speculative analysis for the absence of the positivity effect for nominative case violations in terms of dialectal variations. Thus, in the future, this will need to be tested systematically with a group of the participants who speak different dialects of Hindi.

In Experiment 2, Chapter 4, we observed a positivity effect for initial ergative and accusative arguments. This suggested that the dependency formation works for both the accusative and ergative arguments in Hindi. We observed an early positivity for acc-nom sentences at NP2 and a positivity for nom-acc sentences. We interpreted that the early positivity was observed due to a thematic reanalysis (Bornkessel et al., 2003). The surprising result was the positivity for nom-accusative argument as for such cases, an N400 effect has been observed in other studies (cf. Bornkessel et al., 2004, Wolff et al., 2008). Hence, the occurrence of this positivity effect must be further investigated.

In Experiment 3, Chapter 5, we observed an N400 effect for inanimate arguments at NP1 and for inanimate accusative-marked arguments at NP2. We interpreted that both the effects are observed due a problem in *compute prominence,* as inanimate arguments are not prototypical actors (NP1) and the accusative marking with inanimate arguments are marked, as it is used for specific or definite meaning. The group difference observed in this case must be explored in the future. In this study, only initial ergative sentences were used, hence it might be interesting to see if the result vary when initial nominative arguments are used.

In Experiment 4, Chapter 6, we observed a biphasic N400-late positivity effect for clausal agreement violations. For the extra-clausal agreement violations, we observed only an N400 effect and no positivity. The N400 effect in this case was surprising because earlier studies for agreement violations have reported either a LAN-positivity pattern or only a positivity and in an earlier study on Hindi (Nevins et al., 2007), there was no negative effect observed. In the present experiment, clausal agreement was possible when the matrix subject was nominative, while LDA was possible when the matrix argument was ergative. Thus, we found different results depending on whether on the case marking of NP (nominative or ergative). Apart from that, in the case of the nominative, we also observed a P300 effect for the correct sentences. This showed that the expectation for the agreement is very high in the case of the nominative. We analysed the N400 effect as reflecting the gender mismatch. However, this case also needs to further tested because, in Hindi, the agreement varies across tenses and this study also showed different patterns for nominative and ergative arguments.

8.2 Directions for future research

It is clear from previous sections that there are several questions that must be investigated in the future. The first question arose in Experiment 1 and concerns the disappearance of the positivity for nominative case violations. We already presented in the previous chapter how the absence of positivity could be captured in Hindi. We proposed that it is caused by dialectal variations of Hindi. Hence, this issue needs to be tested with the people who speak different varieties of Hindi.

For the Experiment 2, we used simple sentences and we observed that also in this case, the nominative behaves differently from the ergative. We observed that at NP2, an early positivity was found for the non-canonical order, when the first argument was accusative and second was nominative. Next, we observed that in the case of canonical sentences, nominative arguments (nom-acc) engendered a positivity at NP2. This positivity in itself is surprising because an N400 effect has been observed in other studies. So to look further into this issue, we think one will need to continue this experiment with dative constructions. Moreover, it was problematic that we could not analyse the data from the verb. Nevertheless, it was clear from the results at the position of NP2 that an initial O-argument (accusaitve) was treated as an accusative and not as a dative experiencer. So let us assume a simple experiment like this:

(8.1) a. raam mohan-ko dikh-taa hai.
Ram.m(nom) Mohan.m-dat to be seen-IPFV.3sgm aux
"Mohan sees Ram"

b. raam-ko mohan dikh-taa hai.
Ram.m-dat Mohan.m(nom) to be seen-IPFV.3sg.m aux
"Ram sees Mohan."

c. raam mohan-ko dekh-taa hai.
Ram.m(nom) Mohan.m-acc see-IPFV.3sg.m aux
"Ram sees Mohan."

d. raam-ko mohan dekh-taa hai.
Ram-acc Mohan.m(nom) see-IPFV.3sg.m aux
"Ram sees Mohan."

When comparing both nominative (8.1c/d) and dative (8.1a/b) sentences, it will only be clear at the verb whether the sentence is active or not. In both cases (dative and nominative), when the prediction is not met, a reanalysis will be needed when verb is processed. Hence, we think this experiment could tell us about the processing of dative arguments and how people treat the NP2 in the both cases. We predict that in the case when people assume it to be dative experiencer and sees an active verb or vice versa a reanalysis effect should be observed at the position of the verb and this should reveal an early positivity as in Bornkessel et al., (2003).

In Experiment 3, all initial arguments were always marked with ergative case. It will be important to see in the future how inanimate nominative arguments are treated. So one further experiment should be done using both animate and inanimate nominative initial arguments. In the case of an ergative, it is clear that the argument is an actor, while this is not the case with nominative arguments. Nominative arguments can be the S argument of an intransitive verb, the O argument of a transitive verb (in the case of argument drop or movement) or it could also be the A argument of a transitive verb. Hence, for an inanimate nominative argument, we would not expect an N400 at NP1 as this was observed for ergative arguments in this experiment. In this case, we think it may be interpreted in relational term when a second argument is processed. This means that when the second argument will be encountered, it will be clear how the NP1 is treated. Thus, we assume that an inanimate nominative will need to be interpreted in relational terms.

In the case of differential object marking in Hindi, even theoretically, it has been tough to interpret and capture the variation of accusative marking in Hindi. In addition, in this study, there was no context provided. Hence, it will be really important to provide a context for these sentences and collect people's judgements both offline and online because we saw in the present study that one group of people preferred case marking while another did not. So it will be really interesting to see what results can be found when there is a context provided. In some cases, sentences with two inanimate arguments were rejected by participants unless a context was provided.

Experiment 4 explored the long distance agreement pattern in Hindi. In a previous study on Hindi, Nevins et al. (2007) reported a positivity effect for all the violation types (gender, person, number), while there was no negative effect observed in this study. In the present study, we observed an N400 effect for extra-clausal agreement violations (long distance agreement) and an N400-positivity pattern for intra-clausal agreement violations. The positivity was only observed for the latter. As the filler sentences showed, we observed an N400 effect in both cases but the positivity only was observed for ergative arguments. It is well-known that, in Hindi, agreement varies across tenses and therefore, it will be important to further explore agreement violations in different tenses. We think it will also be important to test object agreement violations in Hindi.

In sum, this thesis presents the first study on a split ergative language, which showed that case, word order and animacy play an important role in the argument interpretation in both nominative-accusative and ergative-absolutive languages. Thus, it supports the prominence-based processing architecture. But at the same time, it also shows crucial differences to the results of earlier studies. These issues will need to be further investigated.

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Appendix

Appendix 1

Statistical analysis for the critical conditions at the position of the verb.

Time window 1(450-700 ms): A repeated measure ANOVA was performed for the factor CASE-NP1(nominative vs. ergative) and ASPECT (imperfective vs. perfective) it only showed an interaction of ROI x CASE-NP1 for midline electrodes: $F(1,23)=3.36$, $p<0.03$ and both at midline and lateral sites interaction of CASE x ASPECT (midline: $F(1,23)=16.78$, $p<0.001$; lateral: $F(1,23)=15.49$, $p<0.001$) and interaction of ROI x CASE x ASPECT: (midline: $F(1,23)=5.47$, $p<0.01$; lateral: $F(1,23)=9.76$, $p<0.001$).

Resolving the interaction by ROI showed an interaction of CASE x ASPECT for FCZ; $F(1,23)=8.18$, $p<0.008$; CZ: $F(1,23)=24.51$, $p<0.001$; CPZ: $F(1,23)=21.17$, $p<0.001$; PZ: $F(1,23)=16.14$,$p<0.001$; POZ: $F(1,23)=13.31$, $p<0.001$ and for lateral sites left anterior: $F(1,23)=3.50$, $p<0.07$; left posterior: $F(1,23)=23.76$, $p<0.001$; right anterior: $F(1,23)=5.83$, $p<0.02$; and right posterior: $F(1,23)=23.28$, $p<0.001$.

Further resolving by ASPECT for imperfective aspect, it revealed a main effect of CASE at CZ: $F(1,23)=12.04$, $p<0.002$; CPZ: $F(1,23)=11.56$, $p<0.002$; PZ: $F(1,23)=10.59$, $p<0.003$; POZ: $F(1,23)=11.76$, $p<0.002$ and for lateral sites left posterior ($F(1,23)=8.63$, $p<0.007$), and right posterior ($F(1,23)=19.78$, $p<0.001$).

For perfective aspect, it showed the main effect of CASE for FCZ: $F(1,23)=8.88$, $p<0.006$; CZ: $F(1,23)=17.77$, $p<0.001$; CPZ: $F(1,23)=18.20$, $p<0.001$; PZ: $F(1,23)=12.26$, $p<0.002$; POZ: $F(1,23)=8.18$, $p<0.008$ and for lateral sites at left posterior: $F(1,23)=8.63$, $p<0.007$; right anterior: $F(1,23)=3.18$, $p<0.08$; and right posterior: $F(1,23)=9.76$, $p<0.004$.

