University of the Basque Country (UPV/EHU)

Doctoral Dissertation

Processing proto-agents and proto-patients:

Eye-tracking and EEG evidence in Spanish

Author:

Marta Sánchez López

Supervisors:

Prof. Itziar Laka

Dr. Mikel Santesteban

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Illustration: Estíbaliz Aguirre López de Munain

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Cuando bailo, soy la agente que levanta la pierna y que gira (porque todo el que haya bailado sabe que la pierna no se levanta sola), pero también soy la que experimenta esa alegría y pasión por el baile. Las dos cosas están ligadas. Entonces me pregunto, si en el lenguaje sucede lo mismo que en el baile, que el agente y el experimentante son lo mismo, ya que no se puede bailar sin disfrutar.

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Abstract

Psycholinguistic research has largely investigated the processing correlates of agents and patients (Bickel et al., 2015; Gómez-Vidal et al., 2022; Haupt et al., 2008; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; *inter alia*). However, little is known about the processing of experiencers. In this dissertation I seek to fill this gap by investigating the processing of experiencers to determine whether this role constitutes a specific role category within the event role repertoire (Fillmore, 1971), as agent and patient categories do, or whether these argument types are grouped within the proto-agent category (Dowty, 1991).

I start this dissertation by reviewing theoretical event role approaches and psycholinguistic evidence about the processing of agents, patients, and experiencers. Next, in three eye-tracking reading experiments and in an EEG reading experiment, I investigate the processing correlates of verbs selecting experiencer role (i.e., *fear*-type, *frighten*-type, and perceptual verbs), as well as the processing correlates of this role in transitive and intransitive structures in Spanish.

The overall pattern of results shows that agents and experiencers exhibit similar processing correlates and both different from patients. These findings are consistent with the proto-role approach, suggesting that experiencers do not conform a distinct role category; instead, they are grouped within the proto-agent category, since both agents and experiencers seem to behave similarly in the syntax-semantic interface and different from patients.

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CrI	Credible Interval
eADM	The Extended Argument Dependency Model
EEG	Electroencephalogram
ERP	Event-Related Potential
LOO-CV	Leave-one-out cross-validation
OVS	Object-Verb-Subject word order
SVO	Subject-Verb-Object word order
TFA	Time-frequency Analysis

Chapter 1

General introduction

A key mechanism of language processing is the identification of *who is doing what to whom*. For example, when processing the sentence (1), *Mary* is identified as the one who hits *the ball* and not the other way around. Within milliseconds, it is recognized the number of participants involved and the role each one plays in the event described by the verb; these roles are known as *event roles*[1].

(1) *Mary hits the ball*.

The representation of event roles dates back to the Sanskrit grammarian Pānini (Levin & Rappaport Hovav, 2005), traditionally placed in the VI-V BCE centuries. This grammar used *karakas* to express the relations between participants (Mishra, 2019). For example, the *kartṛ* was used to refer to the participant which is independent in performing the action, a role now commonly referred to as the *agent* (Mishra, 2019).

[1] Event roles have received different names depending on the theoretical approach: *thematic roles*, *cases*, *thematic relations*, *semantic roles*, etc. (Fillmore, 1968; Gruber, 1965; Levin & Rappaport Hovav, 2005; Van Valin & LaPolla, 1997). In this dissertation, I will use the term *event roles*, since it is the less theoretically burdened expression. When referring to specific theoretical approaches, I will adopt the terminology used within those frameworks: *thematic roles*, in the case of thematic role list approaches (Fillmore, 1968, 1971; Gruber, 1965), *proto-roles*, in the proto-role approach (Dowty, 1991), and *macroroles* in the macrorole approach (Foley & Van Valin, 1984; Van Valin, 1999, 2004; Van Valin & LaPolla, 1997).

In modern linguistics, Gruber (1965) was the first one who highlighted the relevance of event roles in the syntax-semantics interface. Within the generative grammar, he proposed that semantic relations among event participants are systematic. Each participant in the event has a specific role which determines its syntactic realization. For example, in the event denoted in (2), *Mary* is not only *the sender,* but it fits into the agent role category, "the entity which willed the action" (Gruber, 1965, p. 56), *the book* into the theme, "the entity which is conceived as moving" (Gruber, 1965, p. 48), and *John* into the goal of motion. Syntactic rules apply to these role categories to specify their syntactic position. Hence, *Mary* becomes the subject because it is the agent of the event. Gruber referred to these roles as *lexical relationships.*

(2) *Mary sent a book to John.*

Speakers differentiate several nuances of semantic relations; however, not all of them are relevant for syntactic realization. The aim of event role theories is to specify how many of these semantic relations are relevant for argument realization. In examples (3.a) and (3.b), it is easily differentiated that *the girl* in (3.a) is *the eater*, whereas in (3.b) it is *the lover.*

(3) a. *The girl ate the cake.*
b. *The girl loved the cake.*

Some theoretical approaches group these two roles into two different categories, *the eater* as the agent, and *the lover* as the experiencer (Belletti & Rizzi, 1988; Fillmore, 1971). Other approaches, instead, assemble semantic relations into broader role categories, grouping both *the eater* and *the lover* under the same event role: proto-agent (Dowty, 1991) or actor (Foley & Van Valin, 1984; Van Valin, 1999, 2004; Van Valin & LaPolla, 1997).

Many event role categories have been proposed in event role theories without a consensus on the number and properties of them. As Newmeyer described: "there is no construct as murky in ANY subdivision of linguistic theory as that of 'thematic role'. Literally dozens have been proposed over the years, and nothing approaching a consensus has been achieved in terms of delineating the set that are needed for natural language semantics" (Newmeyer, 2010, p. 689). In general, event role theories agree on the existence of agent and patient role categories although they differ in their characterization (Dowty, 1991; Fillmore, 1968, 1971; Jackendoff, 1990; Van Valin & LaPolla, 1997). This agreement aligns with psycholinguistic evidence that these role categories are two core knowledge categories with specific processing correlates each (Rissman & Majid, 2019). However, other event roles, such as the experiencer, are not always included in the set of event roles (Baker, 1997; Jackendoff, 1990), and to date, no psycholinguistic research has directly addressed whether the experiencer role displays specific processing correlates, as agents and patients do.

In this Doctoral Dissertation, I particularly focus on the processing correlates of the experiencer role in both transitive and intransitive structures in Spanish. First, I investigate the processing of different transitive structures with the experiencer role using eye-tracking reading tasks. Next, I study the processing correlates of agent, experiencer, and patient roles in intransitive structures using both EEG and eye-tracking reading methodologies. All these experiments share the research question of whether the experiencer role exhibits specific processing correlates, as agents and patients do.

In this section, I begin by reviewing theoretical approaches on event roles; from the early thematic role list approaches to later frameworks that emerged in response to the limitations of earlier ones. At the same time, I discuss the literature of two other key elements in this research: psychological and perceptual verbs. Reviewing these verbs is crucial for understanding both previous and current experiments involving the experiencer role, since these verbs assign experiencer role to one of their

participants. I then turn to psycholinguistic evidence on agent, patient, and experiencer roles which constitute one of the main focuses on this Doctoral Dissertation.

1. Thematic role list approaches

The first attempts in contemporary linguistic literature to specify the number and nature of event roles appeared in thematic role list approaches. These approaches brought to light compelling and crucial questions concerning the nature of thematic roles and helped establish their relevance at the syntax-semantic interface. One of their central claims is that thematic roles are discrete categories: thematic roles are not characterized in terms of semantic entailments or features, but they are instead treated as primitive, non-decomposable notions (Levin & Rappaport Hovav, 2005), a concept I develop throughout this chapter.

Fillmore's Case Grammar (1968) was the first theoretical study where a detailed list of event role categories was proposed. He named these categories as *cases* and characterized them as notions that "comprise a set of universal, presumably innate, concepts which identify certain types of judgements which human beings are capable of making on the events that are going on around them, judgements on such matters as who did it, who it happened to, what got changed, etc." (Fillmore, 1968, p. 46). He proposed a short list of cases: *agentive*, *instrumental*, *dative*, *factitive*, *locative*, and *objective*. He argued that these cases form a specific finite set that is hierarchically organized. The case that an argument has determines its syntactic realization based on the place it occupies in the thematic hierarchy. He proposed the first thematic role hierarchy for determining subject selection:

> (4) "If there is an Agent, it becomes the subject; otherwise, if there is an Instrument, it becomes the subject; otherwise, the subject is the Objective[2]."
>
> (Fillmore, 1968, p. 60)

After proposing this list of cases, Fillmore expanded the list to account for argument realizations of all verb types; hence, he incorporated other roles such as *experiencer*, *goal*, *source*, *location* (Fillmore, 1971).

Subsequent thematic hierarchies also aimed to explain which argument becomes the subject. Hence, thematic role hierarchies relied on the idea that the highest-ranked role should become the subject – I will henceforth refer to this hypothesis as *the Thematic Role Hierarchy Hypothesis*.

Subsequent approaches proposed different lists of thematic roles and different thematic hierarchies:

(5) Examples of different thematic hierarchies:
a. Agent > Experiencer > Instrument > Object > Source/Goal/Location > Time (Fillmore, 1971)
b. Agent > Experiencer > Theme (Belletti & Rizzi, 1988)
c. Agent > Theme/Patient > Goal/Source/Location (Baker, 1997)
d. Actor > Patient/Benefactive > Theme > Goal/Source/Location (Jackendoff, 1990)

In all proposed hierarchies, agents are placed higher than themes, patients or objects (5.a-d), and experiencers are ranked lower than agents (5.a, 5.b) but higher than objects (5.a) or themes (5.b). However, hierarchies differ in the number of thematic roles they include, in the boundaries of the included categories, and in the rank roles

[2] Fillmore (1968) assigned Objective case to things that are affected by the action of the verb. He characterized it as the most neutral case. It is equivalent to theme/patient thematic role.

have. For example, only Fillmore's (1971) and Belletti & Rizzi's (1988) hierarchies include the experiencer role (5.a, 5.b). In the case of patients and themes, some hierarchies distinguish these two roles (5.d), others do not (5.c), and others only include the theme role (5.b). In Fillmore's (1968, 1971) work, the labels *theme* or *patient* are not included, but he named these roles *object.*

One of the central ideas of thematic role list approaches is that thematic roles are primitive notions – that are not decomposed into smaller elements – and that they conform a finite and small set (Fillmore, 1968, 1971; Levin & Rappaport Hovav, 2005). As Levin and Rappaport Hovav (2005, p. 42) reviewed, thematic roles "are taken to be discrete and unanalyzable", which means that thematic roles are not decomposed into smaller elements, but they are characterized by semantic descriptions. For example, Fillmore described the agent role as "the perceived instigator of the action identified by the verb, typically animate" (Fillmore, 1968, p. 46). These semantic descriptions constituted a first attempt to characterize event roles, however, as Dowty (1989, p. 70) stated: "such descriptions are not intended as final *definitions* of thematic roles but are no doubt thought of as the kind of interim, rough-and-ready intuitive characterizations that linguists sometimes find it expedient to give of those concepts that are acknowledged to be real ones in natural language but whose precise theoretical explication is complex and still controversial".

As I will discuss in later sections, other approaches disagree with these ideas, arguing that event roles are not primitive notions; instead the semantic entailments (Dowty, 1991) or features (Reinhart, 2000, 2002, 2016) that characterize event roles are considered the primitive elements.

Treating thematic roles as primitive conceptual notions entails the absence of precise diagnostic criteria to characterize and differentiate them, leading to fuzzy boundaries (Dowty, 1989, 1991; Levin & Rappaport Hovav, 2005). For example, the agent, one of the most well-known thematic roles, has no clear boundaries. Several authors have proposed different ways of characterizing it. Cruse (1973, p. 18:21) split

it into four types after studying the syntactic properties of agentive verbs in English: *volitive*, *effective*, *initiative* and *agentive*. Fillmore provided two distinct descriptions for the agent role depending on its animacy: agentive case "the case of the perceived instigator of the action identified by the verb typically animate", and instrumental case "the case of the inanimate force or object causally involved in the action or state identified by the verb" (Fillmore, 1968, p. 46).

The characterization issue links with the problem of identifying how many thematic roles are involved in argument realization. As I have previously mentioned, thematic role list approaches try to group semantic relations into a finite set of thematic roles. However, it is not clear how broad thematic role categories should be. One of the most clear disagreements without consensus is whether theme and patient roles are distinct thematic roles or are grouped together, ultimately becoming a catch-all category (Dowty, 1991; Levin & Rappaport Hovav, 2005). For example, Fillmore characterized it as "the entity which moves or which undergoes change" and said that he used this category "as a wastebasket" (1971, p. 42). Later, Levin and Rappaport, in their review, claimed that Filmore's idea of the object role as a wastebasket is still present as "many researchers apply the label theme or patient to almost any NP expressible as an object" (2005, p. 40).

All in all, although thematic role list approaches played a key piece in developing the understanding of event roles, they faced two main limitations that motivated subsequent approaches on this area: (i) the lack of consensus on the number of thematic roles, and (ii) the unclear boundaries of roles.

2. Verbs selecting experiencer role

Before continuing with the discussion of other event role proposals, it is relevant to discuss about the early literature on psychological and perceptual verbs, as these verbs represent the second focus of this dissertation. These verbs are relevant for the present research because they assign experiencer role to one of their participants. I decided to

include this section just after the one of thematic role list approaches because the first theoretical explanations of these verbs emerged in this framework. In subsequent sections, the discussion of psychological verbs will be included within the discussion of each theoretical approach.

Chapin (1967) first mentioned *perceptual statives* to refer to verbs such as *see, hear,* and *feel.* Later, Postal (1970) introduced the term *psychological predicate* to refer to verbs that express "psychological features of animate beings" (p. 41) such as *frighten* and *amuse* (henceforth *frighten*-type verbs). Later, in their seminal paper devoted to psychological verbs, Belletti and Rizzi (1988) argued that *frighten*-type verbs and verbs such as *fear* or *love* (henceforth *fear*-type verbs) constitute a grammatical class, a view I will henceforth refer to as *the Psychological Verb Hypothesis* throughout the dissertation. According to their hypothesis, psychological verbs share the same underlying structure with the same event participants (experiencer, theme) but differ in the assignment of syntactic functions to their arguments resulting in different superficial structures: verbs like *fear* (6.a) map experiencers as subjects, whereas verbs like *frighten* (6.b) map experiencers as objects[3]. The mapping particularities of *frighten*-type verbs deviates from the predictions of the Thematic Role Hierarchy Hypothesis, as these verbs map the highest-ranked role – the experiencer – onto the lowest syntactic position – the object (6.b).

[3] Belletti and Rizzi (1988) included three classes of psychological verbs: *temere, preoccupare,* and *piacere.* They claimed that the last two classes are double object construction with a nonthematic subject position. *Preoccupare* and *piacere* verb types both map the experiencer onto the object and the theme onto the subject position in the superficial structure. Since I am interested in the event roles of these verbs and their superficial mapping, I grouped these two classes under the *frighten*-type class because both map the experiencer as the object.

(6) a. *John*$_{EXPERIENCER}$ *feared Mary*$_{THEME}$.

b. *Mary*$_{THEME}$ *frightened John*$_{EXPERIENCER}$.

(7) *John*$_{EXPERIENCER}$ *saw Mary*$_{THEME}$.

By contrast, there was an agreement that perceptual verbs assign experiencer and theme to their participants, mapping the experiencer as the subject, and the theme as the object (7), without a similar *frighten*-type counterexample. This consensus led researchers to treat perceptual verbs as a distinct class from psychological verbs. Levin (1993), in her classification of English verbs, explicitly distinguished between perceptual and psychological verbs. In subsequent works on event roles, authors continued to include examples of perceptual verbs, maintaining the view that their argument structure is experiencer-theme (Van Valin, 1999, 2004). As it is often the case, there are exceptions, and Reinhart (2000, 2002, 2016) opted for grouping perceptual verbs within *fear*-type verbs, as they share the same event participants and syntactic realization. In any case, to my knowledge, there have been no theoretical studies devoted specifically to perceptual verbs. I therefore summarize that perceptual verbs are generally treated as a distinct category from psychological verbs, and that their argument structure is typically analyzed as experiencer-theme, the same of *fear*-type verbs.

Coming back to psychological verbs, subsequent work posited that *frighten*-type verbs map the experiencer onto the object syntactic position because they select an agent for the subject, instead of a theme (8.b) (Grimshaw, 1990; Pesetsky, 1995; Pylkkanen, 1999). For instance, Grimshaw (1990) proposed that *frighten*-type verbs involve an underlying causative event structure where the subject is an agent or cause that brings about a psychological change in the experiencer. Similarly, Pesetsky (1995) and Pylkkänen (1999) provided syntactic and semantic diagnostics supporting this causative analysis. Further support comes from other theoretical approaches (Dowty, 1991; Parodi-Lewin, 1991; Zaenen, 1993; Arad, 1998; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller, 2013; Fábregas & Marín, 2015, *inter*

alia), all converging on the view that *frighten*-type verbs encode causation, whereas *fear*-type verbs do not (8). I will henceforth refer to this hypothesis as *the Non-Psychological Verb Hypothesis.*

(8) a. *John*$_{EXPERIENCER}$ *feared Mary*$_{THEME}$.
b. *Mary*$_{AGENT}$ *frightened John*$_{EXPERIENCER}$.