In sum, the negativity was observed for both ergative and nominative case violations.

Time window 2 (750-1100 ms): A repeated measure ANOVAs for the time range 750-1100 ms for the verb showed a main effect of CASE at both midline and lateral electrodes (midline: $F(1,23)=31.83$, $p<0.001$; lateral: $F(1,23)=14.38$, $p<0.001$) and ASPECT (midline: $F(1,23)=19.43$, $p<0.001$; lateral: $F(1,23)=12.97$, $p<0.001$) and the interaction of CASE and ASPECT: (midline: $F(1,23)=18.04$, $p<0.001$; lateral: $F(1,23)=8.92$, $p<0.001$) and ROI x CASE x ASPECT: (midline: $F(1,23)=4.233$, $p<0.04$; lateral: $F(1,23)=8.13$, $p<0.001$).

Resolving the interaction by ROI revealed an interaction of CASE x ASPECT at for FCZ: ($F(1,23)=10.76$, $p<0.003$; CZ:($F(1,23)=30.75$, $p<0.001$; CPZ: ($F(1,23)=28.34$, $p<0.001$;
PZ: ($F(1,23)=10.98$, $p<0.003$; POZ: ($F(1,23)=9.90$, $p<0.004$ and for lateral sites left posterior: $F(1,23)=8.24$, $p<0.008$; right anterior: $F(1,23)=6.04$, $p<0.02$ and right posterior: $F(1,23)=16.71$, $p<0.001$.

Further resolving by ASPECT, we observed an effect of CASE for imperfective aspect at FCZ: ($F(1,23)=19.87$, $p<0.001$; CZ: ($F(1,23)=50.28$, $p<0.001$); CPZ: ($F(1,23)=49.30$, $p<0.001$; PZ: ($F(1,23)=24.03$, $p<0.001$; POZ: ($F(1,23)=18.49$, $p<0.001$ and for lateral sites at left posterior: $F(1,23)=20.75$, $p<0.001$; right anterior: $F(1,23)=10.84$, $p<0.003$; right posterior: $F(1,23)=28.54$, $p<0.001$.
Further resolving by perfective aspect did not show any effect both for the midline and lateral sites. Thus, the positivity was only observed for the ergative case violations and there was no effect for the nominative case violation.

Appendix 2

Statistical analysis at the position of verb and aspect for the non accusative-marked (NP2) conditions of Experiment 1.

2.1 Verb without case marked (nominative at NP2) conditions:
Time window1(450-700 ms): A repeated measure ANOVA for non case-marked arguments (NP2) revealed a main effect of ASPECT (midline: $F(1,23)=7.44$, $p<0,01$; lateral: $F(1,23)=8.46$, $p<0.008$) and interaction of ROI x ASPECT for the lateral site ($F(1,23)=3.58$,$p<0.03$) and for midline site interaction of CASE-NP1 x ASPECT (midline: $F(1,23)=3.79$, $p<0.06$) and ROI x CASE-NP1 x ASPECT (midline: $F(1,23)=5.75$, $p<0.01$).
Resolving the interaction by ROI showed an interaction of CASE-NP1 x ASPECT for CPZ: $F(1,23)=12.18$, $p<0.002$; PZ: $F(1,23)=6.41$, $p<0.02$; POZ: $F(1,23)=4.97$, $p<0.03$ and for lateral sites a main effect of ASPECT at left anterior: $F(1,23)=16.22$,$p<0.001$; left posterior: $F(1,23)=8.07$, $p<0.009$; right anterior: $F(1,23)=6.41$, $p<0.02$)

Further resolving the interaction of CASE x ASPECT by ASPECT for the midline electrodes showed a main effect of CASE-NP1 for CPZ: $F(1,23)=5.37$, $p<0.03$; PZ: $F(1,23)=7.00$, $p<0.01$ for the imperfective aspect.

For the perfective aspect, it showed a main effect of CASE-NP1 at CPZ: $F(1,23)=5.58$, $p<0.03$.

Time window 2 (750-1100 ms)

A repeated measure ANOVA for the time range 750-1100 ms for the verb showed an interaction of ROI x ASPECT (midline: $F(1,23)=4.57$, $p<0.008$; lateral: $F(1,23)=4.18$, $p<0.01$), CASE-NP1 and ASPECT (midline: $F(1,23)=23.28$, $p<0.001$; lateral: $F(1,23)=18.97$, $p<0.001$) and ROI x CASE-NP1 x ASPECT (midline: $F(1,23)=7.97$, $p<0.001$; lateral: $F(1,23)=5.72$, $p<0.004$).

Resolving the interaction by ROI revealed an interaction of CASE-NP1 x ASPECT at FZ: $F(1,23)=3.83$, $p<0.06$; FCZ: ($F(1,23)=10.36$, $p<0.003$; CZ: ($F(1,23)=24.80$, $p<0.001$; CPZ: ($F(1,23)=31.30$, $p<0.001$; PZ: ($F(1,23)=22.32$, $p<0.001$; POZ: ($F(1,23)=25.91$, $p<0.001$ and for the lateral electrodes sites at left posterior; $F(1,23)=21.08$, $p<0.001$; right anterior; $F(1,23)=4.29$, $p<0.05$; and right posterior; $F(1,23)=21.15$, $p<0.001$.

Further resolving by ASPECT, an effect of CASE-NP1 was observed for the imperfective aspect at FZ: $F(1,23)=3.67$, $p<0.07$; FCZ: ($F(1,23)=8.58$, $p<0.007$; CZ: ($F(1,23)=16.83$, $p<0.001$); CPZ: ($F(1,23)=16.68$, $p<0.001$; PZ: ($F(1,23)=11.49$, $p<0.002$; POZ: ($F(1,23)=14.87$, $p<0.001$ and at the lateral electrodes sites at left posterior: $F(1,23)=6.33$, $p<0.02$; and right posterior: $F(1,23)=13.77$, $p<0.001$.

For the perfective aspect, it revealed an effect of CASE-NP1 at CZ: ($F(1,23)=6.58$, $p<0.01$); CPZ: ($F(1,23)=12.60$, $p<0.002$; PZ: ($F(1,23)=9.07$, $p<0.006$; POZ:($F(1,23)=8.01$, $p<0.009$ and for the lateral electrodes sites left posterior: $F(1,23)=6.95$, $p<0.01$; and right posterior: $F(1,23)=7.27$, $p<0.01$.

2.2 Aspect without case marked conditions:

Time window 1 (100-300 ms):

A repeated measures ANOVA in the time range from 100 to 300 ms post onset of the aspect marker revealed a main effect of ASPECT for the midline electrodes ($F(1,23)=4.40$, $p<0.05$) and, for both midline and lateral sites the interactions of ROI x ASPECT (midline: $F(5,115)=6.71$, $p<0.002$;

lateral: $F(5,115)=15.57$, $p<0.001$), and an interaction of ROI x CASE x ASPECT (midline: $F(5,115)=8.93$, $p<.003$; lateral: $F(5,115)=6.09$, $p<0.006$).

Resolving the interactions by ROI revealed a main effect of ASPECT at CZ: $F(1,23)=6.76$, $p<0.02$; CPZ: $F(1,23)=8.63$, $p<0.007$; PZ: $F(1,23)=5.30$, $p<0.03$; POZ: $F(1,23)=8.15$, $p<0.001$ and interactions of CASE x ASPECT at CPZ: $F(1,23)=5.64$, $p<0.03$; PZ: $F(1,23)=7.26$, $p<0.01$ and for the lateral electrodes sites at left anterior: $F(1,23)=12.62$, $p<0.002$; right posterior $F(1,23)=5.81$, $p<0.02$ and an interaction of CASE-NP1 and ASPECT at left posterior: $F(1,23)=9.44$, $p<0.005$ and right posterior: $F(1,23)=7.14$, $p<0.01$).

Resolving by aspect the main effect of case for imperfective aspect at PZ: $F(1,23)=3.44$, $p<0.008$ no effect for perfective aspect. For lateral sites main effect of case at left posterior: $F(1,23)=4.93$, $p<0.04$ and right posterior $F(1,23)=4.37$, $p<0.05$) no effect for perfective aspect.

Time window 2 (400-700 ms)

A repeated measures ANOVAs in the time range from 400 to 700 ms post onset of the aspect marker revealed a main effect ASPECT for both midline and lateral sites (midline: $F(1,23)= 4.61$, $p<0.04$; lateral: $F(1,23)= 7.47$, $p<0.01$) and the interactions of CASE x ASPECT (midline: $F(1,23)= 26.23$, $p<0.001$; lateral: $F(1,23)=18.16$, $p<0.001$), ROI x ASPECT (midline: $F(5,115)=6.92$, $p<0.001$; lateral: $F(5.115)=6.20$, $p<0.002$) ROI x CASE x ASPECT(midline: $F(5,115)=8.47$, $p<.001$; lateral: $F(5,115)=6.86$, $p<.002$)

Resolving these interactions by ROIs revealed the interactions of CASE x ASPECT at FCZ: $F(1,23)=11.35$, $p<0.002$; CZ: $F(1,23)=23.97$, $p<0.001$; CPZ : $F(1,23)=34.46$, $p<0.001$; PZ: $F(1,23)=23.81$, $p<0.001$; POZ: $F(1,23)=3017$, $p<0.001$ and for the lateral electrodes sites at left posterior: $F(1,23)=19.58$, $p<0.001$; right anterior: $F(1,23)=3.71$,$p<0.07$; right posterior $F(1,23)=22.40$, $p<0.001$.