Furthermore, even Belletti and Rizzi (1988) admitted that *frighten*-type verbs may assign the agent role to the subject when a human subject is interpreted as voluntarily introducing the psychological process or state:

(9) *The two guys frighten each other intentionally.*

Regarding thematic role hierarchies, the initial hypothesis of Belletti and Rizzi (1988) presented a challenge in accounting for why *frighten*-type verbs map the experiencer onto the object position. In these verbs, the highest-ranked thematic role, the experiencer, is mapped onto the object, whereas the lowest-ranked role, the theme, is mapped onto the subject. The Thematic Role Hierarchy Hypothesis, originally proposed by Fillmore (1968), posits that the highest-ranked thematic role should be mapped onto the subject position. Belletti and Rizzi (1988) proposed an explanation for the particular mapping of *frighten*-type verbs: an unaccusative structure. The lack of an external argument position licenses the movement of the theme to the subject position. This proposal explains the realization of the theme as the subject. However, it still involves a misalignment between the prominence of semantic and syntactic superficial structures, since the highest-ranked thematic role is not mapped onto the highest syntactic position. By contrast, the alternative hypothesis that *frighten*-type verbs entail causation (Grimshaw, 1990; Pesetsky, 1995; Pylkkanen, 1999) converges with the Thematic Role Hierarchy Hypothesis without the need of any movement: the experiencer becomes the object rather than the subject because of the presence of an agent (8.b), the highest-ranked role in the thematic hierarchy.

3. Event roles as non-primitive notions

Coming back to event role approaches, treating event roles as primitive and unanalyzable notions raised several theoretical and descriptive challenges. Nowadays, event role theories no longer view event roles as primitive, but rather as decomposable.

Zaenen (1988), in her study of unaccusative verbs in Dutch, pointed out that agent and theme roles are not primitive, otherwise, these categories could not generalize crosslinguistically. Rozwadowska (1988, 1989) also rejected the idea that event roles are unanalyzable, by claiming that they are characterized by a set of semantic features. She proposed the features of *sentient*, *cause* and *change*: agents are characterized by the three features, experiencers by sentient and by being changed, and patients only by being changed (Rozwadowska, 1988, 1989).

Moreover, Ramchand (2008) directly rejected the Thematic Role Hierarchy Hypothesis, proposing instead that event roles are characterized by the syntactic structure. This means that argument interpretation is specified by the position an argument occupies within the decompositional structure of the event, rather than by a pre-established hierarchy of thematic roles. In her framework, thematic roles are not independent lexical or semantic labels but emerge compositionally from the syntax of event structure itself. Although this approach offers valuable insights into the nature of event roles – such as the proposal of only three roles (*initiatior*, *undergoer*, and *resultee*) instead of an extensive inventory – I will not discuss this approach in detail, as the syntactic representation of event roles lies beyond the scope of this dissertation.

Other approaches consider that the primitives are semantic entailments (Dowty, 1991) or semantic features (Reinhart, 2000, 2002), similar to what Rozwadowska (1988, 1989) pointed out. Others instead claim that the primitives are semantic elements, different from semantic entailments or features, introduced in the semantic structure (Foley & Van Valin, 1984; Van Valin, 1999; Van Valin & LaPolla, 1997). All these approaches agree on the idea that some semantic components characterize

event roles; however, they disagree on what are these semantic components. In this section, I discuss three approaches considering event roles as non-primitive notions: (i) the proto-role approach (Dowty, 1991), (ii) the Theta-System (Reinhart, 2000, 2002), and (iii) the macrorole approach (Foley & Van Valin, 1984; Van Valin, 1999, 2004; Van Valin & LaPolla, 1997).

3.1 The proto-role approach

Unlike thematic role list approaches, Dowty (1991) proposed that semantic relations are grouped into broader role categories rather than into a list of roles. He proposed only two proto-roles, *proto-agent* and *proto-patient*. This idea of grouping event roles into two broad categories was previously proposed in other approaches (Dik, 1989; Dixon, 1972; Foley & Van Valin, 1984). Dixon (1972) introduced this idea in his work on ergativity. He proposed "A" and "O", each of them referred to the semantic classes of subject and object respectively. For example, he explained that one argument of transitive structures receives the "A" role, which can be the agent of affect verbs, the speaker of speaking verbs, or the perceiver of attention verbs (Dixon, 1994, p. 8). The novelty of the proto-role approach is that proto-roles are not discrete categories, they are cluster concepts, and arguments may have different degrees of membership into a proto-role (Dowty, 1991).

According to Dowty (1991), proto-roles are not primitive notions, they are decomposed into semantic entailments. He grouped all semantic relevant entailments that are involved in subject and object selection into proto-agent and proto-patient categories respectively (see Table 1.1).

Dowty argued that semantic entailments are distinctions relevant to us when processing events. For instance, during event processing, it is easily identified whether someone has acted intentionally or not, or whether a participant is causing something

on another one, or even whether a participant is moving or not (Dowty, 1991).

Table 1.1: List of proto-agent and proto-patient entailments (Dowty, 1991, p. 572).

Proto-agent entailments	Proto-patient entailments
Volitional involvement in the event or state	Undergoes change of state
Sentience (and/or perception)	Incremental theme
Causing an event or change of state in another participant	Causally affected by another participant
Movement (relative to the position of another participant)	Stationary relative to movement of another participant

He specified that "these entailments are not any less clear and, more important, that they are more straightforwardly relevant to human life. It is certainly not obvious that in ordinary reasoning and conversation people directly pay attention to or worry about whether something really was or was not a Theme or a Source or an Agent […]; but we do concern ourselves all the time, both in everyday life and in courts of law, and sometimes to a painstaking degree, with whether an act was really volitional or not, whether something really caused something or not, whether somebody was really aware of an event or state or not, or had a certain emotional reaction to it" (Dowty, 1991, p. 575).

As semantic entailments are real distinctions that we make in our day-to-day life, their boundaries are not clear-cut (Dowty, 1991). Particularly, this idea differentiates proto-role entailments from the semantic features proposed by Rozwadowska (1988, 1989). Dowty pointed out that "the boundaries of these kinds of entailments may never be entirely clearcut" (1991, p. 574). There is no reason to expect these distinctions to have clear boundaries. Arguments may exhibit different degrees of an

entailment. For example, the proto-agent entailment of sentience is a typically human quality; however, animals or even computers may have this semantic entailment in specific contexts. Consider a scenario where someone unexpectedly enters your house, and your dog starts barking. When you realize it was your brother, and not a thief, you might say *The dog thought that you were a thief*, thereby assigning the proto-agent entailment of sentience to the dog (Dowty, 1991).

Dowty explicitly avoided ranking proto-role entailments. However, he stated that he "also would not rule out the desirability of 'weighting' some entailments more than others for purposes of argument selection" (Dowty, 1991, p. 547). Specifically, he referred to the proto-agent entailment of causation, since it may be more salient than the others for subject assignment.

To explain how these two proto-roles interact with syntax, he proposed the Argument Selection Principle with two corollaries and a "nondiscreteness" property:

- "Argument Selection Principle: In predicates with grammatical subject and object, the argument for which the predicate entails the greatest number of Proto-Agent properties will be lexicalized as the subject of the predicate; the argument having the greatest number of Proto-Patient entailments will be lexicalized as the direct object.
- Corollary 1: If two arguments of a relation have (approximately) equal number of entailed Proto-Agent and Proto-Patient properties, then either or both may be lexicalized as the subject (and similarly for objects).
- Corollary 2: With a three-place predicate, the nonsubject argument having the greater number of entailed Proto-Patient properties will be lexicalized as the direct object and the nonsubject argument having fewer entailed Proto-Patient properties will be lexicalized as an oblique or prepositional object (and if two nonsubject arguments

have approximately equal numbers of entailed P-patient properties, either or both may be lexicalized as direct object).

- Nondiscreteness: Proto-roles, obviously, do not classify arguments exhaustively (some arguments have neither role) or uniquely (some arguments may share the same role) or discretely (some arguments could qualify partially but equally for both proto-roles)" (Dowty, 1991, p. 576).

Arguments may have different degrees of membership into a proto-role, since they are not discrete categories where arguments belong or not. Arguments may have all, some or only one of the proto-role entailments, or even they may have entailments of both proto-roles. The argument that has more proto-agent entailments becomes the subject. He considered the distinction between proto-agent and proto-patient as a continuum where arguments have different degrees of membership into a proto-role (Dowty, 1991).

Dowty pointed out that there are verbs that assign all proto-agent entailments and all proto-patient entailments to their arguments, as in (10):

(10) *Mary built a house.*

In (10), *Mary* becomes the subject because it has all the proto-agent entailments listed in Table 1.1 and there is no other argument with proto-agent entailments, as *a house* has all the proto-patient entailments and no proto-agent ones. Other verbs select fewer entailments for their arguments, as *fear*-type verbs (11):

(11) *Mary feared dogs.*

In (11), *Mary* has only the proto-agent entailment of sentience. Hence, *Mary* becomes the subject because even if it does not have all proto-agent entailments, it is the only argument that has proto-agent entailments.

Interestingly, there are also verbs like *frighten*-type verbs (12), which assign proto-agent entailments to their two arguments[4]:

(12) *Mary frightened John.*

In (12), while *Mary* has three proto-agent entailments (causation, volition and sentience), *John* has only the proto-agent entailment of sentience, based on the Non-Psychological Hypothesis that *frighten*-type verbs involve causation. According to the Argument Selection Principle, the argument with the greatest number of proto-agent entailments becomes the subject; even though *frighten*-type verbs entail proto-agent entailments for both arguments, *Mary* has more proto-agent entailments than *John,* therefore, it becomes the subject.

To sum up, the novelties of the proto-role approach are: (i) there are only two proto-roles: proto-agent and proto-patient, (ii) proto-roles are characterized by a set of semantic entailments, and (iii) they are non-discrete categories, so arguments may have different degrees of membership into a proto-role. In the following section, I discuss the Theta System proposed by Reinhart (2000, 2002) and which are the similarities and dissimilarities with the proto-role approach.

[4] Dowty (1991) discussed *fear*-type and *frighten*-type verbs to illustrate his proto-role approach. Rather than relying on the Psychological Verb Hypothesis or on the Non-Psychological Verb Hypothesis, he first considered (p. 579) that both verb types involve stimulus and experiencer roles and that both encode causation. Consequently, both verb types select two arguments with proto-agent entailments: stimulus involves causation and experiencer sentience. In page 587, however, Dowty considered the Non-Psychological Verb Hypothesis, according to which only *frighten*-type verbs denote causation. For simplicity, I only discuss how the proto-role approach explains the syntactic realization of these verbs based on the Non-Psychological Verb Hypothesis, since the hypothesis that *fear*-type verbs involve causation has not, to my knowledge, been considered in the literature, as discussed throughout this dissertation.

3.2 The Theta System

Following Dowty's (1991) ideas, Reinhart (2000, 2002, 2016) proposed the Theta System, a feature-based approach where thematic roles are decomposed into semantic features rather than being considered unanalyzable notions. At first glance, semantic entailments and features might seem identical; however, there is a subtle difference between both approaches. While Dowty's (1991) semantic entailments lack clear boundaries and participants may exhibit different degrees of membership into a role type, Reinhart's (2000, 2002, 2016) semantic features have clear boundaries, meaning participants either possess the features of a specific role or not, with no possibility of gradation.

Reinhart (2000, 2002, 2016) realized that some thematic roles share semantic properties. For instance, she noted that the thematic roles of cause and agent overlap: if an argument is assigned the agent role, it inherently involves causation, similar to the cause role. This overlap suggests a semantic commonality between these roles. Thematic role list approaches, which treat thematic roles as discrete and unanalyzable categories, struggle to account for this proximity. However, by decomposing thematic roles into semantic features, Reinhart could explain the semantic proximity among certain thematic roles.

Reinhart (2000, 2002, 2016) proposed two features to characterize all thematic roles: /c – cause change and /m – mental state (see Table 1.2). These two features are combined into four cluster types: [+c+m], [-c+m], [+c-m], [-c-m]. Each cluster characterizes one traditional thematic role: [+c+m] corresponds to agent, [-c+m] corresponds to experiencer, [+c-m] corresponds to cause/instrument and [-c-m] corresponds to theme/patient (see Table 1.2). However, she emphasized that traditional thematic roles do not need to correspond uniquely to a specific cluster (Reinhart, 2002). The [+c-m] cluster characterizes two thematic roles: instrument and cause. It characterizes an instrument just when an agent is also realized or contextually inferred and a cause when the agent is not realized. The cluster [-c-m] characterizes

two thematic roles, theme and patient, although she claimed that it is not clear whether this distinction is relevant to argument realization (Reinhart, 2002).

Table 1.2: Features of the agent, cause/instrument, theme/patient and experiencer roles (Reinhart, 2016, p. 29).

	Agent	Cause/Instrument	Theme (Patient)	Experiencer
[c]	+	+	-	-
[m]	+	-	-	+

Reinhart's (2000, 2002, 2016) feature-system includes also a set of unary clusters; clusters with just one feature specified, and the unmentioned feature is unspecified. The unary clusters are: [+c] for cause role, [+m] for sentient role, [-m] for subject matter or locative source, [-c] for goal or benefactor, and [ ] for arbitrary, which is involved in impersonal constructions. For example, in the argument realization of verbs like *open* or *break* (13, 14), the /m feature is not specified because it is not relevant. These verbs select a subject with a unary [+c] cluster which involves causation. *Open* and *break* verbs may have subjects with /+m (13) and with /-m (14) features; what characterizes subjecthood in these verbs is the unary cluster [+c].

(13) *John opened/broke the window.*

(14) *The wind opened/broke the window.*

(Reinhart, 2002, p. 14)

Other verbs, such as *feed* or *eat*, instead, select subjects with both features specified [+c+m] (15). They specify both features because they require a subject that causes something on the event involved, and this subject has to be a sentient entity (Reinhart, 2002, p. 6):

(15) a. *The boy ate soup.*
b. **The bread ate soup.*

The unary cluster [+m] refers to subjects of *fear*-type and perceptual verbs. Reinhart explained that the sentient role [+m] is not the same as the experiencer role [-c+m]. Both have different syntactic realizations, therefore, they are characterized by different clusters. *Frighten*-type verbs select an object with [-c+m] because it is always a sentient entity and it does not involve any causation in the event. In these verbs, it is the subject [+c] that causes something on the event denoted by the verb, since she based it on the Non-Psychological Verb Hypothesis. *Fear*-type verbs, on the other side, select a subject with [+m] and an object with [-m], because there is no causation involved (Reinhart, 2002).

Regarding the syntactic mapping of roles, Reinhart (2000, 2002, 2016) proposed that some feature-clusters merge obligatorily externally (as subjects) (16.a) and others internally (as objects) (16.b). There are other feature-clusters that can merge in either position (16.c). All feature-clusters that have [+] clusters merge externally, those that have [-] cluster merge internally, and those having mixed clusters vary their syntactic realization.

(16) a. Merge externally: [+c+m] agent
[+c] cause
[+m] sentient
b. Merge internally: [-c-m] theme
[-c] goal
[-m] subject matter
c. Varying: [-c+m] experiencer
[+c-m] instrument

(Reinhart, 2002, p. 27)

In her approach, she focused on the syntactic realizations of *frighten*-type verbs due to their syntactic realization characteristics. She explained that these verbs have the lexical entry ([+c], [-c+m], [-m]) (cause, experiencer, subject matter). The experiencer ([-c+m]) always appears, but only one of the other two roles can appear (i.e. the cause with the [+c] cluster (17.a) or the subject matter with the [-m] cluster (17.b)). As the experiencer is a mixed cluster, it can merge internally (17.a) or externally (17.b), depending on the other argument. If the cause is realized (17.a), the experiencer merges internally because the cause merges externally. If the subject matter role is realized instead of the cause (17.b), then the experiencer merge externally because the subject matter merge internally.

(17) a. *The article frightened Bill* (cause – [+c], experiencer – [-c+m])
b. *Bill was frightened about the article* (experiencer – [-c+m],
subject matter – [-m])

(Reinhart, 2002, p. 50)

Reinhart's (2000, 2002, 2016) and Dowty's (1991) approaches share the idea that event roles are not primitive notions, but they are decomposed into semantic components However, both approaches differ in the nature of these components. Dowty viewed these components as semantic entailments with no clear boundaries, proposing several entailments for each proto-role. In contrast, Reinhart proposed only two semantic features, which she combined in various feature-clusters to characterize all possible thematic roles.

Another difference between these two approaches is the number of event roles and the nature of them. Dowty (1991) included only two proto-roles: proto-agent and proto-patient. Reinhart (2000, 2002, 2016), instead, considered a more extensive list of thematic roles. Dowty emphasized that proto-roles are not discrete categories, which means that arguments may have different degrees of membership into a proto-role type, even that both arguments in the argument structure may have entailments

from the same proto-role. By contrast, Reinhart considered that thematic roles are discrete categories – an argument has or has not the features of a specific thematic role – but she did not consider different degrees of membership into a thematic role.

In the following section, I discuss the Role and Reference Grammar, focusing on how it describes macroroles and the differences and similarities between this approach and Dowty's (1991) and Reinhart's (2000, 2002, 2016) proposals.

3.3 The Role and Reference Grammar

The Role and Reference Grammar approach (henceforth RRG) (Foley & Van Valin, 1984; Van Valin & LaPolla, 1997) proposed, similar to the proto-role approach (Dowty, 1991), two macroroles: *actor* and *undergoer*. The *actor* is described as "the argument of a predicate which expresses the participant which performs, effects, instigates, or controls the situation denoted by the predicate" and the *undergoer* as "the argument which expresses the participant which does not perform, initiate, or control any situation but rather is affected by it in some way" (Foley & Van Valin, 1984, p. 29). Unlike proto-roles, macroroles are not characterized in terms of semantic entailments, but by the position they occupy in the logical structure of the described event, as I discuss throughout this section. Instead of decomposing event roles, this approach decomposes individual verbs semantically and derives the macroroles actor and undergoer as generalizations over verb-specific roles (i.e., agent, experiencer, theme, etc.).

I have discussed that Dowty's (1991) and Reinhart's (2000, 2002, 2016) approaches proposed that event roles are decomposed into semantic entailments or features, respectively. In the RRG (Foley & Van Valin, 1984; Van Valin & LaPolla, 1997), event roles are not decomposed; instead, predicates are decomposed into a set of primitive events that are characterized by semantic features. Based on the

Aktionsart distinctions originally proposed in Vendler (1967), the RRG proposed four basic types of events:

(18) a. States: *be sick, be tall, love, know, believe, have*
b. Achievements: *pop, explode, collapse, shatter* (all intransitive)
c. Accomplishments: *melt, freeze, dry* (the intransitive versions), *recover from illness, learn*
d. Activities*: march, walk, roll* (the intransitive versions), *swim, think, rain, read, eat*

(Van Valin & LaPolla, 1997, p. 92)

These four classes of events are characterized in terms of three features: [±static], [±punctual], and [±telic]. The static feature describes whether an event is static or not, the punctual feature describes whether the event has internal duration or it lacks it, and the telic feature describes whether the event has an inherent terminal point or not.

States are non-dynamic and temporally unbounded events. Activities are dynamic and temporally unbounded. Achievements are instantaneous changes with an inherent temporal point. Accomplishments are temporally extended, not instantaneous, changes of state with a terminal point (see Table 1.3) (Van Valin & LaPolla, 1997).

Table 1.3: Characterization of events (Van Valin & LaPolla, 1997, p. 93).

	[±static]	[±punctual]	[±telic]
State	+	-	-
Activity	-	-	-
Accomplishment	-	-	+
Achievement	-	+	+

Different events can be combined to create complex ones and all these event types have their causative counterparts (Van Valin & LaPolla, 1997, p. 107):

(19) a. State: *The boy is afraid.*
a'. Causative state: *The dog frightens/scares the boy.*
b. Achievement: *The balloon popped.*
b'. Causative achievement: *The cat popped the balloon.*
c. Accomplishment: *The ice melted.*
c'. Causative accomplishment: *The hot water melted the ice.*
d. Activity: *The ball bounced around the room.*
d'. Causative activity: *The girl bounced the ball around the room.*

Each verb has its own logical structure depending on the type of event they denote to (states, activities, achievements, or accomplishments). Sentences with verbs denoting states have the logical structure *predicate' (x)* or *predicate' (x, y)* depending on the number of participants involved (20.a). Sentences with verbs denoting activities have the logical structure *do'(x, [predicate' (x) or (x, y)]* (20.b). Sentences with verbs denoting achievements have *INGR*[5] *predicate' (x) or (x, y)* (20.c); and those with verbs denoting accomplishments have *BECOME predicate' (x)* or *(x, y)* (20.d). If a cause is involved in the event, the CAUSE component is added in the logical structure as in (20.e) (Van Valin, 2006; Van Valin & LaPolla, 1997).

(20) a. States
The window is shattered. shattered'(window)
b. Activities
Carl ate snails. do'(Carl, [eat'(Carl, snails)])
c. Achievements
Th balloon popped. INGR popped' (balloon)

[5] INGR is used to encode instantaneous changes (Van Valin & LaPolla, 1997, p. 104).

d. Accomplishments	
The snow melted.	BECOME melted' (snow)
e. Causatives	
The dog scared the boy.	[do' (dog, ∅] CAUSE [feel' (boy, [afraid'])]
Max broke the window.	[do' (Max, ∅] CAUSE [BECOME broken' (window')]

(Van Valin, 2006, p. 269)

In these logical structures, there are participants involved (i.e. x or y arguments), called *thematic relations* (Van Valin & LaPolla, 1997). These thematic relations correspond to the traditional labels used for thematic roles, such as *agent, experiencer, instrument*, etc. However, the RRG claimed that all these categories are not needed to explain syntactic realizations. They argued that arguments may be grouped into broader generalized semantic categories than the traditional thematic roles, as Dowty (1991) also claimed. For instance, the distinction between agent and perceiver has not significant syntactic consequences (Foley & Van Valin, 1984; Van Valin & LaPolla, 1997). The RRG sought to generalize thematic relations into broad categories with grammatical consequences. Hence, similar to the proto-role approach (Dowty, 1991), the RRG proposed only two macroroles: *actor* and *undergoer*. They are not equivalent to subject or object. Macroroles are described as "generalizations across argument-types found with particular verbs which have significant grammatical consequences" (Van Valin & LaPolla, 1997, p. 139). Macroroles are characterized by the position they occupy in the logical structure of the described event.

Each macrorole subsumes different argument types. The agent is the prototype for actor and patient is the prototype for undergoer (Van Valin, 2006; Van Valin & LaPolla, 1997). Nevertheless, actor is not only the doer of an action (i.e. the agent). Under the actor macrorole, there are other thematic relations that are not involved in

any action, as it happens with experiencers, which they do not do anything but experiencing the event. Actor and undergoer are "generalizations across classes of specific argument positions in logical structure" (Van Valin & LaPolla, 1997, p. 142). Macroroles do not always have the same semantic content (Foley & Van Valin, 1984). In (21), the actor groups the roles of agent, instrument, recipient, and experiencer, whereas the undergoer groups patient, theme, stimulus, and experiencer (Van Valin, 1999, 2004, 2006).

		Actor (A)	Undergoer (U)
(21)	*The farmer (A) killed the duckling (U).*	Agent	Patient
	The rock (A) broke the window (U).	Instrument	Patient
	The lawyer (A) received the summons (U).	Recipient	Theme
	Many tourists (A) saw the accident (U).	Experiencer	Stimulus
	The clown (A) amused the child (U).	Agent	Experiencer

(Van Valin, 2004, p. 2, 2006, p. 270)

In the logical structure, the x argument always has priority over the y argument for actorhood (Van Valin & LaPolla, 1997). In each sentence, there is only one possible actor. For assigning actor and undergoer in the logical structure, the RRG considers the Actor-Undergoer Hierarchy (see Figure 1.1) that states that the leftmost argument in the logical structure becomes the actor and the rightmost becomes the undergoer (Van Valin, 2006; Van Valin & LaPolla, 1997).

Van Valin and colleagues did not particularly focus on perceptual, *fear*-type or *frighten*-type verbs. In their examples, they revealed that both perceptual (21.d) and *frighten*-type verbs (21.e) involve an actor and an undergoer, both mapping the actor onto the subject position and the undergoer onto the object. They particularly classified *frighten*-type verbs as causatives (21.e), contrary to Belletti and Rizzi's (1988) hypothesis.

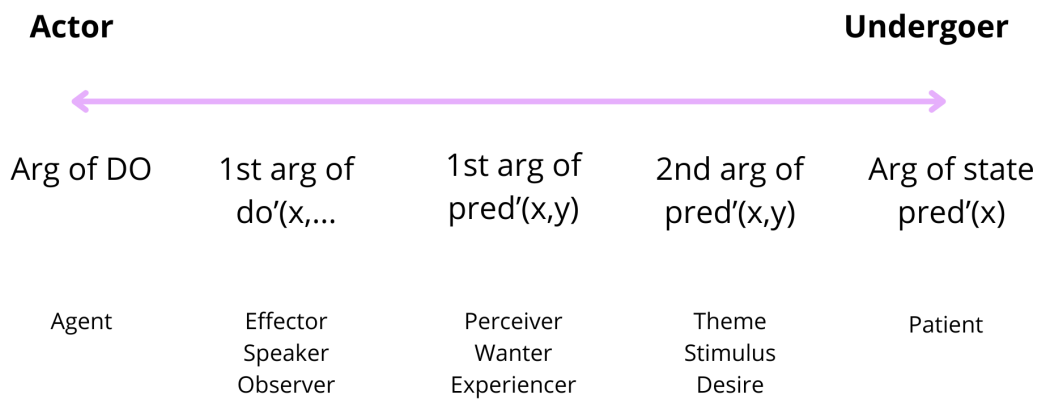

Figure 1.1: The Actor-Undergoer Hierarchy. This figure is an original adaptation inspired by the Actor-Undergoer Hierarchy in Van Valin and LaPolla (1997, p. 147) and by the thematic relations continuum in terms of logical structure argument positions in Van Valin (2004, p. 4).

The Extended Argument Dependency Model (henceforth eADM) (Bornkessel & Schlesewsky, 2006), a well-known model of sentence comprehension based on the macrorole approach, specifically focuses on the processing correlates of *frighten*-type verbs. In Chapter 5, I discuss how this model interprets them.

3.4 Interim conclusion

The three approaches agree on the idea that event roles are not primitive notions, showing similarities and dissimilarities in other aspects. On the one hand, the RRG (Foley & Van Valin, 1984; Van Valin & LaPolla, 1997) and the proto-role approach (Dowty, 1991) differ from the Theta System (Reinhart, 2000, 2002, 2016) in that while the Theta System proposes a vast list of thematic roles, as previous thematic role list approaches do, the RRG and the proto-role approaches propose two generalized roles.

On the other hand, the Theta System, the RRG and the proto-role approaches differ in the characterization of roles. Thematic roles of the Theta System and macroroles are discrete categories, but proto-roles are considered as non-discrete categories; this means that while in the proto-role approach arguments may have different degrees of membership into a proto-role, in the RRG or in the Theta System, they cannot (Dowty, 1991; Reinhart, 2000, 2002, 2016; Van Valin, 1999). For example, in the RRG, each verb can have only one actor and one undergoer, with no possibility of two actors (Van Valin & LaPolla, 1997). When it comes to proto-roles, two arguments may have entailments of both proto-roles, as it happens with *frighten*-type verbs (Dowty, 1991).

Regarding the argument structure of perceptual, *fear*-type, and *frighten*-type verbs, the three approaches agree on the Non-Psychological Verb Hypothesis, since all consider *frighten*-type verbs to be causative. Reinhart (2000, 2002, 2016) claimed that both perceptual and *fear*-type verbs select a sentient role for the subject characterized by the feature [+m]. *Frighten*-type verbs, instead, select an experiencer as object with the features of [-c, +m], and in the active voice, the subject has the role of cause characterized by [+c]. Dowty (1991) proposed that *frighten*-type verbs select two arguments with proto-agent entailments (e.g., *Mary*$_{(CAUSATION\text{-}VOLITION\text{-}SENTIENCE)}$ *frightened John*$_{(SENTIENCE).}$) due to the non-discreetness of proto-roles. By contrast, *fear*-type verbs only select one argument with proto-agent entailments (e.g., *John*$_{(SENTIENCE)}$ *feared John*$_{(0).}$). Furthermore, Van Valin and colleagues (1984; 2004; 1997) posited that the three verb types select an actor for the subject and an undergoer for the object, specifying that *frighten*-type verbs involve causation.

4. Psycholinguistic evidence on event roles

All these previous theoretical approaches offer different ways of describing event roles. However, as many theoretical approaches claim (Dik, 1978, 1991; Kaplan &

Bresnan, 1982; Van Valin, 2006; Van Valin & LaPolla, 1997), they must align with findings from psycholinguistic research.

In psycholinguistics, as in theoretical approaches, the importance of event roles was first recognized in the late 1960s, in child language acquisition and development. Slobin (1969), building on Fillmore's (1968) list, analyzed naturalistic child speech across six languages (English, German, Russian, Finnish, Samoan, and Luo) and identified early expressions of role distinctions. This line of work was continued in early acquisition research, such as Brown's (1973) longitudinal study and Golinkoff's (1975) investigation of agent and recipient roles in infants.

In adults, early studies asked whether event roles modulate processing. For example, Caramazza & Zurif (1976) examined how aphasic participants relied on role-based semantic constraints in a picture-matching task. Osterhout & Holcomb (1992), in an ERP study, demonstrated that event role categories are used to make word predictions. In the 2000s, studies identified specific neural correlates for individual roles, particularly agents (e.g., Bornkessel-Schlesewsky & Schlesewsky, 2009; Demiral et al., 2008; Haupt et al., 2008; Wang et al., 2009). Furthermore, the 2000s and 2010s saw a shift toward questioning the universality and granularity of role categories (e.g., Hafri et al., 2018; Kako, 2006; Rissman & Majid, 2019; Ziegler & Snedeker, 2018).

In this section, I discuss psycholinguistic evidence regarding the processing of agent, patient and experiencer roles. There is clear psycholinguistic evidence for agent and patient role as distinct and core knowledge categories, but the evidence for the experiencer is scarce and unclear (Rissman & Majid, 2019).

In addition to this evidence, psycholinguistic research has also investigated other roles, such as instruments, goals, recipients or sources (Dobel et al., 2007; Goldin-Meadow & Mylander, 1984; Lakusta et al., 2017; Tatone et al., 2015; Ünal et al., 2024; Yin & Csibra, 2015; Ziegler & Snedeker, 2018). Since these roles fall outside the scope of this dissertation, they are not discussed here, but they are addressed in

Chapter 5 as part of the discussion of future research directions for research on event role processing.

4.1 Agents and patients

Strong psycholinguistic evidence supports agent and patient roles as core knowledge categories (Rissman & Majid, 2019). This evidence has been replicated across different types of studies using different methodologies, languages, and populations. Furthermore, this distinction between agents and patients is linked to the Agent Preference Hypothesis that posits a cognitive preference toward agents over patients (Bornkessel-Schlesewsky & Schlesewsky, 2009; Frenzel et al., 2015; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023; Vela-Plo et al., 2022; *inter alia*).

Studies have shown that children learn to identify agents before patients (Arunachalam & Waxman, 2010; Huang et al., 2013; Naigles, 1990; Noble et al., 2011). One-word and two-word children are able to distinguish between agent and patient roles in event processing tasks (Gertner et al., 2006; Golinkoff, 1975), revealing an early bias toward agents (Robertson & Suci, 1980). By the age of two, children are able to extract information of these roles and apply it to learn new verbs (Arunachalam & Waxman, 2010; Naigles, 1990). Furthermore, deaf children, without exposure to a conventional sign system, are able to create gestures to mark agent and patient roles (Goldin-Meadow & Mylander, 1998; Rissman & Goldin-Meadow, 2017).

In adults, psycholinguistic research provides clear evidence for the agent preference. Gómez-Vidal et al. (2022) conducted an experiment using the Visual World Paradigm, where Spanish native speakers were asked to listen to sentences while looking at four different images on the screen. One of the images was semantically related to the subject of the sentence, while the others were distractors

semantically unrelated. The design had three conditions: (i) subject-agents of transitive structures, (ii) subject-agents of intransitive structures, and (iii) subject-patients of intransitive structures. When listening to the verb and the post-object region of the sentence, participants produced more looks to semantically related images in the agent condition (in both transitive and intransitive structures) than in the patient condition, which was interpreted as an attentional bias toward agents (Gómez-Vidal et al., 2022).

Different processing correlates between agents and patients have also been found in EEG reading tasks, particularly an N400 effect toward patient disambiguation when encountering ambiguous arguments. Haupt et al. (2008) investigated the reanalysis of arguments in verb-final transitive sentences in German. They included agent-initial complement clauses (22.a) and patient-initial complement clauses (22.b):

(22) a. *dass Bertram Surferinnen gratuliert hat.*
"that Bertram congratulated surfers."
b. *dass Bertram Surferinnen gratuliert haben.*
"that surfers congratulated Bertram."

The first noun of both sentence types was case marked ambiguously, being both agent and patient possible interpretations, until participants read the verb. Their results revealed an N400 component for disambiguation toward patient at the verb region (22.b).

In Basque, Isasi-Isasmendi et al. (2023) investigated the previously observed preference for interpreting role-ambiguous arguments as the subject or the agent of a sentence. They conducted an EEG reading task with intransitive sentences, ruling out confounds from transitivity and syntactic subject vs object asymmetries since agents and patients were compared in the same syntactic position – the subject. Native Basque speakers were asked to read intransitive sentences presented word-by-word. The arguments could be either agent (23.a, 23.c) or patient (23.b, 23.d), with

ambiguous (23.a, 23.b) and unambiguous (23.c, 23.d) case marking. *Hauek* (23.a, 23.b) is ambiguous because it can be either agent or patient; however, *honek* (23.c) and *hau* (23.d) are unambiguous because *honek* can only be agent, and *hau* patient.