Further resolving by ASPECT a main effect of CASE-NP1 was observed for imperfective aspect at FZ: $F(1,23)=4.20$, $p<0.05$; FCZ: $F(1,23)=11.20$, $p<0.003$; CZ: $F(1,23)=18.03$, $p<0.001$; CPZ: $F(1,23)=18.64$, $p<0.001$; PZ: $F(1,23)=12.85$, $p<0.002$; POZ: $F(1,23)=13.02$, $p<0.002$ and for the lateral electrodes sites at left posterior: $F(1,23)=5.54$, $p<0.03$; right posterior: $F(1,23)=13.19$, $p<0.001$.

For the perfective aspect it revealed a main effect of CASE-NP1 at CZ: $F(1,23)=4.88$, $p<0.04$; CPZ: $F(1,23)=11.83$, $p<0.002$; PZ: $F(1,23)=7.32$, $p<0.01$; POZ: $F(1,23)=7.43$, $p<0.01$ and for the lateral electrodes sites at left posterior: $F(1,23)=7.08$, $p<0.01$ and right posterior: $F(1,23)=6.85$, $p<0.01$.

Appendix 3

Experiment materials

In all of the experiments, the following adverbs were used:

Today

Now

Here

There

Experiment1

The items 1 to 40 were masculine common nouns and the items from 40 to 80 were feminine common nouns and the same verbs were used for both the masculine and feminine arguments. The list of item number 1 to 40 is given below.

001 शिक्षक माली देखना

shikshak maalii dekhanaa

teacher Gardner to see

002 डाक्टर छात्र मारना

doktar chatra marnaa

doctor student to beat

003 लोहार प्रजा पकरना

lohaar prajaa pakaranaa

blacksmith citizen to catch

004 लड़का राजा चूमना

laDkaa raajaa cumanaa

boy king to kiss

005 आदमी नेता छोड़ना

aadmii netaa choDnaa

man leader to leave

006 चित्रकार कमार गिराना

citrakaar kamaar giraanaa

Painter kamaar to make fall

007 नौकर फूफा लुभाना

naukar phuphaa lubhanaa

servant uncle to make greedy

008 मालिक युवक भिगाना

maalik yubak bhigaanaa

master youth to make wet

009 सोनार मुनी चाहना

sonaar muni cahanaa

goldsmith saint to like

010 नायक भक्त ठगना

naayak bhakt thangnaa

hero devotee to cheat

011 भतीजा मोची जगाना

bhatijaa mocii jagaanaa

nephew barber to awake

012 नेता साधु बुलाना

netaa sadhu bulaanaa

leader saints to call

013 वकिल मामा हराना

vakil maamaa haraanaa

advocate uncle(maternal) to defeat

014 भिखारी पिता डाँटना

bhikhaarii father daatnaa

beggar father to chide

015 खिलाड़ी बेटा मनाना

khilaarii betaa manaanaa

player son to coax

016 लेखक कवि लटिाना

lekhak kavi litaanaa

Writer poet to make lye

017 दानव जज छिपाना

daanav jaj chipaanaa

monster judge to hide

018 सिपाही ताऊ रोकना

sipaahii tau rokanaa

soldier uncle to stop

019 गायक दादा जलाना

gaayak daadaa jalaanaa

singer uncle to burn

020 पथिक नाना खिलाना

pathik naanaa khilaanaa

traveller grandfather(maternal) to feed

021 जुलाहा मंत्री बांधना

julaahaa mantrii bandhnaa

a caste minister to bind

022 बनिया चोर दफनाना

baniyaa chor daphnaanaa

a caste thief to put under grave

023 सेनापति योद्धा ढुँढना

senapati yodhaa Dhudhnaa

chief of soldier soldier to look for

024 देवता सिकारी डराना

devtaa sikaarii daraanaa

demigod hunter to make fear

025 बच्चा बूढा जानना

baccaa budhaa jannaa

child oldman to know

026 दोस्त तेली धमकाना

dost telii dhamkaanaa

friend oil man to threat

027 मुनीम चाचा फुसलाना

muniim caacaa phslaanaa

secretary uncle coax

028 पुरुष सेठ घुरना

purush seth ghuranaa

man rich man to stare

029 पंडित भाइ हँसाना
pandit bhaaii hasaanaa
priest brother to make laugh

030 असुर ग्वाला रुलाना
asur gwalaa rulaanaa
demon milkman to make weep

031 किसान धोबी बिठाना
kisaan dhobii bitaanaa
farmer washer man to make seat

032 दामाद दीवान बचाना
damaad diwaan bachaanaa
son-in-law diwan to save

033 बनिया सिख गिराना
baniyaa sikh giraanaa
Shop keeper Siksh tomake fall

034 संन्यासी सुरी चिढ़ाना
sanyaasii surii chidhanaa
saint a caste totease

035 पाठक नेता लुटना
pathak netaa lutanaa
reader leader loot

036 मलाह जज पालना
malaah jaj paalanaa
fisherman Judge to foster

037 बालक दास घुमाना
baalak daas ghumaanaa
boy servant to make walk

038 अध्यक्ष तेली नचाना
adhyaksha telii nachaanaa
president oilman to make dance

039 बिद्यार्थी लाला जलाना
bidyarthii lalaa jalaanaa
student lala to burn

040 पुजारी राक्षस सताना

pujaarii rakshak sataanaa

priest demon to oppress

Apart from this, filler sentences were also used in the experiments. The filler sentences consisted of: 1st argument was again common (both masculine and feminine) nouns but at NP2 it were animals, inanimate which did not need case marking.

Experiment 2

80 sets of sentence material were created but the NP1, NP2 and the verb were same in the 1 to 40 and 40 to 80, the position of the NP1 and NP2 were changed in 40 to 80. So the arguments which were A-argument in 1to 40 were O-argument in 40 to 80 and vice versa and the verb was used with different combinations. So same verbs were not used in the same combination. No filler sentences were used in this experiment.

01 किशोर मोहन मारना

kishore mohan maarnaa

Kishore Mohan to beat

02 आलोक सोहन पकड़ना

alok sohan pakaDanaa

Alok Sohan to catch

03 गोपाल आकाश चूमना

gopal akash cumanaa

Gopal Akash to kiss

04 पवन प्रभात गिराना

pawan prabhat giraanaa

Pawan Prabhat to make fall

05 अशोक प्रवीण लुभाना

ashok praveen lubhaanaa

Ashok Praveen to make greedy

06 प्रकाश अरुण सुलाना

prakash arun sulaanaa

Prakash Arun to make sleep

07 बरुण नरेश देखना

barun naresh dekhnaa

Barun Naresh to see

08 गोपाल गणेश डाँटना

gopal ganesh daaTanaa

Gopala Ganesh to chide

09 राकेश रमेश पीटना

rakesh ramesh PiTaanaa

Rakesh Ramesh to beat

10 श्याम राजेश ठगना

shyam rajesh Thaganaa

Shyam Rajesh to cheat

11 अमित सुभाष जगाना

amit subhash jagaanaa

Amit Subhash to make awake

12 बबलु मुकेश बुलाना

bablu mukesh bulaanaa

Bablu Mukesh to call

13 बैभव आशीष हराना

baibhav ashish haraataa

Baibhav Ashish to defeat

14 बादल सरोज छिपाना

baadal saroj chipaataa

Badal Saroj to hide

15 नीरज अखिल मनाना

niraj akhil manaataa

Niraj Akhil to coax

16 पंकज सुमित लिटाना

pankaj sumit liTanaa

Pankaj Sumit to make lie down

17 सुधीर अजीत फँसाना

sudhiir ajiit phasaanaa

Sudhir Ajit to take in trap

18 प्रधान विजय रोकना

pradhaan vijay rokanaa

Pradhan Vijaya to stop

19 निखिल सुरज पुकारना

nikhil suraj pukaaraa

Nikhil Suraj to call

20 सुवोध नवीन धकेलना

subodh navin dhakelanaa

Subodh Navin to push

21 रमेश मदन बांधना

ramesh madan bandhanaa

Ramesh Madan to bind

22 शंकर ललित दफनाना

shankar lalit daphanaanaa

Shankar Lalit to put in grave

23 अखिल संतोष ढुँढना

akhil santosh DhuDhanaa

Akhil Santosh to look for

24 चैतन्य चंदन डराना

caitanya candan daraanaa

Chaitnya chandan to make afraid

25 प्रनीत प्रमोद जानना

praneet pramod jaananaa

Praneet pramod to know

26 भूषण रंजन धमकाना

bhusaN ranjan dhamkaanaa

Bhushan Ranjan to threat

27 दिलीप रंजीत फुसलाना

dilip ranjeet phuslaanaa

Dilip Ranjeet to coax

28 दीपक मदन घुरना

dipak madan ghuraanaa

Dipak Modan to stare

29 कुनाल रोहित रुलाना

kunaal rohit rulaanaa

Kunal Rohit to make weep

30 दिनेश राजेश बिठाना

dinesh rajesh bithaanaa

Dinesh Rajesh to make sit

31 धिरज रमन बचाना

dhiraj raman bacaanaa

Dhiraj raman to save

32 अजय रंधीर चिढ़ाना

ajaya randheer cidhaanaa

Ajaya Randheer to tease

33 बिभाष सागर लुटना

bibhash sagar lutnaa

Bibhash sagar to loot

34 गगन साहिल पालना

gagan sahil paalanaa

Gagan Sahil to ...