(23) a. Agent-Ambiguous
Emakume hauek gaur goizean eskiatu dute mendian.
"These women skied in the mountains this morning."
b. Patient-Ambiguous
Emakume hauek gaur goizean irristatu dira mendian.
"These women slipped in the mountains this morning."
c. Agent-Unambiguous
Emakume honek gaur goizean eskiatu du mendian.
"This woman slipped in the mountains this morning."
d. Patient-Unambiguous
Emakume hau gaur goizean irristatu da mendian.
"This woman slipped in the mountains this morning."

They found that, at the verb auxiliary region (*dute/dira/du/da*), disambiguation toward patients (23.b), compared to agents (23.a), elicited an N400 component over central and posterior electrodes, along with a decrease in power in alpha and low-beta bands. They interpreted this power decrease as revision of unexpected readings and the N400 component as a recategorization of the event role category due to the Agent Preference Hypothesis: the first ambiguous argument is initially assigned the agent role, and when it is later realized to be a patient, an event role recategorization occurs, reflected in an N400 component.

This N400 component linked to the agent preference is also found in languages that prefer to place patients before agents, as Äiwoo (Sauppe et al., 2023), and in languages where patients typically occur without case-marking, as Hindi (Bickel et al., 2015).

Further processing studies reveal that adults have a strong tendency to fixate on agents earlier than on patients (Webb et al., 2010), and rapidly extract agent and patient role information from visual events (Hafri et al., 2013; Rissman & Lupyan, 2022). This tendency shows even when the task is not related to event roles, such as to localize spatially a particular gender or shirt color of the event participants (Hafri et al., 2018). Additionally, aphasic adults retain the capacity to detect agents and patients (Ivanova et al., 2021), and recognize agents faster than patients (Arantzeta et al., 2017).

Interestingly, this agent preference has also been shown in non-human apes (Brocard et al., 2024, 2025; V. Wilson et al., 2022, 2024). Wilson et al. (2024) asked whether the agent-patient role identification mechanism used by humans is also employed by non-human apes. They compared the visual event tracking between humans and great apes (chimpanzees, gorillas, and orangutans) in causative events. Their results revealed that both humans and great apes produced similar gaze patterns to agent-patient relations. All species alternated attention to agents and patients, producing higher proportion of fixations on agents compared to patients. Brocard et al. (2024) investigated the evolutionary origins of the agent preference, also with visual event tracking in humans, chimpanzees, gorillas, and orangutans. They replicated the previous results of a preference toward agents across species, suggesting that the agent preference evolved before language.

This body of psycholinguistic research supports the idea that agent and patient roles are core knowledge categories with specific processing correlates, revealing an agent preference across species. However, it fails to determine whether these two role categories are primitive notions (Fillmore, 1968, 1971; Gruber, 1965) or whether they are decomposed into primitive elements, as suggested by other approaches (Dowty, 1991; Foley & Van Valin, 1984; Reinhart, 2000, 2000, 2002, 2016; Van Valin & LaPolla, 1997).

In a series of experiments, Kako (2006) examined whether event roles can be decomposed into primitive entailments. Following Dowty's (1991) proto-role approach, Kako hypothesized that proto-role entailments have a psychological reality. He conducted several experiments where participants were asked to rate the proto-role entailments of subjects and objects using both real and unreal verbs in English. Participants rated subjects as more proto-agent-like than objects, and objects as more proto-patient-like than subjects, with both real and unreal verbs. In one of the experiments, he also included semantic properties that were not proto-role entailments, such as "can make noise", founding that participants relied on proto-role entailments instead of on some other semantic properties for subject and object identification.

Following with the testing of proto-role entailments, Rissman and Lupyan (2022) conducted explicit categorization tasks. English speakers were asked to induce agent and patient role categories from visual stimuli representing events. They found that the entailment of volition was the most reliable entailment for the identification of event roles. Vernice and Hartsuiker (2019) also found that Italian native speakers associated proto-agent entailments with subjects and proto-patient entailments with objects. In structural priming tasks, they showed that participants produced more active structures when patients entailed more proto-patient entailments than proto-agent ones, and more passives when patients entailed more proto-agent entailments than proto-patient ones. Together, these findings provide evidence that the entailments proposed by Dowty (1991) have a psychological reality contributing to the identification and assignment of subjects and objects.

4.2 Experiencers

Regarding the experiencer role, the evidence is less clear than for agents and patients. Psycholinguistic research has not directly compared the processing correlates of

experiencers with those of other roles, as it has been done for agents and patients. Nor have previous studies asked whether the experiencer role has specific processing correlates, comparable to those identified for agents and patients. In this section I review psycholinguistic results involving structures with the experiencer role, as I consider them informative for understanding this role category, even though the research questions they address differ from those of this dissertation, since they mainly focused on the processing consequences of the specific syntactic realization of *frighten*-type verbs.

To investigate the processing of *frighten*-type verbs, researchers compared the processing of structures with *frighten*-type verbs with the one of structures with *fear*-type verbs using the active-passive alternation paradigm. Wilson and Dillon (2022) conducted a self-paced reading task with both verb types alternating the active and passive voice in English. They found participants produced larger reading times and were less accurate with active sentences containing *frighten*-type verbs compared to those with *fear*-type verbs. Conversely, when processing passive sentences, participants made larger reading times and were less accurate with *fear*-type verbs compared to *frighten*-type verbs.

In a production task, Do and Kaiser (2021) found the same pattern of results: participants were faster to fixate on the subject and to begin speaking when producing active sentences with *fear*-type verbs compared to *frighten*-type verbs, showing the opposite pattern in the passive voice. These two studies replicate previous findings revealing that *fear* and *frighten*-type verbs involve distinct processing correlates in production tasks with healthy speakers (Bidgood et al., 2020; Ferreira, 1994; Gennari & MacDonald, 2009), and agrammatic aphasics (Thompson & Lee, 2009), as well as in comprehension experiments with healthy adults (Brennan & Pylkkänen, 2010; Cupples, 2002; Gennari & MacDonald, 2009; Manouilidou & De Almeida, 2013), agrammatic aphasics (Thompson & Lee, 2009), and participants with Alzheimer's disease (Manouilidou et al., 2009).

The different processing correlates of *frighten*-type verbs compared to *fear*-type verbs has hitherto been explained by the Misalignment Hypothesis (Do & Kaiser, 2021; M. Wilson & Dillon, 2022) which in turn builds on both the Psychological Verb Hypothesis and the Thematic Role Hierarchy Hypothesis.

As discussed before, the Psychological Verb Hypothesis claims that *fear*-type and *frighten*-type verbs select the same event roles (experiencer and theme) but differ in the syntactic realization. Based on this and on the Thematic Role Hierarchy Hypothesis, *frighten*-type verbs map the highest-ranked role (the experiencer) onto the lowest syntactic position (the object) in the active voice, which causes a misalignment between the prominence of semantics and syntax, as the experiencer is not placed in the subject position (see Figure 1.2). The Misalignment Hypothesis posits (Do & Kaiser, 2021; M. Wilson & Dillon, 2022) that the atypical semantic-to-syntax mapping of *frighten*-type verbs would become the trigger of their processing difficulties compared to *fear*-type in the active voice. In the passive voice, instead, the prominence of thematic roles and syntactic functions of *frighten*-type verbs converge, which is reflected in lower processing costs compared to *fear*-type verbs in the same passive voice (see Figure 1.2).

The processing of structures with *frighten*-type verbs has also been compared to the processing of structures with agent-patient verbs using the word-order alternation paradigm. Similarly to active-passive alternation studies, authors of these studies rely on the Psychological Verb Hypothesis to explain their results, which leads to the concepts of *thematic reanalysis* (Bornkessel et al., 2002, 2003), and *prominence* (Bornkessel & Schlesewsky, 2006; Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015), which resemble the concept of *misalignment*. However, instead of relying on the Thematic Role Hierarchy Hypothesis, these studies are grounded on the Actor-Undergoer Hierarchy based on the macrorole approach (Foley & Van Valin, 1984; Van Valin & LaPolla, 1997). These studies have been

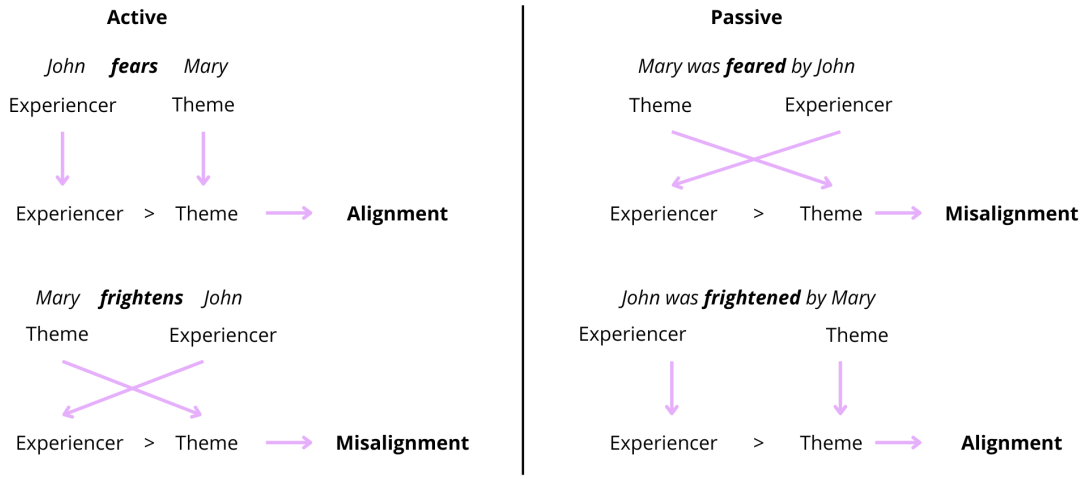

Figure 1.2: A visual representation of the Misalignment Hypothesis in the active-passive alternation. On the left, it is shown the active form of both *fear* and *frighten* verbs. On the right, it is shown the passive voice of these verbs.

conducted primarily in Spanish and German. I first discuss word-order alternation studies in Spanish (Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015), followed by those in German (Bornkessel et al., 2002, 2003).

Authors of word-order alternation studies in Spanish (Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015) claim that *frighten*-type verbs may select an accusative or a dative argument as their object (see Figure 1.3).

If these verbs select an accusative argument, they involve causation and assign actor (agent in other approaches) for the subject and undergoer role (experiencer in other approaches) for the object; hence, the prominence of the syntactic and the semantic structures aligns in the subject-verb-object (henceforth SVO) word order and misaligns in the object-verb-subject (henceforth OVS) (see Figure 1.3). However, if these verbs exhibit a dative argument, they do not involve causation and instead select an undergoer (theme) for the subject, and a nonmacrorole for the object (experiencer) (see Figure 1.3). These verbs assign a nonmacrorole because datives cannot receive

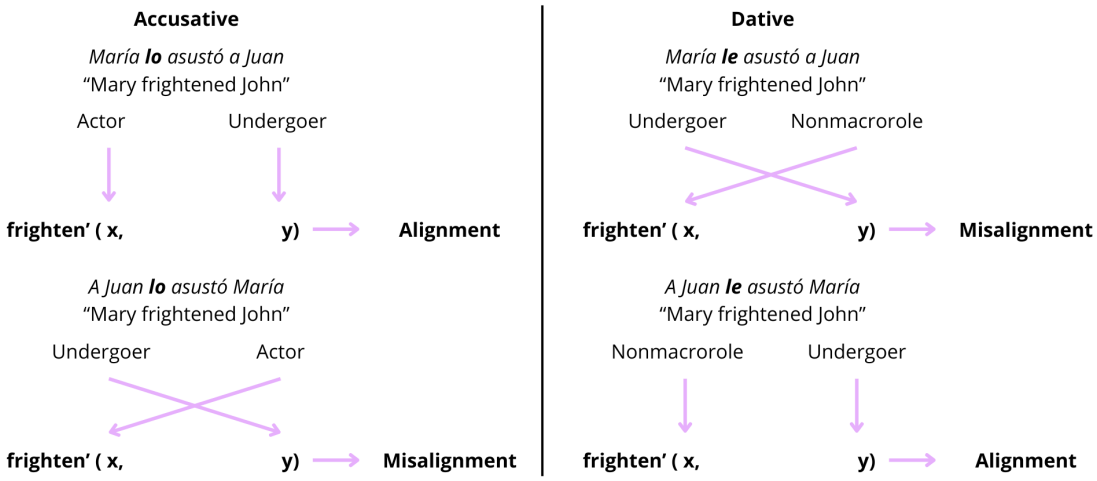

Figure 1.3: This figure shows the misalignment of *frighten*-type verbs from the Actor-Undergoer Hierarchy perspective. On the left, the accusative version of this verb is displayed, and on the left, the dative version.

macroroles (Bornkessel & Schlesewsky, 2006). Therefore, in this second case, there is a misalignment in SVO word order structures because undergoers are mapped onto the first syntactic position of the predicate (i.e., frighten'(x, y)), which is not its canonical position. This misalignment disappears by changing the word order from SVO to OVS, where the undergoer occupies its corresponding second syntactic position (see Figure 1.3).

To the best of my knowledge, only the study of Gattei et al. (2022) in Spanish included the case alternation as an experimental condition, comparing word-order alternation with *frighten*-type verbs selecting either accusative or dative case, without including *fear*-type or agent-patient verb conditions. Since I am not interested in the

alternation of case[6], I discuss studies where authors compared *frighten*-type verbs with agent-patient verbs. In these studies, they included the dative version of *frighten*-type verbs (see Figure 1.3) considering the Non-Psychological Verb Hypothesis that these verbs do not involve causation.

In a self-paced reading task, Gattei, Dickey, et al. (2015) reported higher reading times in the region following the verb in *frighten*-type verb condition than in agent-patient verb condition in sentences with SVO word order and the inverse pattern with OVS sentences. In the next region, they found the same results and a main effect of verb type: sentences with *frighten*-type verbs showed higher reading times than those with agent-patient verbs. In an eye-tracking reading experiment, Gattei et al. (2017) used the same conditions and found the same pattern of results: *frighten*-type verbs elicited higher fixation times than agent-patient verbs in SVO word order sentences, and the inverse pattern in OVS sentences.

In another study, Gattei, Tabullo et al. (2015) compared the ERPs elicited while reading the same type of sentences, founding that, at the verb region, agent-patient verbs elicited a higher negativity at the 400-550 ms early time-window as compared to *frighten*-type verbs in sentences with OVS word order. In sentences with SVO order, no significant effect appeared in this window. In a later 600-750 ms time-window, *frighten*-type verbs elicited a broadly distributed positivity in sentences with SVO word order, with no significant differences in sentences with OVS word order.

[6] Although I am interested in the processing correlates of *frighten*-type verbs, I do not consider in this dissertation the alternance of accusative/dative. In Spanish, this distinction is marked solely by the choice of the clitic – *lo* for accusatives and *le* for datives –, and the clitic usage is highly variable across dialects due to the phenomena of *laísmo, leísmo,* and *loísmo* (Bosque et al., 1999). In many Spanish varieties, these distinctions are unstable or even absent, which complicates any generalization based on clitic use. Furthermore, this clitic alternation is not exclusive of *frighten*-type verbs in Spanish. In non-psychological verbs, such as *dejar* ("to let"), or *hacer* ("to do"), this clitic alternation appears: *lo/le dejan correr fuera* ("They let him run outside") or *la/le hacen caminar mucho* ("they make her walk a lot") (Guajardo, 2021, p. 2).

Similar to active-passive alternation studies, researchers argued that the higher processing cost associated with *frighten*-type verbs in SVO word order compared to *fear*-type verbs is due to the misalignment in the prominence of syntactic and semantic structures, since the first argument is an undergoer occupying its non-canonical syntactic position.

Following a similar reasoning, Bornkessel et al. (2002) also investigated the processing correlates of sentences with agent-patient structures (24.a) compared to those with *frighten*-type verbs (24.b) using ERPs in German. They found an early parietal positivity when processing sentences with *frighten*-type verbs at the verb position.

(24) a. Agent-patient verbs (NOM-DAT order)
…dass der Priester dem Gärtner folgt und …
… that the$_{\text{NOMINATIVE}}$ priest the$_{\text{DATIVE}}$ gardener follows and …
… "that the priest is following the gardener."

b. *Frighten*-type verbs (NOM-DAT order)
…dass der Priester dem Gärtner imponiert und …
… that the$_{\text{NOMINATIVE}}$ priest the$_{\text{DATIVE}}$ gardener impresses and …
… "that the priest impresses the gardener."

c. Agent-patient verbs (DAT-NOM order)
…dass dem Priester der Gärtner folgt und …
… that the$_{\text{DATIVE}}$ priest the$_{\text{NOMINATIVE}}$ gardener follows and …
… "that the gardener is following the priest."

d. *Frighten*-type verbs (DAT-NOM order)
…dass dem Priester der Gärtner imponiert und …
… that the$_{\text{DATIVE}}$ priest the$_{\text{NOMINATIVE}}$ gardener impresses and …
… "that the gardener impresses the priest."

(Bornkessel et al., 2003, pp. 279, 280)

In a subsequent study, Bornkessel et al. (2003) included the variable of word order to determine whether the processing of *frighten*-type verbs is facilitated in OVS sentences, since the highest-ranked role – the experiencer, based on Belletti and Rizzi's (1988) proposal – would occupy the first syntactic position. They included nominative-dative (24.a, b) and dative-nominative (24.c, d) word order with *frighten*-type (24.b, d) and agent-patient structures (24.a, c). Their results revealed that *frighten*-type verbs elicited an early parietal positivity at the final verb position, independently of word order (Bornkessel et al., 2003).