35 कपिल साकेत घुमाना

kapil saket ghumaanaa

Kapil Saket to move aroun

36 गनेश समीर नचाना

gaNesh samiir nacaanaa

Ganesh sameer to make dance

37 गिरीश नितीश खोजना

girish nitish khojanaa

Girish Nitish to search

38 गौतम योगेश सताना

gautam yogesh sataanaa

Gautam yogesh to oppress

39 हृदय योगेन्द्र सजाना

hriday yogendra sajaanaa

Hridaya Yogendra to decorate

40 केदार अचल झुकाना

kedaar acal jhukaanaa

Kedar Achal to bend

Experiment3

The following materials were used in this experiment to generate the the critical sentences. The arguments which were A-arguments in 1 to 40 were O-arguments in 40 to 80 and vice versa. The list of item 1 to 40 is given belwo. No filler sentences were used in this experiment.

01 मोहन किशोर क्रेन ट्रक उठाना

mohan kishore kren truck uthaanaa

mohan kishore crane truck to lift

02 सोहन आलोक कंकर इत्र लुढकाना

sohan aalok kankar itra ludhakaanaa

sohan aalok piece of stone scent to roll down

03 आकाश गोपाल धागा रस्सी लपेटना

aakaash gopaal dhaagaa rassii lapeTanaa

aakaash gopaal thread rope to rap

04 प्रभात पवन लाठी छड़ी पीटना

prabhaat pawan laathii chaDii piiTanaa

prabhaat pawan thikstick stick to beat

05 प्रवीण अशोक कम्प्यूटर रोवोट हराना

prabeeN ashok kampyutar robot haraanaa

prabeeN ashok computer Robot to defeat

06 अरुण प्रकाश झूला डाल हिलाना

aruN prakaash jhulaa daal hilaanaa

aruN prakaash swing branch of tree to shake

07 नरेश बरुण किताब नाव डुबाना

naresh baruN kitaab naav dubaanaa

naresh baruN book boat to make sink

08 गणेश गोपाल बल्ला गेंद मारना

gaNesh gopaal ballaa geNd maanaa

gaNesh gopaal bat ball to hit

09 रमेश राकेश गाड़ी ट्रैक्टर लाना
ramesh rakesh gaaDii traktar laanaa
ramesh rakesh van tracter to bring

10 राजेश श्याम साईकल ठेला रोकना
rajesh shyaam saaiikal thellaa rokanaa
rajesh shyaam cycle van to stop

11 सुभाष अमीत ताला पैसा बचाना
subhash amit taalaa paisa bacaanaa
subhash amit lock money to save

12 मुकेश बबलू बैलगाड़ी रिक्शा पछाड़ना
mukesh bablu bailgaaDii riksha pachaaDanaa
mukesh bablu ox van rikshaw to leave behind

13 आशीष बैभव तलवार सीढ़ी काटना
aashish baibhav talbaar siidhii kaaTanaa
aashish baibhav sword ladder to cut

14 सरोज बादल ताँगा टैक्सी खींचना
saroj baadal taangaa taxii khichanaa
saroj baadal horsevan taxi to pull

15 अखलि नीरज जहाज पनडुब्बी ढूँढना
akhil niiraj jahaaj pandubbii dhudhanaa
akhil niiraj ship pandubi to look for

16 सुमति पंकज मेज कुर्सी ढकना
sumit paankaj mez kursii dhakanaa
sumit paankaj table chair to cover

17 अजीत सुधीर पैरासूट गुब्बारा उड़ाना
ajiit sudhiir pairaasut gubbaaraa uDaayaa
ajiit sudhiir parachute balloon to make fly

18 विजय प्रधान मशाल रबर जलाना
vijay pradhaan maacis rabar jalaanaa
vijay pradhaan matchbox rubber to burn

19 सूरज निखिल पत्ता चादर छिपाना
suraj nikhal pattaa caaadar chipaanaa
suraj nikhal leaf bedshit to hide

20 नवीन सुवोध गिलास साबुन दबाना
naveen subodh gillaas sabun dabaanaa
naveen subodh glass shoap to press

21 मदन रमेश सुराही घड़ा भिगाना
madan ramesh suraahii ghaDaa   bhigaanaa
madan ramesh pitcher(thin neck) pitcher to make wet

22 ललति शंकर मोटर छिलका उछालना
lalit shankar motar chilkaa uchaalaa
lalit shankar motar make to make jump

23 संतोष अखलि धूप कपड़ा सुखाना
santosh akhil pankhaa kapDaa sukhaanaa
santosh akhil fan clothes to make dry

24 चंदन चैतन्य लकड़ी डंडा झुकाना
chandan chaitanya lakaDii Danda jhukayaa
chandan chaitany wood likestick to make bend

25 प्रमोद प्रणीत रथ फटफटिया दौड़ाना
pramod praneet rath phatphatiyaa dauraanaa
pramod praneet chariot a van to make run

26 रंजन भूषण पीतल पलना डुलाना
ranjan bhushan pital palanaa dulaanaa
ranjan bhushan swing for child to shake

27 रंजीत दिलीप मशीन इंजन चलाना
ranjeet dilip mashiin injan calaanaa
ranjeet dilip machine engine to start/make walk

28 मदन दीपक ईट पत्थर कुरचना
madan diipak iiTa pathar kurchaa
madan diipak brick stone to rub

29 रोहित कुनाल जीप कार ठोकना
rohit kunaal jeep kaar thokaa
rohit kunaal jeep car to hit

30 राजेश दिनेश त्रिशूल चाकू मोड़ना
rajesh dinesh trishul caakuu moDaa

rajesh dinesh weapon knife to fold

31 रमन धीरज टिकट थैला लुटाना

raman dhiiraj tikat thailaa lutaanaa

raman dhiiraj ticket bag to

32 रंधीर अजय बस ट्राली खिसकाना

randhiir ajaya bas traalii khiskaanaa

randhiir ajaya bus a van to push further

33 सागर बिभाष तीर मोमबत्ती बेधना

saagar bibhash tiir mombatii bedhaa

saagar bibhash bow candle to fix

34 साहिल गगन हल चुम्बक धकेलना

saahil gagan hal cumbak dhakelanaa

saahil gagan plough magnet to push

35 साकेत कपिल चिमटा खिलौना पकड़ना

saket kapil cimaTaa khilaunaa pakaDanaa

saket kapil cimtaa toys to hold/catch

36 समीर गणेश पानी पर्दा बहाना

samiir gaNesh paanii pardaa dhonaa

samiir gaNesh water curtain to wash

37 नितीश गिरीश हेलीकाप्टर पटरी हटाना

nitish giriish helikopter patrii hataanaa

nitish giriish helicopter scale to remove

38 योगेश गौतम चुट्टा कैंची छोड़ना

yogesh gautam cuttaa kainchii choranaa

yogesh gautam chutta scissor to leave

39 योगेन्द्र हृदय झाड़ू जंजीर झाड़ना

yogendra hridaya jhaDu janjeer jharaanaa

yogendra hridaya broom chain to clean

40 अचल केदार बाल्टी डब्बा टिकाना

achal kedaar baaltii dabbaa tikaanaa

achal kedaar bucket box to hold

Experiment 4

The items used to generate the sentences for Experiment 4 are given below. The items show NP1, NP2 and infinitive verb. The control verb used in this experiment was caahnaa (to want).

01 मोहन साईकल चलाना
mohan saikal calaanaa
Mohan saikal to ride

02 सोहन टहनी काटना
sohan tahnii kaaTnaa
Sohan branch(tree) to cut

03 रोहन किताब पढ़ना
rohan kitaab paDhanaa
Rohan book to read

04 पवन टैक्सी देखना
pawan taksii dekhanaa
Pawan taxi to see

05 पंकज जमीन बेचना
pankaj jameen bechanaa
Pankaj land to sell

06 महेश गीत सुनना
masesh geet sunanaa
mahesh song listen

07 सुरेश खेती करना
suresh khetii karnaa
Suresh farming to do

08 रमेश गेंद फेंकना
ramesh gend pheNkanaa
Ramesh ball to throw

09 धीरज कढ़ाही तोड़ना
dheeraj KaDhahii toDanaa
dhiraj pot to break

10 दीपक गोली दागना
diipak golii daaganaa

dipak bullet to fire

11 सुभाष गोभी भूनना

subhash gobhii bhunanaa

Subhash cauliflower to fry

12 राकेश नाव डुवाना

rakesh naav dubaanaa

rakesh boat to make sink

13 अरुण खिड़की सजाना

arun khirakhii sajaanaa

Arun window to decorate

14 शंकर गाड़ी गिराना

shankar gaaDii giraanaa

shankar van to make fall

15 राजेश कार रोकना

rajesh kaar rokanaa

rajesh car to stop

16 वरुण चाभी लटकाना

barun caabhii latkaanaa

Barun key to hang

17 मनीष चाय पीना

manish caaya piinaa

manish tea to drink

18 विकास पोटली सीना

vikaas potalii siinaa

Vikas potali to sew

19 प्रभात कुर्सी उठाना

prabhaat kursii uthaanaa

Prabhat chair to lift

20 आलोक दरी मोड़ना

alok darii moDanaa

Alok bed to fold

21 बबलु कपड़ा पहनना

bablu kapaDaa pahannaa

bablu clothes to wear

22 अमीत कटोरी पकड़ना

amit katorii modanaa

Amit small(pot) to hold

23 विशाल रोटी पकाना

vishaal roTii pakaanaa

Vishal bread to bake

24 सुशील चिट्टी लिखना

sushil chithii likhanaa

Sushil letter to write

25 प्रनीत टंकी भरना

praneet tankii bharanaa

pranneet tank to fill

26 भूषण सुराही खिसकाना

bhushan suraahii khiskhaanaa

Bhushan pitcher to push

27 दिलीप मोमबत्ती पिघलाना

dilip mombatii pighalaanaa

Dilip candle to melt

28 संतोष गद्दी छोडना

santosh gaddii   choranaa

Santosh   thrown   to leave

29 कुनाल जीप खरीदना

kunaal jeep kharidanaa

Kunal jeep to buy

30 दिनेश मटकी फोड़ना

Dinesh matkii phoranaa

Dinesh pot(of mud) to break

31 विनय बोतल रंगना

vinaya botal ranganaa

Vinay botle to colour

32 अजय पेटी धकेलना

ajaya petii dhakelanaa

Ajay box to push

33 बिभाष चटाई बिछाना

bibhash cataaii bichanaa

Bibhash mat to put

34 गगन मिट्टी खोदना

gagan mittii khodanaa

Gagan soil to dig

35 कपिल बगीचा घेरना

kapil bagiicaa gheranaa

Kapil garden to make fences

36 गणेश कॉँपी फाड़ना

ganesh kaanpii phaaDnaa

ganesh copy to tear

37 गिरीश हाकी खेलना

girish haukii khelnaa

Girish hockey to play

38 गौतम घंटी बजाना

gautam ghantii bajaanaa

gautam bell to ring

39 हृदय घड़ी बनाना

hridaya gharii bananaa

Hridaya watch to repair

40 केदार कैंची खोजना

kedaar kainchii khojanaa

Kedar scissor to search

41 प्रकाश पगड़ी उड़ाना

prakash pagarii uraanaa

Prakash pagarii to flew

42 साकेत लकड़ी समेटना

saket lakrii sametanaa

Saket lakarii to gather

43 आकाश वासुरी खींचना

akaash basurii khincanaa

Akash flute to pulll

44 नीरज आँटा तौलना

Niraj aantaa taulnaa

Niraj floor to wet

45 प्रवीण थैली चुराना

praviin thailii churaanaa

Praveen bag to steal

46 निखील छूडी हटाना

nikhil churii haTaanaa

Nikhil knife to remove

47 नरेश रस्सी लपेटना

naresh rasii lapetanaa

naresh rope to rap

48 कौशल माला पिरोना

kaushal maalaa pironaa

kaushal necklace to make

49 बिरजु चारपाई बुनना

biraju charpaaii bunanaa

Birju charpaii to make

50 मुरली सारी सुखाना

muralii saarii sukhaanaa

Muralii saarii to dry

51 सुनील अँगुठी लाना

sunil anguthii laanaa

Sunil ring to bring

52 मुकेश आलमारी खोलना

mukhesh almaarii kholanaa

Mukesh almari to open

53 आशीष इलैयची चबाना

ashish ilaiyacii chabaanaa

Ashish cardamom to grind

54 सरोज ईट गिनना

saroj int ginanaa

Saroj brick to count

55 अखिल पपिस्तौल हिलाना

akhil pistaul hilaanaa

Akhil revolver to shake

56 सुमीत कविता सुनाना

sumit kavitaa sunaanaa

Sumit poetry to make hear

57 अजीत कमीज़ उतारना

ajit kameej utaarnaa

Ajit shirt to open

58 विजय कहानी कहना

vijaya kahaanii kahnaa

Vijaya story to tell

59 सुरज कुल्हारी निकालना

suraj kulhaarii nikaalnaa

Suraj axe to get out

60 नवीन पेंसील छिपाना

navin pensiil chipaanaa

Navin pencil to hide

61 मदन छतरी तानना

madan chatarii tannaa

Madan umbrella to open

62 ललित छड़ी घुमाना

lalit charii ghumaanaa

Lalit stick to wind

63 जीवन टोपी उछालना

jeevan Topii uchalnaa

Jivan cap to throw

64 चंदन तस्वीर चिपकाना

chandan tasveer chipkaanaa

Chandan photo to paste

65 श्याम पत्ती बिखेरना

shyam pattii bikheranaa

Shyam leaf to scatter

66 रंजन गिट्टी गाड़ना

ranjan gittii gaaranaa

Ranajan brick to put under soil

67 रंजीत प्याली बाटना

ranjeet pyalii baatanaa

Ranjeet cup to dstribute

68 प्रशांत फसल उगाना

prashant phasal ugaanaa

Prashant crops to grow

69 रोहिति बर्फी खाना

rohit barphii khaanaa

Roshit sweet to eat

70 प्रभाष राखी बाँधना

prabhash rakhii badhnaa

Prabhas rakhii to bind

71 रमन बाल्टी लुढकाना

raman baltii luDhkaanaa

Raman bucket to roll down

72 रंधीर भिण्डी धोना

randheer bhindii dhonaa

Randheer veg. to waash

73 सागर मेज रखना

saagar mez rakhanaa

sagar mez to keep

74 साहिल लौंग पीसना

saahil laung piisanaa

Sahil laung to grind

75 रतन शराब उडेलना

ratan sharaab uDelanaa

Ratan wine to pour

76 समीर सब्जी उवालना

sameer sabjii ubaalanaa

Sameer veg to boil

77 नितीश सिगरेट जलाना

nitiish sigret jalaanaa

Nitish cigarette to light

78 योगेश सीट बिठाना

yogesh sit bithaanaa

Yogesh seat to fix

79 योगेन्द्र दाल परोसना

yogendra daal parosanaa

Yogendra lentil to serve

80 अचल चाँदी लुटना

achal chandii lutanaa

Achal silver to snatch

ABSTRACT

GERMAN

Empirische Befunde aus Studien zu Nominativ-Akkusativ-Sprachen lieferten übereinstimmende Ergebnisse für die Annahme, dass Merkmale wie Kasus, Wortstellung und Belebtheit eine wichtige Rolle beim Aufbau von Prominenzrelationen zwischen Argumenten spielen, die bei der inkrementellen Interpretation hergestellt werden (Bornkessel und Schlesewsky, 2006). Das Hauptziel der vorliegenden Arbeit lag in der Überprüfung der Frage, ob sich die Ergebnisse von Nominativ-Akkusativ-Sprachen bezüglich der Rolle dieser Merkmale auf Sprachen mit gespaltener Ergativität wie Hindi übertragen lassen. Zur Beantwortung dieser Frage wurden vier Experimente mit ereigniskorrelierten Potentialen (EKPs) und eine Fragebogenstudie durchgeführt. Alle Studien konzentrierten sich auf die Verarbeitung des Ergativs im Hindi und dessen Interaktion mit anderen Merkmalen wie Aspekt, Wortstellung und Kongruenz.

Experiment 1 überprüfte die Interaktion zwischen Kasusmarkierung und Aspekt. Als Ergebnis zeigte sich eine N400, gefolgt von einer späten Positivierung auf Grund der Diskrepanz zwischen Aspekt und Ergativmarkierung, was durchaus mit Befunden aus Nominativ-Akkusativ-Sprachen vergleichbar ist. Die Diskrepanz zwischen Aspekt und Nominativmarkierung evozierte jedoch nur eine N400 ohne Positivierung, was darauf hindeutet, dass die beiden Kasus unterschiedlich verarbeitet werden.