Bornkessel et al. (2002, 2003) interpreted this result as evidence of a thematic reanalysis within the macrorole framework based also on Belletti and Rizzi's (1988) approach: *frighten*-type verbs assign an undergoer – a theme in thematic role list approaches – to the nominative argument, which requires a reanalysis, since this argument was predicted to be an actor.

To briefly summarize, although previous studies have relied on either the Thematic Role Hierarchy (Do & Kaiser, 2021; M. Wilson & Dillon, 2022) or the Actor-Undergoer Hierarchy (Bornkessel & Schlesewsky, 2006; Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015) to explain the syntactic realization of *frighten*-type verbs, they converge on the idea that the syntactic and semantic prominence of these verbs does not align in active or SVO structures, resulting in higher processing costs compared to aligned structures (i.e., *fear*-type and agent-patient verbs). They all based their conclusions on the Psychological Verb Hypothesis that *frighten*-type verbs do not involve causation. For these reasons and for simplicity, I will henceforth group these two perspectives under *the Misalignment Hypothesis*.

The Misalignment Hypothesis can explain the previous results because it is based on the Psychological Verb Hypothesis. If these previous studies considered the alternative hypothesis that *frighten*-type verbs denote causation (Grimshaw, 1990; Dowty, 1991; Parodi-Lewin, 1991; Zaenen, 1993; Pesetsky, 1995; Arad, 1998; Pylkkanen, 1999; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller,

2013; Fábregas & Marín, 2015), the misalignment would disappear. This is because the experiencer becomes the object, since the agent – the highest-ranked role – is mapped onto the subject position.

Leaving aside *frighten*-type verbs and the Misalignment Hypothesis, the processing of structures with *fear*-type verbs has also been compared with that of agent-patient verbs, revealing no processing cost differences between experiencer-theme and agent-patient structures in either English (Gennari & Poeppel, 2003; Katsika et al., 2012) or in Mandarin Chinese (Ma et al., 2023). Although they were not looking for specific processing correlates for the experiencer role, their results shed light on whether the experiencer role exhibits specific processing correlates. If the experiencer role constitutes a distinct category from agent, experiencer-subjects would be expected to show different processing correlates from agent-subjects. This is because, as it has been observed for patients, due to the well assessed Agent Preference Hypothesis, participants are likely to predict that the first argument is an agent; when it turns out to be an experiencer, a reanalysis should occur. However, reported results revealed no processing differences between experiencer-subjects and agents. I acknowledge that the design employed in these experiments may not be sensitive enough to detect processing differences between agents and experiencers, as this was not the aim of these works.

This body of psycholinguistic evidence reveals that processing experiencer-subjects (i.e., with *fear*-type verbs) does not involve higher processing costs than processing agent-subjects (i.e., with agent-patient verbs) (Gennari & Poeppel, 2003; Katsika et al., 2012; Ma et al., 2023). However, structures with experiencer-objects (i.e., with *frighten*-type verbs) entail larger processing correlates compared to both structures with agent-subjects in SVO structures (Bornkessel et al., 2002, 2003; Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015), and with experiencer-subjects in active structures (Bidgood et al., 2020; Brennan & Pylkkänen, 2010; Cupples, 2002; Do & Kaiser, 2021; Ferreira, 1994; Gennari & MacDonald,

2009; Manouilidou et al., 2009; Manouilidou & De Almeida, 2013; Thompson & Lee, 2009; M. Wilson & Dillon, 2022). In this dissertation, I directly investigate whether the experiencer role exhibits specific processing correlates as agent and patients do, or alternatively, whether they behave as agents.

5. Aims and outline of the dissertation

Overall, the main goal of this dissertation is the processing of structures with experiencer role in Spanish. More specifically, I investigate (a) whether psychological verbs elicit processing specificities (Chapter 2), (b) whether the experiencer role has specific processing correlates (Chapters 2 and 4), and (c) whether the number of proto-agent entailments of the subject modulates the processing costs of *frighten*-type verbs (Chapter 3).

To investigate question (a), I consider two hypotheses: the Psychological Verb Hypothesis and the Non-Psychological Verb Hypothesis, both previously introduced in Chapter 1. For question (b), I also consider two hypotheses: the Experiencer Role Hypothesis, based on event role approaches that propose a specific role category for experiencers (Belletti & Rizzi, 1988; Fillmore, 1971; Reinhart, 2000, 2002, 2016), and the Proto-Role Hypothesis based on the proto-role approach which proposes no specific category for experiencers, since they are grouped under the proto-agent role. I specifically introduced these labels for the hypotheses based on these theoretical approaches for ease of reference throughout the dissertation. Lastly, for question (c), I further test the Proto-Role Hypothesis. The predictions of these hypotheses are explained in the experimental chapters.

Throughout this dissertation, I use two methodological techniques: eye-tracking and electroencephalography (EEG). Since the same procedure and preprocessing criteria were applied across all eye-tracking experiments (Experiments 1, 2, and 3),

these are described only in Chapter 2. The EEG procedure and data preprocessing methods are explained in Chapter 4.

Chapter 2
Searching for experiencers in transitive sentence processing

1. Experiment 1

In Experiment 1, I conducted a sentence reading task recorded with eye-tracking to ask (i) whether psychological verbs elicit processing specificities, and (ii) whether experiencers exhibit specific processing correlates.

To test the first research question, I investigated the processing correlates of *fear*-type verbs compared to both perceptual and *frighten*-type verbs. Perceptual verbs "designate psychological states, process, or attributes" (Postal, 1970, p. 39) but have not been considered to be part of the category of psychological verbs, although they have the same argument structure than *fear*-type verbs (1.a, b). I compared them with *fear*-type verbs as both select the same event participants (experiencer, theme) (1) (Levin, 1993; Van Valin, 2004; Van Valin & LaPolla, 1997), and entail an identical set of proto-agent entailments (2) (Dowty, 1991).

(1) a. *John*$_{EXPERIENCER}$ *fears Mary*$_{THEME}$
b. *John*$_{EXPERIENCER}$ *sees Mary*$_{THEME}$

(2) a. *John*$_{SENTIENCE}$ *fears Mary*$_{0}$
b. *John*$_{SENTIENCE}$ *sees Mary*$_{0}$

On one hand, the Psychological Verb Hypothesis predicts similar processing correlates between *fear*-type and *frighten*-type verbs as they both belong to the psychological verb category. Furthermore, it predicts processing differences between *fear*-type and perceptual verbs as they belong to distinct verb categories. On the other

hand, the Non-Psychological Verb Hypothesis predicts different processing correlates between *fear*-type and *frighten*-type verbs, since *frighten*-type verbs denote causation and *fear*-type do not. Moreover, it predicts no processing differences between *fear*-type and perceptual verbs as they both select the same argument structure (1, 2).

To address the second research question, I included sentences with agent-patient verbs to compare to verbs like *frighten*. Both verb types denote causative events. I based predictions on the proto-role approach (Dowty, 1991); however, as it is not a processing proposal but a theoretical one, I adapted some aspects of the theory to explain the processing correlates.

I considered that the idea of two proto-roles decomposed into semantic entailments aligns with previous literature discussed in Chapter 1 revealing that these entailments are relevant for subject and object identification (Kako, 2006; Rissman & Lupyan, 2022; Vernice & Hartsuiker, 2019), and with psychologistic evidence of agent and patient roles as core knowledge categories (Rissman & Majid, 2019). Although Dowty (1991) did not propose an explicit mechanism to verify the number of entailments of arguments, I counted the entailments based on the traditional thematic roles and on the association Dowty offered of these roles and proto-role entailments: agents are arguments with the proto-agent entailments of sentience, volition, and causation, experiencers with sentience, and patients do not have proto-agent entailments (see Table 2.1).

Table 2.1: Proto-agent entailments of traditional thematic roles used in Experiment 1.

Thematic role	Proto-agent entailments
Agent	3 - sentience, volition, causation
Experiencer	1 - sentience
Patient	0

Therefore, *frighten*-type verbs select two arguments with proto-agent entailments (3.a) and agent-patient verbs only select one argument with proto-agent entailments (3.b).

(3) a. *Mary*$_{3\text{-PROTO-AGENT ENTAILMENTS}}$ *frightens John*$_{1\text{-PROTO-AGENT ENTAILMENT}}$
b. *Mary*$_{3\text{-PROTO-AGENT ENTAILMENTS}}$ *abandons John*$_{0\text{-PROTO-AGENT ENTAILMENTS}}$

If there is no category of experiencer role within the event role repertoire, as proposed by the Proto-Role Hypothesis, greater processing costs are predicted for *frighten*-type verbs compared to agent-patient verbs. This is because verbs like *frighten* select two arguments with proto-agent entailments, which should lead to a competition for subject assignment (3.a), while no competition is predicted in agent-patient sentences where only one argument has proto-agent entailments (3.b).

In contrast, based on thematic role list approaches (Belletti & Rizzi, 1988; Fillmore, 1971), I propose the Experiencer Role Hypothesis, which posits that experiencer role constitutes a specific category within the event role repertoire. According to this hypothesis, no processing differences are expected between *frighten*-type and agent-patient verbs, since the costs of assigning the agent as subject should not depend on whether the other argument is theme or experiencer, as both are different event participants as compared to agents (4.a and 4.b).

(4) a. *Mary*$_{AGENT}$ *frightens John*$_{EXPERIENCER}$
b. *Mary*$_{AGENT}$ *abandons John*$_{PATIENT}$

Although several psycholinguistic studies have investigated the processing correlates of *frighten*-type verbs with those of *fear*-type verbs and agent-patient verbs, as I discussed in Chapter 1, to the best of my knowledge, no prior study has directly compared the processing correlates of *frighten*-type verbs with those of both *fear*-type and agent-patient verbs in Spanish. Furthermore, no prior study has studied the

processing of these three verb types without using active-passive or word-order alternation paradigms.

1.1 Participants

Fifty native speakers of Spanish participated in the experiment. They were between 18-30 years old (10 = male, mean age = 21.33; *SD* = 2.72). This study was approved by the Ethics Committee for Research Involving Human Beings of the University of the Basque Country (CEISH-UPV/EHU: M10_2020_182). One participant was excluded due to technical problems, and another one due to severe vision problems, resulting in a total of forty-eight participants with normal or corrected to normal vision.

1.2 Materials

The experiment was a 2x2 repeated measures design with the Verb Type (Psych vs. Non-psych) and Argument Structure Type (Agent-experiencer/patient vs. Experiencer-theme) conditions (see Table 2.2). Forty experimental items were created (see Appendix B2). Each experimental item had four different versions of the same sentence, one for each condition. Each version of experimental items differed from the others only in the verb. All sentences were distributed to four lists following a Latin Square design; each participant only saw one of the versions of each experimental item.

The experiment had forty experimental sentences, eighty fillers, and ten practice items. I added comprehension questions to thirty percent of the items, resulting in thirty-six items with comprehension questions: twelve experimental items and twenty-four fillers had a comprehension question. Comprehension questions required

Table 2.2: Example of the 4 conditions of an experimental item in Experiment 1.

	Conditions		**Sentence Regions**				
	Verb Type	**Argument Structure Type**	**Subject Region**	**Verb Region**	**Object Region**	**Post-object Region**	**Last-word Region**
(a)	Psych	Experiencer-theme	La cantante	desea	al poeta	durante el recital de	poesía.
			The singer desires the poet during the recital of poetry.				
(b)	Non-psych	Experiencer-theme	La cantante	contempla	al poeta	durante el recital de	poesía.
			The singer contemplates the poet during the recital of poetry.				
(c)	Psych	Agent-experiencer	La cantante	enamora	al poeta	durante el recital de	poesía.
			The singer makes fall in love the poet during the recital of poetry.				
(d)	Non-psych	Agent-patient	La cantante	abandona	al poeta	durante el recital de	poesía.
			The singer abandons the poet during the recital of poetry.				

yes/no-answer types and referred to the semantic content of different parts of the sentence. Answers were balanced: eighteen questions had *yes* correct answer and eighteen had *no* correct answer.

To create the different versions of experimental trials, I selected twenty different verbs per condition (each verb was repeated twice to get forty experimental items) (see Appendix B1). The length (in number of letters in the conjugated form used in the experimental sentences) and the frequency of verbs (in the infinitive form due to the lack of frequency of some verbs in their conjugated form) was controlled using the SUBTLEX-ESP corpus (Cuetos et al., 2011). I conducted Bayesian one-sample models on the pairwise differences (e.g., ΔLength = $\text{Length}_{\text{FEAR}}$-$\text{Length}_{\text{FRIGHTEN}}$) to

assess whether there were credible differences in length or frequency across conditions. The posterior distributions indicated that the mean differences were close to zero, with 95% credible intervals overlapping zero (see Table 2.3).

Table 2.3: Pairwise comparisons of length and frequency of verbs used in Experiment 1.

Δ	Length Estimate [CrI]	Frequency Estimate [CrI]
Fear – frighten	-0.60 [-1.50, 0.32]	-0.22 [-0.63, 0.20]
Fear – perceptuals	-0.41 [-1.38, 0.58]	-0.23 [-0.70, 0.24]
Fear – agent-patient	-0.12 [-0.95, 0.72]	-0.20 [-0.70, 0.29]
Frighten – agent-patient	0.48 [-0.39, 1.32]	0.01 [-0.29, 0. 32]
Frighten – perceptuals	0.13 [-0.88, 1.09]	-0.03 [-0.36, 0.33]
Agent-patient – perceptuals	-0.33 [-1.20, 0.60]	-0.04 [-0.51, 0.43]

Table 2.4: Posterior distributions of the naturalness questionnaire model of Experiment 1.

Slopes	Estimate	Standard Error	CrI
Verb Type	0.13	0.10	[-0.06, 0.33]
Perceptual – agent-patient	-0.05	0.11	[-0.28, 0.17]
Fear – frighten	-0.09	0.09	[-0.27, 0.09]
Argument Structure Type	-0.07	0.08	[-0.24, 0.10]
Frighten – agent-patient	0.15	0.12	[-0.09, 0.39]
Fear – perceptuals	0.11	0.11	[-0.10, 0.33]

Experimental items were previously normed by naturalness. Forty-four Spanish native speakers filled an online sentence naturalness questionnaire in PCIbex (Zehr & Schwarz, 2022). They were asked to rate the naturalness of sentences on a 5-point Likert scale. As shown in Table 2.4, no remarkable differences among conditions were found. This table exhibits the posterior distributions of the Bayesian Mixed-Effects Model. I used the same nested coding, as the one I will use in the analysis of

Experiment 1 to verify that there were no differences in the interest contrasts. I explain in detail the nested coding used in the next Data processing and analyses section.

1.3 Procedure

Eye-movements were recorded with an EyeLink 1000 Plus desktop eye tracker sampling at 1000 Hz. The dominant eye of each participant was set up and calibrated. The distance between the participants and the camera was 55.5 cm, and the display screen was set at 92 cm from the participants. Stimuli were displayed in black against a light grey background (RGB values: 217, 217, 217). They appeared in a single line using the Courier New Bold font type at size 26. The stimuli were positioned at coordinates (60, 540) on a screen size with a resolution of 1920x1080.

The experiment began with a calibration and validation phase using a 9-points grid for both processes. In cases where participants wore contact lenses, a 5-points calibration was sometimes required, as the corner points could not be accurately calibrated. However, since sentences were presented in a single line at the vertical center of the screen, calibrating the corner points was not essential.

Participants were instructed to read sentences and to answer comprehension questions after some of the sentences. Each trial was initiated automatically after participants fixated on a left-central fixation point, located at the position where the first letter of the sentence was to appear. Participants had 3000 ms to look at the fixation circle and they had to maintain their sight at the fixation point during 500 ms for the stimulus to be presented. If their gaze was not detected, the trial was recycled and I calibrated and validated again.

Participants had to press three different buttons in a button-box: the left button corresponded to *yes*-type answers, the button in the middle to see the following stimulus, and the right button to *no*-type answers. Trials were presented in three blocks

of 40 trials, with two pauses for participants to rest. The whole session lasted around 45 minutes.

1.4 Data processing and analyses

Sentence Reading Times, Gaze Duration, Regression Path Duration, Re-reading Duration, Regression In Count, Regression Out Count, and Total Duration measures were the dependent variables. The Sentence Reading Times variable records the time, in milliseconds, that participants took reading the sentence from its presentation until they pressed the button to see the next stimulus. Eye-tracking measures are divided into three categories: early, intermediate, and late measures. Gaze Duration is an early measure, Re-reading Duration, and Regression Path Duration are intermediate measures, and Total Duration is a late measure. Early measures are associated with word recognition and lexical process and late measures with argument structure integration (Conklin et al., 2018).

The Gaze duration variable measures the time participants have been looking at the target region the first time they come in before looking at any region to the right or to the left. The Regression Path Duration variable measures the time participants have fixated on an interest region before having fixated on a region on the right. The Re-reading Duration is the difference between Regression Path Duration and Gaze Duration. The Regression Out Count variable measures the number of times participants have exited an interest region to a region to the left before a region to the right was fixated. The Regression In Count variable measures the number of times participants have entered an interest region from a region to the right. Finally, the Total Duration variable measures the total time participants have been looking at the target region, including re-reading times from both sides (Conklin et al., 2018; SR Research, 2020). See Figure 2.1 and Table 2.5 for an exemplification of an eye-movement pattern during reading and their corresponding eye-tracking variables.