Im zweiten Experiment wurden Wortstellungsvariationen in Nominativ- und Ergativkonstruktionen untersucht. Sowohl in Experiment 1 als auch in Experiment 2 konnte eine Positivierung für ergativ- und akkusativmarkierte Argumente an der Position des ersten Arguments (NP1) beobachtet werden. Dieses Ergebnis untermauert die Hypothese, dass Ergativ und Akkusativ den Aufbau von Dependenzrelationen bedingen, die sich in einer Positivierung niederschlagen. Darüber hinaus zeigte sich in Experiment 2 eine Positivierung (zwischen 350 und 650ms) für Nominativ-Akkusativ-Konstruktionen, die für eine kanonische Abfolge überraschend war. Da frühere Studien in diesem Fall eine N400 berichten (Bornkessel et al., 2004; Wolff et al., 2008), stellt das vorliegende Ergebnis die bisherige Analyse der N400 als ein generelles Indiz für die Erweiterung von einer intransitiven zu einer transitiven Lesart in Frage.

In Experiment 3 wurden die Rolle der Belebtheit und deren Interaktion, sowohl mit dem Ergativ als auch dem Akkusativ überprüft. Es zeigte sich, dass sowohl unbelebte Argumente im Ergativ (NP1)

als auch unbelebte Argumente im Akkusativ (NP2) eine N400 elizitierten. Die Negativierung an der ersten NP ist darauf zurück zu führen, dass unbelebte Argumente im Gegensatz zu belebten keine Eigenschaften eines potentiellen Handlungsverursachers (Actor) tragen. Unbelebte Akkusativargumente (NP2) sind markiert (d.h. spezifisch bzw. definit). Beide N400-Effekte(an NP1 und NP2) können als Korrelat eines Problems bei der Erstellung von Prominenzrelationen interpretiert werden. Ferner zeigte sich für NP2 im Nominativ eine Positivierung am Verb, die ausgeprägter war, wenn das zweite Argument des Satzes belebt (d.h. den geforderten Akkusativ nicht erfüllte) und das erste Argument unbelebt war. Obwohl dieser Befund als Reflexion der Überprüfung der Wohlgeformtheit analysiert werden könnte, wird eine weitere mögliche Interpretation, die pragmatische Faktoren bei der Realisierung von Argumenten mit einbezieht, vorgeschlagen.

Experiment 4 untersuchte schließlich das Phänomen der satzübergreifenden Kongruenz („long-distance agreement“), die von der Kasusmarkierung des Subjekts im Matrixsatz abhängt. Die Ergebnisse ergaben eine N400 gefolgt von einer späten Positivierung für die Verletzung der satzinternen Kongruenz, während Verletzungen der satzübergreifenden Kongruenz nur eine N400 evozierten. Dieser Befund steht im Widerspruch zu Ergebnissen von Nevins et al. (2007), die bei Verletzungen der Kongruenz im Hindi nur eine Positivierung aber keine Negativierung fanden. Möglicherweise kann die N400 der vorliegenden Studie, einer Überprüfung von Genusverletzungen zugerechnet werden (Carreiras et al., 2005). Zu beachten ist jedoch, dass die Verletzung von satzinterner und satzübergreifender Kongruenz zu unterschiedlichen Ergebnissen führte.

Zusammenfassend scheint die N400 in Experiment 1 Unstimmigkeiten hinsichtlich der Prominenzinformationen widerzuspiegeln. Analog dazu ist die N400 in Experiment 3 an NP1 und NP2 ein Indiz für Probleme bei der Bestimmung von Prominenzrelationen. Für den Einfluss ähnlicher Merkmale konnten vergleichbare Effekte für Nominativ- und Ergativsprachen beobachtet werden. Die Ergebnisse aus dem Hindi bieten daher Evidenz für eine prominenzbasierte Sprachverarbeitungsarchitektur und lassen vermuten, dass die Merkmale Kasus, Wortstellung und Belebtheit in beiden Sprachtypen eine entscheidende Rolle spielen. Gleichwohl werfen die abweichenden Befunde im Falle des Hindi einige Fragen auf, denen in weiteren Untersuchungen nachgegangen werden muss.

ENGLISH

The experimental evidence from nominative-accusative languages has provided converging support for the assumption that information types like case, word order and animacy play an important role in establishing prominence relations between the arguments, which takes place in incremental argument interpretation (Bornkessel and Schlesewsky, 2006). Therefore, the main goal of this thesis was to test whether findings from nominative-accusative languages with respect to the role of these information types in argument interpretation can be generalized to split-ergative languages like Hindi. To address these questions four experiments using event-related brain potentials (ERPs) and two questionnaire studies were conducted. All of these studies focused on the processing of ergative case in Hindi, and how this interacts with other information types such as aspect, word order, animacy and agreement.

Experiment 1 tested the interaction between case (nominative and ergative) and aspect. The result showed an N400 and late positivity for the mismatch of aspect and ergative case, which is quite comparable to the results from nominative languages. Whereas, for the mismatch of nominative case and aspect there was only an N400 and no positivity, suggesting that these two cases are not treated exactly the same way.

Experiment 2 was concerned with word order variations in both nominative and ergative constructions. Both in Experiment 1 and 2 a positivity was observed for ergative and accusative marked arguments at NP1. This finding supports the hypothesis that ergative and accusative case lead to dependency formation, which is reflected in a positivity. In addition, in Experiment 2 ERPs at NP2 showed a positivity (350-650ms) for nominative-accusative sentences. The positivity for the canonical order is surprising. As earlier studies have shown an N400 (Bornkessel et al., 2004; Wolff et al., 2008) in such a case, the present result challenges the earlier analysis of the N400 as a general marker for the extension from an intransitive to a transitive reading.

In Experiment 3 we tested the role of animacy and its interaction with both ergative and accusative cases. The result revealed an N400 for inanimate ergative arguments at NP1 and an N400 for inanimate accusative arguments at NP2. This is because inanimate arguments do not have the properties of a potential actor unlike animate arguments. At NP2, inanimate accusative arguments are marked (specific or definite). Thus, the N400, observed both at NP1 and NP2, can be interpreted in terms of problems in prominence computation. Apart from this, a positivity was elicited at the position of the verb when NP2 was nominative, which was more pronounced when the second argument was animate (i.e. for a violation of accusative case) and first argument was inanimate. Though this result can be analyzed in some sense in terms of well-formedness, a speculative analysis is also presented in terms of pragmatic properties of argument realization.

Finally, experiment 4 examined long-distance agreement (across a clause boundary), which is dependent on the case marking of the matrix subject. Results revealed an N400 followed by a late positivity for clausal agreement violations (nominative), whereas long distance agreement violations only showed an N400 (ergative). This result contrasts with the findings by Nevins et al. (2007), who observed only a positivity for agreement violations in Hindi and no negativity. Possibly, the N400 in the present study can be attributed to the examination of gender violations (Barber and Carreiras, 2005). Interestingly however, violations of clausal and long-distance agreement showed different results.

In sum, the N400 observed in Experiment 1 can be interpreted as prominence mismatch (Bornkessel and Schlesewsky, 2006) and N400 observed in Experiment 3 at NP1 and NP2 due to the problem in prominence computation. For the role of similar information types similar results are observed in both types of languages (accusative and ergative). Thus the results from Hindi support the prominence-based processing architecture and suggest that these information types (case, word order, animacy) play an important role in both types of languages. Nevertheless, the differences observed in case of Hindi raise several questions that must be investigated in future research.

Zusammenfassung

In der psycholinguistischen Literatur ist allgemein bekannt, dass die Satzverarbeitung inkrementell abläuft (Crocker, 1994; Stabler, 1994). Um die inkrementelle Verarbeitung verbfinaler Satzstrukturen zu erklären, schlagen Bornkessel und Schlesewsky (2006) vor, dass Merkmale wie Kasus, Wortstellung und Belebtheit für das Erstellen von Prominenzrelationen zwischen den Argumenten, d.h. ob ein Argument mehr Eigenschaften eines Handlungsverursachers (Actor) oder eines Handlungserleidenden (Undergoer) besitzt, schon vor der Verarbeitung des Verbs eine wichtige Rolle spielen. Diese Annahmen basieren jedoch überwiegend auf Ergebnissen aus Untersuchungen von Nominativ-Akkusativ-Sprachen. Über die Verarbeitung von Ergativ-Sprachen ist bisher wenig bekannt.