Figure 2.1: This figure illustrates a made-up example of eye-movement pattern during reading an experimental sentence. Each dot represents a fixation, the bigger it is, the more milliseconds a participant has spent on this fixation. The number in the dots indicates the order of the fixations during sentence reading.

Table 2.5: The number of corresponding fixations of each eye-tracking measure with the fixation numbers in the verb region of Figure 2.1. In all duration measures (i.e., Gaze Duration, Regression Path Duration, Re-reading Duration, and Total Duration), the sum of the fixations results in a number in milliseconds (e.g., 350 ms). In the count measures (i.e., Regression Out Count and Regression In Count), the sum of fixations results in a specific number of counts (e.g., 3 counts).

Eye-tracking measures	Fixation numbers
Gaze Duration	3 + 4
Regression Path Duration	3 + 4 + 6
Re-reading Duration	6
Regression Out Count	4 + 8
Regression In Count	8
Total Duration	3 + 4 + 6 + 8 + 10

Experimental items were split into five regions: subject region, verb region, object region, post-object region, and last-word region (see Figure 2.1). The last-word region was included to avoid wrap-up effects.

Fixations shorter than 80 ms and longer than 800 ms were removed using

DataViewer software (SR Research Ltd, 2022). Values of the Sentence Reading Time measure below 1 second were considered outliers due to too fast reading and were removed (6 out of 1920 observations). All participants showed accuracy rates over 80% in the comprehension questions, hence no participant was excluded due to accuracy criteria.

I made data analysis using R (R Core Team, 2025) and Bayesian Mixed-Effects Models with *brms* function (Bürkner, 2017). For Sentence Reading Time, Gaze Duration, Regression Path Duration, Re-reading Duration and Total Duration measures, I created Bayesian Mixed-Effects Models with Shifted-lognormal likelihood. For Regression Out Count and Regression In Count variables I used Poisson likelihood. I specified uninformative normal distributed priors for the intercept and slopes to reflect reasonable expectations about the uncertainty of these parameters while remaining nonrestrictive to let the data guide the estimation (Kruschke, 2015; Nicenboim et al., 2025). To specify the prior distributions of the parameters of models with Shifted log-normal likelihood, I chose normal distributions for the intercept (μ = log(5000), σ = log(2000) for Sentence Reading Times; μ = log(500), σ = log(200) for Gaze Duration, Regression Path Duration and Re-reading Duration; and μ = log(1000), σ = log(500) for Total Durations) and for the slopes (μ = 0, σ = 2). In the case of models with Poisson likelihood, I chose also normal distributions for the intercept (μ = 0, σ = 10) and slopes (μ = 0, σ = 2) parameters due to convergence problems with the conjugate Gamma distribution.

Conditions were nested coded to specifically get the specific comparisons for research questions (Nicenboim et al., 2025). Since I was not interested in the interaction between Verb Type and Argument Structure, I focused in the comparisons between both psych verb types (conditions a vs. c in Table 2.2) (henceforth *Psych comparison*), between both experiencer-theme verbs (a vs. b) (henceforth *Exp-theme comparison*), and between agent-experiencer and agent-patient (c vs. d) (henceforth *Agent-exp/patient comparison*). In the Verb Type condition, the non-psych level was

sum-coded as -0.5 and psych level as 0.5. In the Argument Structure Type condition, experiencer-theme level was sum-coded as -0.5 and agent-exp/theme level as 0.5. I created a model where the Argument Structure Type condition was nested inside the Verb Type condition to get the Psych comparison (a vs. c). Next, I reversed the nested-coding, Verb Type condition nested inside the Argument Structure Type condition, to get the Exp-theme comparison (a vs. b), and the Agent-exp/patient comparison (c vs. d). See Appendix B3 for an exemplification of the syntax of the nested code employed.

I controlled the lexical predictability of the experimental sentences by incorporating to the Bayesian Mixed-Effects Models the lexical surprisal values of the sentences (Huber et al., 2024). This allowed me to ensure that any observed effects were not solely driven by difference in the predictability. I used a pretrained GPT-2 model from HuggingFace (*flax-community/gpt-2-spanish*) and a library provided by Remo Nitschke (University of Zurich) to obtain the surprisal values of each word of experimental sentences as the sentence unfolds (Nitschke, 2024). Surprisal measures how expected a word is given the preceding context, according to a language large model. The higher the surprisal, the more unexpected the word is. In the experiments of this dissertation, the surprisal of the words of each region was the sum of the surprisal values of all the words within that region, and the surprisal value of the whole sentence was the sum of all words.

I compared models with leave-one-out cross-validation (LOO-CV) (McElreath, 2020; Vehtari et al., 2017) using the stacking technique (Yao et al., 2018). I chose LOO-CV instead of the Bayes factor for model comparison because LOO-CV is a widely accepted and robust method for evaluating predictive performance in Bayesian models (Huber et al., 2024; McElreath, 2020; Nicenboim et al., 2025). It offers a data-driven way of comparing models in terms of their expected out-of-sample predictive accuracy. Bayes factor is known to be highly sensitive to prior specifications, especially in models with weakly informative priors, and may penalize complex

models even when they generalize better. In contrast, LOO-CV predictions are based on posterior predictive distributions. As the prior predictive distribution is highly sensitive to the priors (Nicenboim et al., 2025), using the Bayes factor can be problematic as I used uninformative priors because I did not have strong prior knowledge.

I compared four fitted Bayesian Mixed-Effects Models per each region and variable: a model without any predictor, a model with only surprisal values as predictor, a model with Verb Type and Argument Structure Type predictors, and a model with surprisal values, Verb Type and Argument Structure Type predictors (see Appendix B3). The result of this comparison gave the weight of each model, which reflects the relative predictive performance of each model in explaining the data. These weights are derived from the posterior predictive performance of the models, where each observation is iteratively excluded, and the ability of the model to predict that left-out observation is evaluated (Vehtari et al., 2017). I reported the posterior distributions of the fitted Bayesian Mixed-Effects Models with the highest weight. When the highest-weight model was the one without predictors, I did not report anything. When the highest-weight model included Verb Type and Argument Structure Type predictors, they always had the comparisons previously mentioned. Weights of model comparisons are shown in Appendix B3.

Unlike Frequentist framework, Bayesian approach models uncertainty by estimating a posterior distribution of possible parameter values rather than a single point estimate. Consequently, for a given contrast, Bayesian inference produces a range of plausible values for the effect. If this posterior distribution overlaps zero, there is uncertainty about whether the effect is positive or negative. In contrast, if the distribution does not overlap zero, the direction of the effect can be inferred with high certainty.

Bayesian posterior probability of pairwise comparisons ($P(\hat{\beta} > 0)$) represents the degree of belief in the effect itself, conditioned on the observed data. It indicates the

probability that the effect is greater (or smaller) than zero, providing a measure of certainty about the direction of an effect. For example, a probability $P(\hat{\beta} > 0) = 99$ implies a 99% confidence that the effect is positive.

2. Results

2.1 Surprisal results

In this section, I briefly discuss the effect of lexical surprisal values found in Experiment 1. All these models reveal a positive surprisal effect showing that participants made higher fixation times, and more regression counts with higher surprisal values than with lower surprisal values.

This effect appeared in the subject region in Gaze Duration ($\hat{\beta}_{\text{Surprisal}} = 0.070$, SE = 0.023, 95% CrI = [0.024, 0.117], $P(\hat{\beta} > 0) = 0.99$), Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.145$, SE = 0.043, 95% CrI = [0.060, 0.231], $P(\hat{\beta} > 0) = 0.99$), Total Duration ($\hat{\beta}_{\text{Surprisal}} = 0.102$, SE = 0.032, 95% CrI = [0.039, 0.166], $P(\hat{\beta} > 0) = 0.99$), and Regression In Count ($\hat{\beta}_{\text{Surprisal}} = 0.111$, SE = 0.037, 95% CrI = [0.038, 0.185], $P(\hat{\beta} > 0) = 0.99$). The effect was also found in the verb region in Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.062$, SE = 0.019, 95% CrI = [0.025, 0.100], $P(\hat{\beta} > 0) = 0.99$) and Total Duration ($\hat{\beta}_{\text{Surprisal}} = 0.043$, SE = 0.019, 95% CrI = [0.005, 0.079], $P(\hat{\beta} > 0) = 0.99$). It also appeared in the object region in Gaze Duration ($\hat{\beta}_{\text{Surprisal}} = 0.057$, SE = 0.015, 95% CrI = [0.027, 0.086], $P(\hat{\beta} > 0) = 0.99$), Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.149$, SE = 0.025, 95% CrI = [0.100, 0.198], $P(\hat{\beta} > 0) = 0.99$), Regression Out Count ($\hat{\beta}_{\text{Surprisal}} = 0.262$, SE = 0.109, 95% CrI = [0.062, 0.488], $P(\hat{\beta} > 0) = 0.99$), and Total Duration ($\hat{\beta}_{\text{Surprisal}} = 0.140$, SE = 0.023, 95% CrI = [0.097, 0.184], $P(\hat{\beta} > 0) = 0.99$), and in the post-object region in Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.067$, SE = 0.030, 95% CrI = [0.010, 0.125], $P(\hat{\beta} > 0) = 0.99$), and Regression Out Count ($\hat{\beta}_{\text{Surprisal}} = 0.349$, SE = 0.092, 95% CrI = [0.169, 0.531], $P(\hat{\beta} > 0) = 0.99$). Lastly, this effect

also appeared in the Reading Time measure ($\hat{\beta}_{\text{Surprisal}} = 0.084$, SE = 0.016, 95% CrI = [0.052, 0.115], $P(\hat{\beta} > 0) = 0.99$).

As shown above, lexical surprisal affects the processing of stimuli; however, as discussed in the next section, it is not sufficient to account for the data, since in some models the predictors of Verb Type and Argument Structure Type must be included.

2.2 Eye-tracking measures and Sentence Reading Times

Table 2.6 shows predicted values of eye-tracking measures, Table 2.7 predicted values of Sentence Reading Times measure, and a table with the raw data of all regions and measures is shown in Appendix B4.

In the subject region, none of the models including Verb Type and Argument Structure Type predictors had the highest weight, revealing no effects (see Appendix B3).

In the verb region, the fitted models with the highest weight included Verb Type and Argument Structure Type predictors in the Gaze Duration, Regression Path Duration, Regression In Count, and Total Duration measures (see Appendix B3).

Results showed a remarkable difference in the Agent-exp/patient comparison in Total Duration ($\hat{\beta}_{\text{Agent-exp/patient comparison}} = 0.126$, SE = 0.053, 95% CrI = [0.023, 0.230], $P(\hat{\beta} > 0) = 0.99$): participants made larger total fixation times on agent-experiencer than on agent-patient conditions (see Figures 2.2 and 2.3). To assess directly whether the experiencer-theme psych condition (*fear*-type verbs) results in longer total fixation times than the control condition (agent-patient verbs), as verbs like *frighten* do, I run the model again using treatment coding with agent-patient non-psych condition as the reference level. I found no remarkable differences between experiencer-theme psych condition and agent-patient non-psych condition ($\hat{\beta}_{\text{Agent-patient non-psych: exp-theme psych}} = 0.064$, SE = 0.049, 95% CrI = [-0.033, 0.161], $P(\hat{\beta} > 0) = 0.91$) (see Figures 2.2 and 2.3).

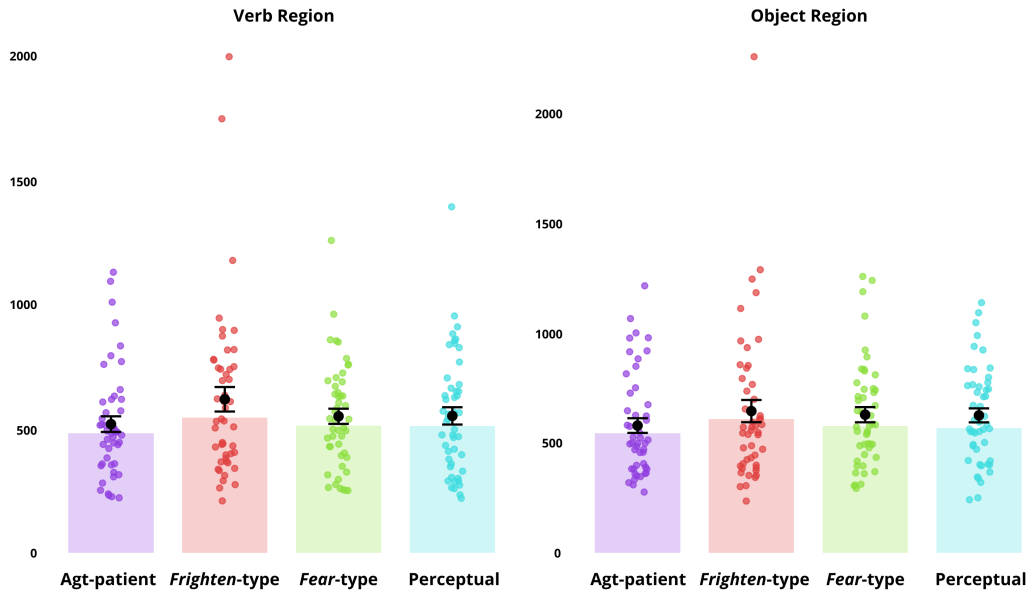

Figure 2.2: The plots show both observed and predicted means in the verb (on the left) and object (on the right) regions in the Total Duration variable per condition. Bars indicate the model-predicted mean, black dots show the overall observed mean, and colored dots show individual participant means. Black vertical lines correspond to the standard error of the mean around the overall observed mean.

I did not find a Verb Type effect in any measure (Gaze Duration: ($\hat{\beta}_{\text{Verb Type}} = 0.042$, SE = 0.027, 95% CrI = [-0.012, 0.097], $P(\hat{\beta} > 0) = 0.94$); Regression Path Duration: ($\hat{\beta}_{\text{Verb Type}} = 0.038$, SE = 0.036, 95% CrI = [-0.034, 0.110], $P(\hat{\beta} > 0) = 0.86$); Regression In Count: ($\hat{\beta}_{\text{Verb Type}} = 0.070$, SE = 0.079, 95% CrI = [-0.087, 0.224], $P(\hat{\beta} > 0) = 0.82$); Total Duration: ($\hat{\beta}_{\text{Verb Type}} = 0.065$, SE = 0.038, 95% CrI = [-0.010, 0.138], $P(\hat{\beta} > 0) = 0.96$)), nor differences in the Psych comparison (Gaze Duration: ($\hat{\beta}_{\text{Psych comparison}} = 0.034$, SE = 0.048, 95% CrI = [-0.062, 0.128], $P(\hat{\beta} > 0) = 0.77$); Regression Path Duration: ($\hat{\beta}_{\text{Psych comparison}} = 0.000$, SE = 0.062, 95% CrI = [-0.123, 0.125], $P(\hat{\beta} > 0) = 0.50$); Regression In Count: ($\hat{\beta}_{\text{Psych comparison}} = 0.012$, SE = 0.119, 95% CrI = [-0.226, 0.242], $P(\hat{\beta} > 0) = 0.55$); Total Duration: ($\hat{\beta}_{\text{Psych comparison}} = 0.061$,

SE = 0.066, 95% CrI = [-0.066, 0.191], P ($\hat{\beta}$ > 0) = 0.82)), nor in the Exp-theme comparison (Gaze Duration: ($\hat{\beta}_{\text{Exp-theme comparison}}$ = 0.37, SE = 0.038, 95% CrI = [-0.038, 0.111], P ($\hat{\beta}$ > 0) = 0.84); Regression Path Duration: ($\hat{\beta}_{\text{Exp-theme comparison}}$ = 0.032, SE = 0.051, 95% CrI = [-0.067, 0.133], P ($\hat{\beta}$ > 0) = 0.73); Regression In Count: ($\hat{\beta}_{\text{Exp-theme comparison}}$ = 0.112, SE = 0.109, 95% CrI = [-0.100, 0.325], P ($\hat{\beta}$ > 0) = 0.85); Total Duration: ($\hat{\beta}_{\text{Exp-theme comparison}}$ = 0.003, SE = 0.060, 95% CrI = [-0.115, 0.124], P ($\hat{\beta}$ > 0) = 0.52)).