Im Rahmen der vorliegenden Arbeit wurden daher die Merkmale Kasusmarkierung, Wortstellung und Belebtheit im Hindi als Beispiel einer Sprache mit gespaltener Ergativität untersucht, um zu überprüfen, ob sich die Ergebnisse aus Nominativ-Akkusativ-Sprachen übertragen lassen. Somit werden erstmalig Erkenntnisse darüber geliefert, ob und wie diese Merkmale die Interpretation von Argumenten in einer Ergativ-Sprache beeinflussen. Zu diesem Zweck wurden insgesamt vier EKP-Experimente und eine Fragebogenstudien durchgeführt. Alle Studien konzentrierten sich auf die Verarbeitung des Ergativs im Hindi sowie dessen Interaktion mit den Merkmalen Aspekt, Wortstellung, Belebtheit und Kongruenz. Im ersten Experiment wurde das Zusammenspiel von Nominativ und Ergativ mit Aspekt untersucht. Experiment 2 testete Wortstellungsvariationen in Nominativ- und Ergativkonstruktionen. Experiment 3 wurde durchgeführt, um die Rolle der Belebtheit und dessen Interaktion sowohl mit dem Ergativ als auch dem Akkusativ zu überprüfen. Experiment 4 erforschte schließlich das Phänomen der satzübergreifenden Kongruenz („long distance agreement“), die an die Kasusmarkierung des Subjekts im Hauptsatz gebunden ist.

Kasusmarkierung und Aspekt

In Experiment 1 wurden die elektrophysiologischen Korrelate aspektbedingter Kasusverletzungen im Nominativ und Ergativ untersucht. Im Hindi wird das Subjekt transitiver Verben mit perfektivem Aspekt durch Ergativ markiert während es ansonsten im Nominativ steht. In Experiment 1 wurden daher Kasusverletzungen durch eine Manipulation der satzfinalen Aspektmarkierung (perfektiv vs. imperfektiv) herbeigeführt. Als Kontrollsätze dienten Konstruktionen mit einer grammatikalisch korrekten Kombination aus Kasus- und Aspektmarkierung.

In früheren EKP Studien zu Nominativ-Akkusativ-Sprachen führten Kasusverletzungen zu einer Reihe von qualitativ unterschiedlichen Mustern. Frisch und Schleswesky (2001, 2005) berichteten ein biphasisches Muster bestehend aus einer parietalen Negativierung (N400), gefolgt von einer späten Positivierung bei doppelten Kasusverletzungen im Deutschen (d.h. für Sätze, in denen zwei Argumente dieselbe Kasusmarkierung tragen). Im Gegensatz dazu beobachteten Friederici und Frisch (2000) eine links-anterioren Negativierung (LAN) mit einer späten Positivierung für

Verletzungen des Objektkasus (d.h. Akkusativ vs. Dativ in Abhängigkeit vom jeweiligen Verb). Bornkessel und Schlesewsky (2006) interpretieren den N400-Effekt bei Kasusverletzungen als Indikator für einen Konflikt zwischen bereits verarbeiteten Prominenzinformation der Argumente mit darauffolgenden Informationen. Die LAN wird hingegen als ein Korrelat morphosyntaktischer Verletzung betrachtet. In Experiment 1 zeigte sich, dass Abweichungen vom geforderten Ergativ eine N400 gefolgt von einer späten Positivierung evozierten, während Verletzungen des Nominativs nur eine N400 auslösten. In Übereinstimmung mit den Ergebnissen von Frisch und Schlesewsky (2005) wurde die N400 als Indikator widersprüchlicher Prominenzinformationen interpretiert. Das Ausbleiben einer Positivierung für Abweichungen vom Nominativ war unerwartet und wird durch kein aktuelles Sprachverarbeitungsmodell vorhergesagt. Als mögliche Erklärung wird daher der Einfluss eines Kriteriums, das die Wohlgeformtheit (Bornkessel und Schlesewsky, 2006) beeinflusst, vorgeschlagen. Zusammenfassend konnten durch Experiment 1 Gemeinsamkeiten zwischen den Korrelaten für Kasusverletzungen des Ergativs im Hindi und den Ergebnissen aus früheren Studien, die Kasusverletzungen in Nominativ-Akkusativ-Sprachen untersuchten, festgestellt werden: In beiden Fällen wurde ein N400-Effekt beobachtet. Die Abweichungen zwischen Nominativ und Ergativ im Hinblick auf die späte Positivierung deuten jedoch daraufhin, dass die beiden Kasus unterschiedlich verarbeitet werden.

Eine weitere entscheidende Beobachtung aus Experiment 1 betrifft das Erstellen von Dependenzrelationen. Mehrere Studien zu Nominativ-Akkusativ-Sprachen konnten zeigen, dass ein Actor durch die Existenz eines Undergoers vorhergesagt werden kann (z.B. Roehm et al., 2004), da beide Rollen semantisch miteinander verknüpft sind (Primus, 1999). Auf der Grundlage von Ergebnissen aus dem Japanischen argumentieren Wolff et al. (2008), dass der Prozess, der mit der Bildung von Abhängigkeitsbeziehungen einhergeht, mit einer späten Positivierung korreliert. Demnach wurde eine Positivierung an der Position eines initialen Akkusativarguments evoziert, dem per default die Undergoer-Rolle zugewiesen wird und welches ein nachfolgendes Actor-Argument erwarten lässt. Überträgt man diese Annahmen auf das Hindi, so weist ein initiales Argument im Ergativ, das als Actor interpretiert wird, eindeutig auf die Existenz eines Undergoers in der vom Verb beschriebenen Handlung hin. Ein Vergleich der initialen Nominalphrasen in Experiment 1 (nominativ vs. ergativ) zeigte erwartungsgemäß eine Positivierung für die Nominalphrase im Ergativ. Diese Ergebnisse geben Anlass zur Annahme, dass die Bestimmung von Dependenzrelationen während der Sprachverarbeitung nicht nur die Vorhersagbarkeit eines Actors durch einen Undergoer betrifft, sondern auch die eines Undergoers durch einen Actor.

Kasusmarkierung und Wortstellung

Bornkessel und Schlesewsky (2006) argumentieren, dass ein vollständiges Verständnis der neurokognitiven Architektur menschlicher Sprachverarbeitung eine sorgfältige Analyse der Verarbeitung unterschiedlicher Wortstellungsphänomene voraussetzt, da in früheren Studien sowohl von Effekten für eine durch Scrambling veränderte Wortstellung als auch für die kanonische Basisabfolge von Argumenten berichtet wurde. Generell hat sich gezeigt, dass umgestellte, eindeutig indentifizierbare Argumente eine so genannte „scrambling negativity" auslösen – ein Effekt mit einer Amplitudenspitze zwischen 300 und 500ms nach Beginn des kritischen Wortes und einer topographischen Verteilung zwischen der klassischen Verteilung einer LAN und der einer zentro-parietalen N400 (Schlesewsky et al., 2003). Darüber hinaus wurde sowohl für das Deutsche (Bornkessel et al. 2004) als auch das Japanische (Wolff et al. 2008) bereits nachgewiesen, dass die Basiswortstellung (NP1: Nominativ, NP2: Akkusativ) im Vergleich zur umgekehrten Argumentabfolge eine N400 an der Position der zweiten Nominalphrase auslöst. Dieser Effekt wurde als Korrelat für die Erweiterung einer intransitiven zu einer transitiven Lesart interpretiert.

Da das Hindi eine Sprache mit freier Wortstellung ist, konnte im zweiten Experiment die Verarbeitung von Wortstellungsvariationen untersucht werden, um im Einklang mit den wesentlichen Fragestellungen dieser Arbeit zu überprüfen, ob Wortstellungsvariationen im Nominativ und Ergativ zu ähnlichen Ergebnissen führen würden. Zu diesem Zweck wurden nominativ- bzw. ergativ-initiale Sätze mit ihren akkusativ-initialen Gegenpaaren verglichen. Alle Sätze hatten eine vergleichbare syntaktische Struktur mit einer NP-NP-Verb Abfolge. An Stelle der ersten Nominalphrase wurde eine Positivierung für Ergativ- und Akkusativargumente im Vergleich zu initialen Nominativargumenten elizitiert. Dieses Ergebnis bestätigt die vorangegangene Hypothese, dass Ergativ und Akkusativ zur Erstellung einer Dependenzrelation führen, die eine Positivierung auslöst. Hierbei ist zu beachten, dass in diesem Fall keine „scrambling negativity" evoziert wurde, was sich mit Ergebnissen aus anderen pro-drop Sprachen wie dem Türkischen (Demiral et al., 2008) und dem Japanischen (Wolff et al., 2008) deckt.

Ereigniskorrelierte Potentiale an der Position der zweiten Nominalphrase zeigten eine frühe Positivierung (200-350ms) für Akkusativ-Nominativ-Sätze, während Sätze mit Nominativ-Akkusativ Abfolge eine etwas spätere Positivierung (350-600ms) verursachten. Die frühe Positivierung wird als thematisch bedingter Reanalyseeffekt (Bornkessel et al.2003) interpretiert. Die Positivierung für die kanonische Abfolge ist ein überraschender Befund, da frühere Studien N400 Effekte für vergleichbare Konstruktionen fanden (Bornkessel et al., 2004, Wolff et al., 2008). Die Ergebnisse aus Experiment 2 zeigen daher sowohl Übereinstimmungen mit früheren Befunden als auch entscheidende Unterschiede und stellen somit die bisherige Interpretation der N400 als einen generellen Indikator für die Erweiterung der Lesart von intransitiv zu transitiv dar.

Kasusmarkierung und Belebtheit

Die Rolle der Belebtheit und deren Zusammenspiel mit Kasusmerkmalen wurde für Nominativ-Sprachen bereits eingehend untersucht. Für das Deutsche wurde festgestellt, dass die Verarbeitung eines initialen Akkusativarguments (Undergoer) die Vorhersage eines belebten Nominativarguments (Actor) verursacht. Wird diese Prädiktion nicht erfüllt z.B. durch ein nachfolgendes unbelebtes Nominativargument, wird eine N400 elizitiert (Roehm et al. 2004). Ein vergleichbares Ergebnis wurde auch im Chinesischen verzeichnet (Philipp et al., 2008). Daher wurde in Experiment 3 die

Rolle der Belebtheit und deren Zusammenhang mit Ergativ- bzw. Akkusativmarkierung im Hindi untersucht. Es wurden ebenfalls NP-NP-Verb-Strukturen als Stimulusmaterial verwendet. Hierbei gab es zwei kritische Regionen im Satz: NP1, die einen Vergleich zwischen belebten und unbelebten Ergativargumenten ermöglichte und NP2, die eine Gegenüberstellung von belebten und unbelebten Nominativ- bzw. Akkusativargumenten beinhaltete (es muss hierbei angemerkt werden, dass belebte Nominativargumente zu einer Verletzung der differenzierten Objektsmarkierung, kurz DOM, führen). Unbelebte Ergativargumente erzeugten im Vergleich zu ihrem belebten Pendant eine N400 an Stelle der ersten NP. Die zweite Nominalphrase löste eine Interaktion der Faktoren Belebtheit und Kasusmarkierung aus, da unbelebte und belebte Nominativargumenten keine signifikanten EKP-Unterschiede aufwiesen, während die Gegenüberstellung von unbelebten und belebten Akkusativargumenten einen N400-Effekt für die unbelebten Argumente zur Folge hatte. Beide N400-Effekte können als Reflexion einer Diskrepanz zwischen unterschiedlichen Prominenzmerkmalen (e.g. Kasus und Belebtheit) interpretiert werden. Im Hindi wird ein Actor durch den Ergativ markiert. Demnach würde ein belebtes Argument erwartet werden. Die Verarbeitung eines unbelebten Ergativs führt demnach zu einem Konflikt zwischen der Kasusmarkierung (Ergativ = Actor) und des Belebtheitsmerkmals (unbelebt ≠ Actor). Für die zweite Nominalphrase gilt, dass ein unbelebtes Argument im Akkusativ eine spezifische / bestimmte Bedeutung voraussetzt für die es jedoch keine unabhängige Evidenz oder Unterstützung durch einen Kontext gab.

Überraschenderweise spiegelte sich die Verletzung der differenzierten Objektsmarkierung nicht unmittelbar im Muster der ereigniskorrelierten Potentiale an NP2 wider. Daher wurde auch die Position des Verbs analysiert. An dieser Stelle wurde eine Positivierung für alle Sätze mit Nominativobjekten gefunden. Dieser Effekt war ausgeprägter, wenn das zweite Argument belebt und das erste unbelebt war, also eine Verletzung der DOM vorlag. Obwohl dieser Befund im Sinne einer Überprüfung der Wohlgeformtheit analysiert werden kann, ist es dennoch erstaunlich, dass er erst am Verb auftritt. Eine weitere mögliche Erklärung dieses Ergebnisses zieht pragmatische Eigenschaften bei der Argumentrealisierung in Betracht. Schumacher (im Druck) schlägt vor, dass die P600 als Korrelat einer semantischen oder pragmatischen Anreicherung interpretiert werden könnte. Man kann also annehmen, dass sich der zusätzliche Anreicherungsprozess, der durch bestimmte Optionen in der syntaktische Realisierung eines Arguments ausgelöst wird, in einer erhöhten P600-Amplitude niederschlägt.

Kasusmarkierung und Kongruenz

Zur Kongruenz zwischen Subjekt und Verb liegen bereits mehrere Studien vor, die zumeist eine LAN gefolgt von einer Positivierung für Kongruenzverletzungen dokumentierten (Kutas and Hillyard, 1983; Coulson, King, and Kutas, 1998; Hagoort and Brown, 2000). In einer früheren Studie zum Hindi berichten Nevins et al. (2007) jedoch lediglich eine späte Positivierung für Verletzungen der Kongruenz in Bezug auf Genus, Numerus und Person in einfachen Sätzen. Hindi bietet darüber hinaus ein besonderes Kongruenzmuster, das als „long distance agreement“ (kurz

LDA) bezeichnet wird und auf Hauptsatzsubjekte beschränkt ist, die im Ergativ stehen. Im vierten Experiment wird daher die Verarbeitung kasusabhängiger und satzübergreifender Kongruenzmuster im Hindi untersucht. Da in Experiment 1 bereits Unterschiede zwischen der Verarbeitung des Ergativ und Nominativ evoziert wurden, war es nun wichtig zu überprüfen, ob sich die beiden Kasus auch hinsichtlich der Verarbeitung von Kongruenzmerkmalen unterscheiden würden. Zu diesem Zweck wurden Kontrollsätze mit einem Hauptsatzsubjekt im Nominativ (kein LDA erlaubt) mit kritischen Sätzen verglichen, die ein Hauptsatzsubjekt im Ergativ enthielten (LDA ist möglich). Das Verb des Hauptsatzes kongruierte entweder mit dem Hauptsatzsubjekt oder dem Objekt des Nebensatzes bzw. mit dem darin enthaltenen Infinitiv. Darüber hinaus wurde eine weitere Bedingung hinzugefügt, in der das Hauptsatzverb mit dem Subjekt des Hauptsatzes kongruiert und der Infinitiv mit dem Objekt des Nebensatzes womit eine satzübergreifende Inkongruenz entsteht.

Die Ergebnisse zeigten eine N400 gefolgt von einer späten Positivierung für Kongruenzverletzungen innerhalb des Hauptsatzes, während LDA-Verletzungen zwischen dem eingebetteten Objekt und dem Hauptsatzverb nur eine N400 evozierten. Diese Resultate widersprechen den Ergebnissen von Nevins at al. (2007), die für Kongruenzverletzungen im Hindi lediglich eine Positivierung aber keine Negativierung berichteten. Möglicherweise kann die N400, die in Experiment 4 auftrat, auch auf Genusverletzungen zurückgeführt werden (Barber et al., 2005). Weitere Untersuchungen dieses Aspekts sind hierfür jedoch unumgänglich. Eine sehr interessante neue Erkenntnis ist jedoch, dass die Verarbeitung satzinterner einerseits und satzübergreifender Kongruenz andererseits zu unterschiedlichen elektrophysiologischen Reaktionen geführt hat, da im ersten Fall (satzintern) eine späte Positivierung evoziert wurde.

Zusammenfassung

Die vorliegende Studie bekräftigt die Annahme einer prominenzbasierten Sprachverarbeitungsarchitektur und liefert erste Erkenntnisse, dass diese sowohl für Nominativ-Akkusativ-Sprachen als auch für Ergativ-Absolutiv-Sprachen Gültigkeit besitzt. Die Ansicht von Bornkessel und Schlesewsky (2006), dass Kasus, Wortstellung und Belebtheit bei der Erstellung von Prominenzhierarchien zwischen einzelnen Argumenten eine zentrale Rolle spielen, wird somit durch sprachübergreifende Daten bestätigt.

Dennoch unterscheiden sich einige Ergebnisse von früheren Untersuchungen zu Nominativ-Akkusativ-Sprachen. Eine wichtige Beobachtung war das Ausbleiben einer Positivierung für Kasusverletztungen, was zum jetzigen Zeitpunkt durch keines der existierenden Sprachverstehensmodelle vorhergesagt werden kann. Lediglich innerhalb des eADM (extended Argument Dependency Model) könnten die Ergebnisse möglicherweise durch ein Wohlgeformtheitskriterium erklärt werden. Ein weiterer entscheidender Unterschied zeigte sich bei der Untersuchung von Wortstellungsvariationen; eine kanonische Abfolge ($NP1_{NOM}$ - $NP2_{AKK}$) elizitierte eine Positivierung an NP2 wohingegen in früheren Studien zu Nominativ-Sprachen eine N400 dokumentiert wurde. Das vorliegende Ergebnis stellt daher die Interpretation, der N400 als

Korrelat einer generellen Erweiterung von einer intransitiven zu einer transitiven Lesart, infrage. Im großen und ganzen bestätigt die vorliegende Studie zwar grundsätzlich eine prominenzbasierte Sprachverstehensarchitektur, dennoch bedarf es weiterer Untersuchungen, um zu klären, ob die beobachteten Unterschiede auf prinzipielle Unterschiede zwischen Ergativ- und Nominativ-Sprachen auf spezifische Eigenschaften des Hindi oder aber auf die verwendeten Konstruktionen zurückzuführen sind.

Curriculum Vitae

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