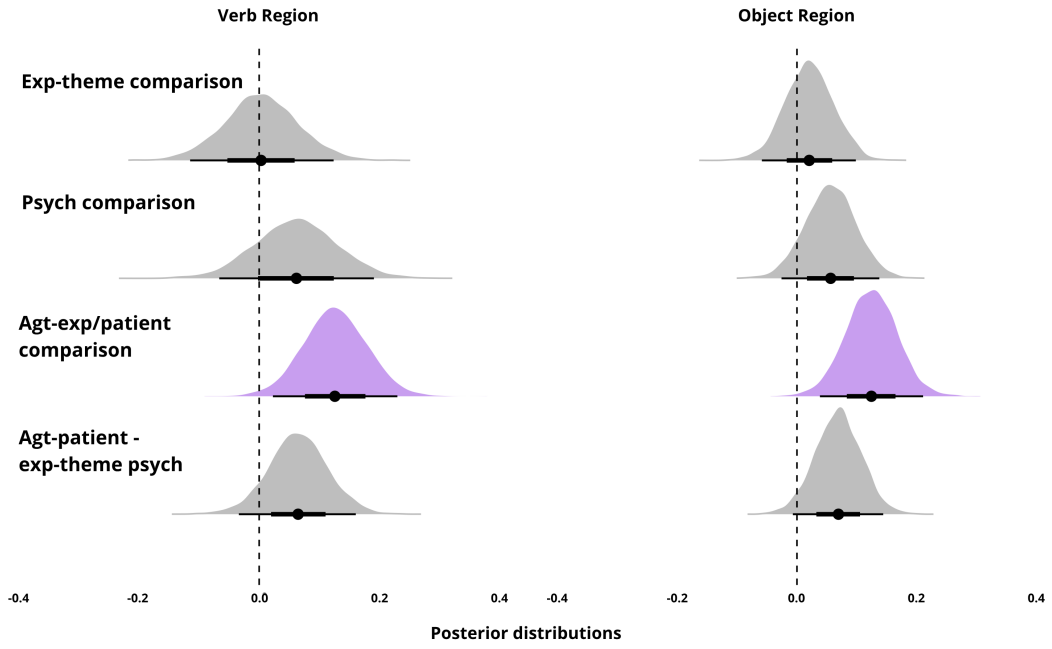

Figure 2.3: Posterior distributions of the models for Total Duration variable across verb and object regions. Notable differences in the Agent-exp/theme comparison in the verb and object regions with 95% Credible Intervals that do not overlap zero are highlighted in color.

In the object region, the fitted models with the highest weight included Verb Type and Argument Structure Type predictors in the Regression Path Duration, Regression Out Count, Regression In Count, and Total Duration measures (see Appendix B3).

Table 2.6: Mean predicted values and 95% Credible Intervals (CrI) for eye-tracking measures across sentence regions and conditions of Experiment 1. Values indicate that the highest-weighted models include the predictors of interest for that region and measure. Empty cells show that the highest-weighted models do not include the predictors of interest.

Eye-tracking measures	Subject Region	Verb Region	Object Region	Post-object Region
	Mean [CrI]	Mean [CrI]	Mean [CrI]	Mean [CrI]
Gaze Duration (ms)				
Exp-theme (psych)		283 [260, 307]		
Exp-theme (non-psych)		274 [252, 296]		
Agt-exp		291 [270, 314]		
Agt-pat		279 [258, 301]		
Regression Path Duration (ms)				
Exp-theme (psych)		332 [286, 390]	448 [347, 584]	
Exp-theme (non-psych)		323 [278, 381]	439 [339, 573]	
Agt-exp		331 [284, 387]	496 [383, 654]	
Agt-pat		319 [275, 375]	442 [343, 579]	
Re-reading Duration (ms)				
Exp-theme (psych)				887 [705, 1109]
Exp-theme (non-psych)				1010 [792, 1264]
Agt-exp				814 [636, 1028]
Agt-pat				821 [658, 1013]
Regression Out Count (counts)				
Exp-theme (psych)			0.13 [0.06, 0.23]	
Exp-theme (non-psych)			0.11 [0.05, 0.20]	
Agt-exp			0.18 [0.09, 0.34]	
Agt-pat			0.12 [0.06, 0.22]	
Regression In Count (counts)				
Exp-theme (psych)		0.44 [0.34, 0.55]	0.24 [0.18, 0.31]	
Exp-theme (non-psych)		0.39 [0.30, 0.49]	0.19 [0.14, 0.25]	
Agt-exp		0.44 [0.33, 0.56]	0.16 [0.11, 0.21]	
Agt-pat		0.44 [0.34, 0.54]	0.22 [0.16, 0.28]	
Total Duration (ms)				
Exp-theme (psych)		513 [437, 605]	578 [440, 763]	
Exp-theme (non-psych)		511 [435, 605]	568 [432, 749]	
Agt-exp		545 [456, 649]	609 [463, 810]	
Agt-pat		482 [412, 567]	544 [416, 719]	

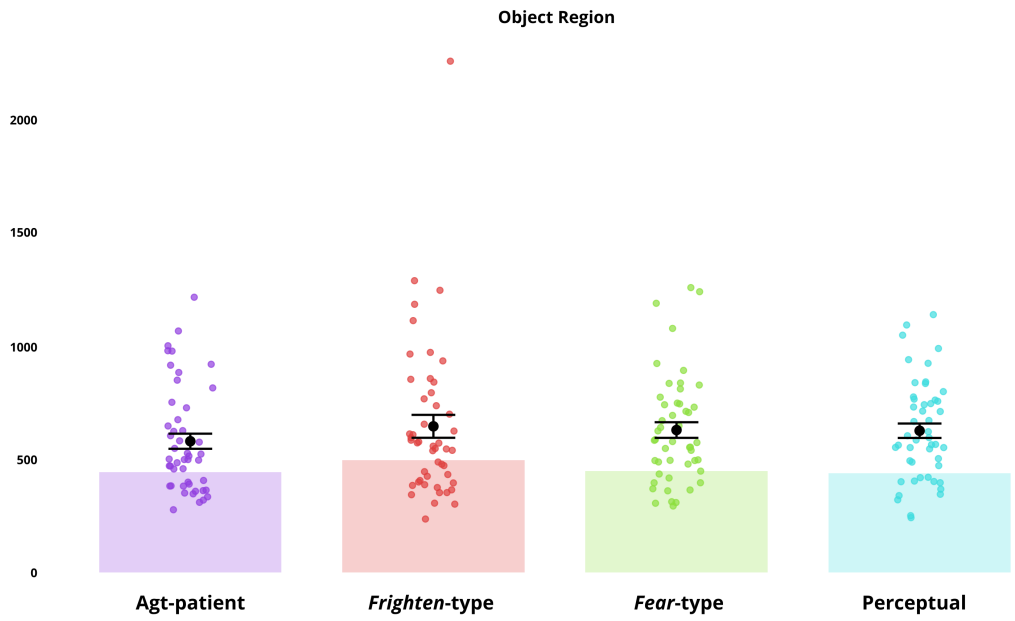

Figure 2.4: The plot shows both observed and predicted means in the object region in the Regression Path Duration variable per condition. Bars indicate the model-predicted mean, black dots show the overall observed mean, and colored dots show individual participant means. Black vertical lines correspond to the standard error of the mean around the overall observed mean.

As in the verb region, there were notable differences in the Agent-exp/patient comparison in Total Duration ($\hat{\beta}_{\text{Agent-exp/patient comparison}} = 0.124$, SE = 0.043, 95% CrI = [0.038, 0.210], $P(\hat{\beta} > 0) = 0.99$) (see Figures 2.2 and 2.3), and also in Regression Path Duration ($\hat{\beta}_{\text{Agent-exp/patient comparison}} = 0.137$, SE = 0.052, 95% CrI = [0.035, 0.241], $P(\hat{\beta} > 0) = 0.99$) (see Figures 2.4 and 2.5): agent-experiencer condition involved larger fixation times than agent-patient condition. As in the verb region, I releveled the model were the Agent-exp/patient was found to assess directly whether the experiencer-theme psych condition (*fear*-type verbs) results in longer fixation times than the control condition (agent-patient verbs). I found no notable differences between experiencer-theme psych condition and agent-patient non-psych condition in

either Regression Path Duration ($\hat{\beta}_{\text{Agt-patient non-psych: exp-theme psych}} = 0.016$, SE = 0.039, 95% CrI = [-0.060, 0.092], $P(\hat{\beta} > 0) = 0.66$), or Total Duration ($\hat{\beta}_{\text{Agt-patient non-psych: exp-theme psych}} = 0.069$, SE = 0.038, 95% CrI = [-0.004, 0.143], $P(\hat{\beta} > 0) = 0.97$) (see Figures 2.2, 2.3, 2.4, and 2.5).

I found a remarkable difference in the Psych comparison in Regression Path Duration ($\hat{\beta}_{\text{Psych comparison}} = 0.120$, SE = 0.051, 95% CrI = [0.018, 0.219], $P(\hat{\beta} > 0) = 0.99$): participants had larger fixation times on agent-experiencer psych verbs (*frighten*-type) than on experiencer-theme psych verbs (*fear*-type) (see Figures 2.4 and 2.5). In Regression In Count, there was also a notable difference in the same comparison, but in the opposite direction ($\hat{\beta}_{\text{Psych comparison}} = -0.428$, SE = 0.167, 95% CrI = [-0.760, -0.110], $P(\hat{\beta} < 0) = 0.99$): experiencer-theme psych verbs elicited more regression in counts to the object region from posterior regions than agent-experiencer psych verbs.

A Verb Type effect was found in Total Duration ($\hat{\beta}_{\text{Verb Type}} = 0.073$, SE = 0.031, 95% CrI = [0.013, 0.134], $P(\hat{\beta} > 0) = 0.99$), and Regression Path Duration ($\hat{\beta}_{\text{Verb Type}} = 0.081$, SE = 0.030, 95% CrI = [0.021, 0.139], $P(\hat{\beta} > 0) = 0.99$): participants' total fixation times on the object were larger on psych verbs than on non-psych verb conditions (see Table 2.6).

There were no notable differences in the Exp-theme comparison in any measure (Regression Path Duration: ($\hat{\beta}_{\text{Exp-theme comparison}} = 0.025$, SE = 0.043, 95% CrI = [-0.061, 0.109], $P(\hat{\beta} > 0) = 0.72$); Regression Out Count: ($\hat{\beta}_{\text{Exp-theme comparison}} = 0.181$, SE = 0.222, 95% CrI = [-0.247, 0.631], $P(\hat{\beta} > 0) = 0.80$); Total Duration: ($\hat{\beta}_{\text{Exp-theme comparison}} = 0.021$, SE = 0.040, 95% CrI = [-0.058, 0.098], $P(\hat{\beta} > 0) = 0.70$)).

In the Sentence Reading Time measure, the fitted model with the highest weight included Verb Type and Argument Structure predictors (see Appendix B3). I found a difference in the Agent-exp/patient comparison, where participants had larger

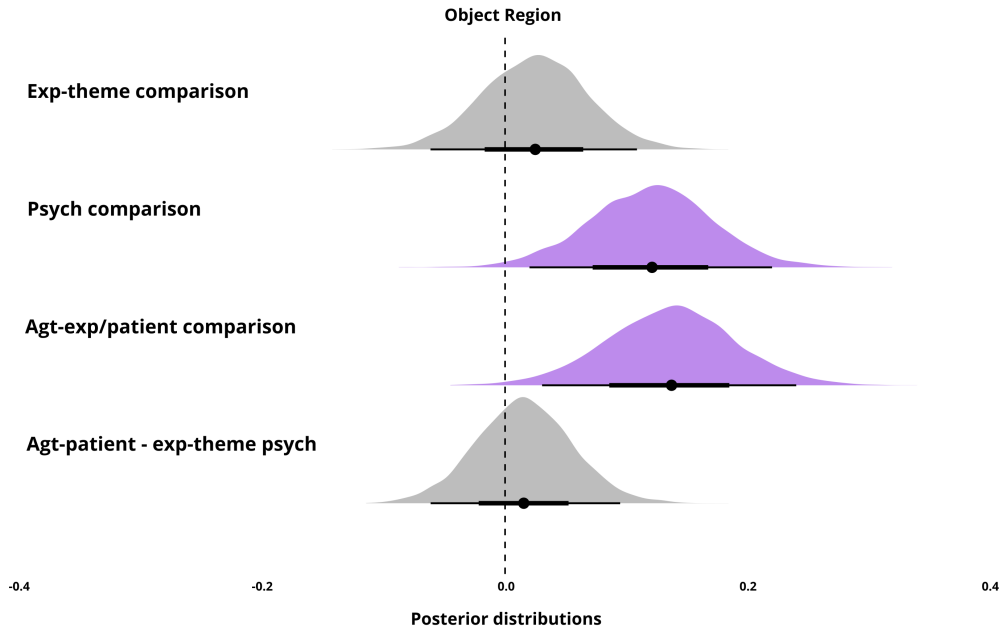

Figure 2.5: Posterior distributions of the models for Regression Path Duration variable in the object region. Notable differences in the Agent-exp/theme comparison and in the Psych comparison in the verb region with 95% Credible Intervals that do not overlap zero are highlighted in color.

sentence reading times on agent-experiencer than on agent-patient condition ($\hat{\beta}_{\text{Agent-exp/patient comparison}} = 0.079$, SE = 0.034, 95% CrI = [0.013, 0.146], $P(\hat{\beta} > 0) = 0.99$). As in the eye-tracking measures, I releveled the model to assess whether the experiencer-theme psych condition (*fear*-type verbs) results in longer reading times than the control condition (agent-patient verbs). There were no notable differences between experiencer-theme psych condition and agent-patient non-psych condition ($\hat{\beta}_{\text{Agt-patient non-psych: exp-theme psych}} = 0.043$, SE = 0.032, 95% CrI = [-0.018, 0.107], $P(\hat{\beta} > 0) = 0.92$). Additionally, I did not find notable differences in neither the Psych comparison ($\hat{\beta}_{\text{Psych comparison}} = 0.036$, SE = 0.037, 95% CrI = [-0.038, 0.111], $P(\hat{\beta} > 0) = 0.84$, nor in the Exp-theme comparison ($\hat{\beta}_{\text{Exp-theme comparison}} = -0.029$, SE = 0.033, 95% CrI = [-0.094,

0.036], $P(\hat{\beta} < 0) = 0.82$), nor a Verb Type effect ($\hat{\beta}_{\text{Verb Type}} = 0.025$, SE = 0.022, 95% CrI = [-0.038, 0.111], $P(\hat{\beta} > 0) = 0.86$).

Table 2.7: Mean predicted values and 95% Credible Intervals (CrI) for the reading time measure of Experiment 1. The values are in milliseconds.

Sentence Reading Time	All sentence
	Mean [CrI]
Exp-theme (psych)	3347 [2855, 3916]
Exp-theme (non-psych)	3422 [2905, 4027]
Agt-exp	3440 [2912, 4062]
Agt-pat	3243 [2771, 3795]

3. Discussion of Experiment 1

In the subject region, I only found a positive surprisal effect, revealing that participants produced larger fixation times and regressions on sentences with subjects with higher surprisal values. However, as expected by the fact that all experimental items were identical across conditions in the subject region, no other effect was found.

Results showed that participants did not produce different fixation times between sentences with verbs like *fear* and those with perceptual verbs, in any region or variable. Belletti and Rizzi's (1988) hypothesis of a grammatically relevant category of psychological verbs led to predicting processing differences between verbs like *fear* and perceptual verbs, since neither Postal (1970) nor Belletti and Rizzi (1988) included perceptual verbs in the psychological verb category. This distinction is also reflected in later approaches of verb classes (Levin, 1993). This null effect fails to provide evidence supporting the existence of a psychological verb category. Instead, this result is consistent with predictions based on the Non-Psychological Verb Hypothesis, since no processing differences were found between *fear*-type and

perceptual verbs, but *frighten*-type verbs involved higher processing costs than *fear*-type verbs in Regression Path Duration.

Both in the verb and in the object regions, I found remarkable differences in fixation times between sentences with verbs like *frighten* as compared to sentences with agent-patient verbs. In *frighten*-type verb sentences (5.a) participants produced larger total fixation times on the verb *enamora* and on the object *al poeta* than they did on the verb *abandona* and on the object *al poeta* when reading agent-patient verb sentences (5.b). Furthermore, I found that sentences with *frighten*-type verbs display higher Regression Path Duration fixation times in the object *al poeta* than those with *fear*-type verbs like (5.c).

(5) a. *La cantante enamora al poeta.*
"The singer makes fall in love the poet."
b. *La cantante abandona al poeta.*
"The singer abandons the poet."
c. *La cantante desea al poeta.*
"The singer desires the poet."

These results converge with the Proto-Role Hypothesis which states that the argument labeled *experiencer* in thematic role list approaches has the proto-agent entailment of sentience. Furthermore, they converge with the competition effect which claims that when two arguments exhibit proto-agent entailments, a competition for subject assignment emerges.

The *frighten*-type verb condition is the only one where both arguments have proto-agent entailments: in (5.a)*, la cantante* has three proto-agent entailments (i.e. sentience, volition, and causation), and *al poeta* has one (i.e. sentience). In contrast, in (5.b)*, la cantante* has three proto-agent entailments (i.e. sentience, volition, and causation), whereas *al poeta* has no proto-agent entailments (Dowty, 1991). The same occurs with *fear*-type verbs (5.c) where only l*a cantante* exhibits proto-agent

entailments (i.e., sentience). The larger fixation times obtained for sentences with *frighten*-type verbs as compared to sentences with *fear*-type and agent-patient verbs support the existence of competition for subjecthood, with both arguments with proto-agent entailments being activated as possible proto-agent candidates. The fact that this effect appears in Regression Path Duration and Total Duration variables indicates a reanalysis aligning with this idea of competition.

Results of this experiment replicate previous studies reporting higher processing costs for *frighten*-type verbs compared to agent-patient verbs in both Spanish and German (Bornkessel et al., 2002, 2003; Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015). Furthermore, they provide new evidence that processing *frighten*-type verbs incurs higher costs than *fear*-type verbs also in Spanish. This contrast had not previously been tested in this language, although it has been done in English (Do & Kaiser, 2021; M. Wilson & Dillon, 2022). Interestingly, the present study replicates these effects comparing at the same time *frighten*-type verbs with both *fear*-type and agent-patient verbs, without using active-passive or word-order alternation paradigms.

So far, as previously discussed, previous studies have accounted for this pattern of results based on the Psychological Verb Hypothesis: both *fear* and *frighten*-type verbs select the same event participants (experiencer and theme) but differ in their superficial syntactic realization. The processing difficulty associated with *frighten*-type verbs has been explained due to the mismatch between the prominence of the syntactic and semantic structures. This explanation has been mainly supported by the processing of these verbs in the passive structure as the pattern of results reverses: *frighten*-type verbs involve shorter processing costs than *fear*-type verbs in passive structures, with the inverse pattern in active structures (Bidgood et al., 2020; Do & Kaiser, 2021; Ferreira, 1994; Thompson & Lee, 2009; M. Wilson & Dillon, 2022). Processing is easier with an alignment between the syntactic and semantic prominence (actives with *fear*-type verbs, and passives with *frighten*-type verbs) than with a

misalignment between both (passives with *fear*-type verbs, and actives with *frighten*-type verbs). Here, I propose that the proto-role approach (Dowty, 1991) can account for these patterns of results in a more parsimonious way, as it aligns well with existing experimental evidence of event roles.

The proto-role approach (Dowty, 1991) assigns subject based on the accumulation of proto-agent entailments: arguments may have different degrees of membership into a proto-role, and the argument that has more proto-agent entailments becomes the subject. I interpret the fact that verbs like *frighten* involve higher processing cost than agent-patient verbs as a consequence of the competition for subject assignment: in structures of verbs like *frighten,* both arguments have proto-agent entailments, increasing competition for subject assignment, as compared to sentences where only one argument has proto-agent entailments, and thus, there is no competition. This result provides evidence in favor of the proto-role approach, showing that experiencer arguments are arguments with the proto-agent entailment of sentience, not a discrete category within the event role repertoire, as the Experiencer Role Hypothesis states.

Furthermore, assuming the Non-Psychological Verb Hypothesis which posits that *frighten*-type verbs entail causation whereas *fear*-type verbs do not (Grimshaw, 1990, and subsequent work), the proto-role approach can also account for the results in the active-passive alternation with *fear* and *frighten*-type verbs, which have traditionally been cited as key evidence supporting Belletti and Rizzi's (1988) proposal. Specifically, the proto-role approach would predict higher processing costs for passive than for active structures overall, as the argument with higher proto-agent entailments does not become the subject. However, this cost might be smaller for *frighten*-type verbs than for *fear*-type verbs. This is because *frighten*-type verbs map the argument with one proto-agent entailment onto the subject in passive constructions (the experiencer). While this argument may not be the strongest candidate for subjecthood, it still possesses proto-agent entailments, which likely reduces the processing cost in passive constructions. In contrast, *fear*-type verbs select only one

argument with proto-agent entailments. As a result, in passive constructions, *fear*-type verbs must map an argument without proto-agent entailments onto the subject position, which may increase processing difficulty compared to *frighten*-type verbs.

Although Do and Kaiser (2021) did not compare statistically the onset times of active vs. passive structures, their data show that *frighten*-type verbs involve slightly higher speech onset times in passive (2073 ms) than in active (2029 ms) sentences. This larger processing cost of less preferred passive structures seems to be more pronounced for both *fear*-type and agent-patient verbs: speech onset times of passive structures (2426 and 2234 ms, respectively) was about 400 ms slower than the one of active structures (1739 and 1818 ms). These findings suggest that the processing cost increases in passive structures for all verb types, but this increase is higher in *fear*-type and agent-patient verbs than in *frighten*-type verbs. These results align with the proto-role approach since the cost of passives is reduced in verbs selecting both arguments with proto-agent entailments (i.e., *frighten*-type verbs) than in those with only one argument with proto-agent entailments (i.e., *fear*-type and agent-patient verbs).

Do and Kaiser (2021) offered an alternative explanation to Belletti and Rizzi's (1988) approach based on the Non-Psychological Verb Hypothesis: *frighten*-type verbs should be easier to process in passive structures than *fear*-type verbs due to the causation marker (i.e. *by*). Since *frighten*-type verbs select two arguments with proto-agent entailments, one with causation and one without it, the assignment of subjecthood can be facilitated when causation is overtly marked, as this clearly identifies which argument maps to that position. Do and Kaiser (2021) considered this possibility as an explanation for their findings, as they did not find significant differences between *frighten*-type and agent-patient verbs in either active or passive structures. This hypothesis also aligns with the results of Bidgood et al. (2020), who showed that both children and adults exhibited a greater disadvantage for passives compared to actives for *fear*-type verbs than for both agent-patient and *frighten*-type

verbs. *Fear*-type would reveal a processing increase in passive structures because they do not involve causation, as *frighten*-type and agent-patient verbs do, hence it hampers the causation marker. Additionally, Ferreira (1994) observed that passives were generally less frequent in production in both verb types, with participants preferring actives overall. If passive structures facilitated processing for *frighten*-type verbs, one would expect a more balanced production of active and passive sentences. Overall, these patterns of results suggest that the processing cost of processing passives is smaller for *frighten*-type than for *fear*-type verbs, but not suppressed.

A related alternative explanation comes from causative/representational complexity theories (Brennan & Pylkkänen, 2010; Gennari & Poeppel, 2003; Levinson, 2023; McKoon & Love, 2011; McKoon & Macfarland, 2000), which provide also another explanation, attributing the processing differences between *fear* and *frighten*-type verbs to the greater conceptual complexity of causative events. *Frighten*-type verbs are argued to involve more complex event structures because they encode causation (Grimshaw, 1990, and subsequent work). Specifically, *frighten*-type verbs describe both a psychological state experienced by the experiencer and the cause of that state, whereas *fear*-type verbs simply denote a psychological state, making them conceptually simpler. Brennan and Pylkkänen (2010) found the previous mentioned result that *frighten*-type verbs involve larger reading times compared to *fear*-type verbs in the region following the verb. They interpreted this as evidence for the increased event complexity associated with *frighten*-type verbs.

However, causative/representational complexity theories face a limitation: they do not explain why *frighten*-type verbs elicit higher processing costs compared to agent-patient verbs (Bornkessel, 2002; Bornkessel et al., 2003; Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015), which are also causative. In Experiment 1, agent-patient verbs also described causative events, like *frighten*-type verbs do. If causative complexity alone explained processing difficulty, these two verb types should have showed similar processing correlates, distinct from *fear*-type verbs.

Instead, I found no differences between *fear*-type and agent-patient verbs, while both differed from *frighten*-type verbs. This suggests that causative complexity alone cannot account for the distinct processing costs associated with *frighten*-type verbs, indicating the need for alternative explanations, such as the competition for subjecthood account proposed here.

Related to studies using the active-passive alternation, studies using the word-order alternation paradigm have been also considered to provide evidence supporting Belletti and Rizzi's approach that *frighten*-type verbs do not denote causation. Nevertheless, these results do not reveal clear evidence that *frighten*-type verbs are preferred in OVS word orders. As discussed in Chapter 1, Gattei, Tabullo et al. (2015) found a higher negativity in agent-patient verbs compared to *frighten*-type verbs in sentences with OVS word order in the early time-window (400-550 ms), with no significant effect in SVO. In the late time-window (600-750 ms), their results revealed that *frighten*-type verbs elicited a broadly distributed positivity, in sentences with SVO word order, importantly, with no significant differences in sentences with OVS word order. Bornkessel et al. (2002, 2003) reported a parietal positivity (300-600ms) at the verb final position of sentences with verbs like *frighten* as compared to sentences with agent-patient verbs independently of word order. These results reveal that there is not a clear preference for OVS word order in *frighten*-type verbs.

Results from active-passive alternation and word order reversal show that *frighten*-type verbs involve larger processing costs than *fear*-type verbs and agent-patient verbs in active/SVO constructions. Nevertheless, it remains unclear whether there is a smaller cost of processing passives/OVS constructions in *frighten*-type verbs compared to *fear*-type and agent-patient verbs. The absence of a significant difference between *frighten*-type and agent-patient verbs in active-passive constructions (Bidgood et al., 2020; Do & Kaiser, 2021) aligns with the hypothesis that *frighten*-type verbs denote causation (Grimshaw, 1990, and subsequent work), since causation is overtly marked with the causation marker facilitating the construction of the passive

form compared to *fear*-type verbs which do not denote causation. All this considered, I propose that findings of Experiment 1 best align with the competition effect based on the Proto-Role Hypothesis and on the Non-Psychological Verb Hypothesis.

4. Interim conclusion

Experiment 1 shows that *frighten*-type verbs involve higher fixation times than both *fear*-type and agent-patient verbs, with no notable differences between *fear*-type, perceptual, and agent-patient verbs. These results align with both the Non-Psychological Verb Hypothesis and the Proto-Role Hypothesis. *Frighten*-type verbs exhibit different argument structure than *fear*-type verbs, since the former entail causation. Moreover, *frighten*-type verbs select two arguments with proto-agent entailments which involves a higher processing cost compared to verbs selecting only one argument with proto-agent entailments (i.e., *fear*-type and agent-patient verbs), revealing a competition for subject assignment. In Chapter 3, I further investigate the processing of *frighten*-type verbs by asking whether the number of proto-agent entailments of the subject modulates their processing cost.

Chapter 3

Testing the modulation of proto-agent entailments

1. Experiment 2

Findings of Experiment 1 showed that *frighten*-type verbs exhibit higher processing costs than agent-patient verbs. This result aligns with the competition effect which states that verbs selecting two arguments with proto-agent entailments incur in an increased processing cost compared to those selecting only one argument with proto-agent entailments.

Previous studies have provided empirical evidence that speakers use proto-agent entailments for subject and object identification (Kako, 2006; Rissman & Lupyan, 2022; Vernice & Hartsuiker, 2019). A key next step is to investigate the mechanisms underlying proto-role entailment assignment. In Dowty's (1991) approach, the argument that exhibits a higher number of proto-agent entailments becomes the subject. He proposed that all entailments are equally weighted; hence, the assignment of subject or object relied only on the number of proto-agent entailments, not on the type of them.

As the proto-role is a theoretical approach, it does not offer specific mechanisms of how to apply it to language processing. I propose that the mechanism of proto-role entailments resembles the one of cue-based retrieval models (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006), although they have primarily focused on explaining syntactic dependencies (e.g., agreement, filler-gap resolution), and not on event role assignment. These models rely

on retrieving items in memory based on sets of cues or features. When multiple arguments share overlapping features relevant for subjecthood, they are simultaneously activated in memory, increasing competition for subject assignment.

According to cue-based retrieval models (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006), during sentence processing, the parser stores each element of the sentence in memory as a chunk, gathering the content and the features associated with it. For example, when processing the chunk *the girl*, its meaning and the [+singular] and [+animate] features are stored, whereas when processing *spaghetti*, the features [+uncountable] and [-animate] are stored. Therefore, when the parser arrives to the verb *eats*, it searches for arguments with suitable features for each syntactic function. Based on the previous chunks, the only possible candidate for the subject is *the girl,* resulting in the sentence *the girl eats spaghetti.*

In this storage of chunks (or phrases), there are some that are characterized by having more matching features than others. For example, when processing the sentence *the woman danced, the woman* exhibits the features of [+human] and [+singular], which makes it a perfect match for the subject of this verb, as human beings are preferred to be agents and it matches the number of the verb. However, if the sentence *the bird danced* is encountered, *the bird* is characterized by [-human] and [+singular]. *The bird* aligns with the number required by the verb but it has fewer matching features than *the woman*, since it is not human and humans are preferred as agents to the verb *dance*. The more matching features an argument has, the higher is its activation, and the faster its retrieval.

Interestingly, cue-based retrieval is also modulated by similarity-based interference (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006), according to which co-activated items sharing features compete for retrieval. In self-paced reading tasks, Gordon and colleagues

(2001, 2004) compared the processing of subject-relative and object-relative clauses. They used sentences like:

(1) a. *The banker that praised [the barber/a barber/Joe/you/everyone] climbed the mountain.*
b. *The banker that [the barber/a barber/Joe/you/everyone] praised climbed the mountain.*

They found that the previously found subject-relative advantage over object-relative clauses was reduced or eliminated when the second noun phrase was either a pronoun or a proper name. These data provide evidence of the similarity-based interference, since when the second noun phrase is from the same referential class as the first noun phrase (*the banker-the/a barber*) the similarity-based interference appears involving higher processing costs than when the two noun phrases are from different verb classes (*the banker-you/Joe/everyone*). In Experiment 2, I test this similarity-based interference in structures of *frighten*-type verbs.

The similarity-based interference effect states that the more matching features an argument has, the higher is its activation, and the faster its retrieval. Applying this to *frighten*-type verbs, they select two arguments with proto-agent entailments, which involves a competition for subject assignment. In the structures of Experiment 1, the subject exhibits three proto-agent entailments (sentience, volition, and causation) and the object one (sentience) (2.a). In this case, although both arguments are possible candidates for subjecthood, the one with three proto-agent entailments becomes the subject because it exhibits a higher number of proto-agent entailments than the other argument. However, the number of proto-agent entailments of the subject can change as these verbs allow subjects with only one proto-agent entailment, the one of causation (2.c).

(2) a. *Mary*$_{3\text{-PROTO-AGENT ENTAILMENTS}}$ *frightens John*$_{1\text{-PROTO-AGENT ENTAILMENT}}$.
b. *Mary*$_{3\text{-PROTO-AGENT ENTAILMENTS}}$ *hits John*$_{0\text{-PROTO-AGENT ENTAILMENTS}}$.
c. *The wind*$_{1\text{-PROTO-AGENT ENTAILMENTS}}$ *frightens John*$_{1\text{-PROTO-AGENT ENTAILMENT}}$.
d. *The wind*$_{1\text{-PROTO-AGENT ENTAILMENTS}}$ *hits John*$_{0\text{-PROTO-AGENT ENTAILMENTS}}$.

As I mentioned in Experiment 1, Dowty (1991) did not propose specific mechanisms for identifying proto-role entailments. Hence, I relied on the set of entailments he associates with traditional thematic roles to specify the number of proto-agent entailments associated with each argument. Dowty noted that agent roles can be instantiated either by arguments with the proto-agent entailments of sentience, volition, and causation, or by those that exhibit causation alone, which correspond to the cause role (Dowty, 1991, p. 577). In line with thematic role list approaches, a distinction has been made between agents and causes due to their animacy: agents are animate whereas causes are inanimate (Fillmore, 1968, 1971); hence, *frighten*-type verbs select both types of arguments – agents (2.a) and causes (2.c). Accordingly, I interpreted these verbs as selecting arguments that either exhibit all three proto-agent entailments (sentience, volition, causation) when the subject is animate (2.a), or only causation when the subject is inanimate (2.c).

In Experiment 2, I aimed to replicate the previous competition effect showing that competing structures (with verbs like *frighten*) incur higher processing costs than non-competing structures (with agent-patient verbs). As in Experiment 1, both verb types denote causative change-of-state events. Furthermore, I aimed to test the similarity-based effect with *frighten*-type verbs. To achieve it, I modulated the animacy of subjects of both *frighten*-type and agent-patient verbs, using the second one as a control condition without competition. I predicted higher processing costs in (2.c) than in (2.a) due to greater cue overlap and heightened interference during subject assignment. I also expected that the number of entailments of the subject does not affect the processing of agent-patient verbs, since there is no competition involved.

1.1 Participants

Fifty native speakers of Spanish participated in the experiment. They were between 19-32 years old (12 = male; mean age = 22.02; *SD* = 3.02). This study was approved by the Ethics Committee for Research Involving Human Beings of the University of the Basque Country (CEISH-UPV/EHU: M10_2023_290). All participants had normal or corrected to normal vision. One participant was excluded due to calibration problems, resulting in a total of forty-nine participants.

1.2 Materials

This experiment had a 2x2 repeated measures design with Subject Type (Animate vs. Inanimate) and Verb Type (*Frighten*-type vs. Agent-patient-type) conditions (see Table 3.1). Items in Experiment 2 were created following the same criteria as in Experiment 1 (see Appendix C2).

I selected twenty different verbs per condition (each verb was repeated twice to get forty experimental items) (See Appendix C1). The length (in number of letters in the conjugated form used in the experimental sentences) and the frequency of verbs (in the infinitive form due to the lack of frequency of some verbs in their conjugated form) was controlled using the SUBTLEX-ESP corpus (Cuetos et al., 2011). As for Experiment 1, I conducted Bayesian one-sample models on the pairwise differences (e.g., ΔLength = $\text{Length}_{\text{FRIGHTEN}}$-$\text{Length}_{\text{AGENT-PATIENT}}$) to assess whether there were credible differences in length or frequency across conditions. The posterior distributions indicated that the mean differences were close to zero, with 95% credible intervals overlapping zero ($\hat{\beta}_{\text{LENGTH}}$ = 0.51, 95% CrI = [-0.24, 1.23]; $\hat{\beta}_{\text{FREQUENCY}}$ = -0.12, 95% CrI = [-0.50, 0. 25]). Additionally, I controlled the length of animate and inanimate subjects with the same analysis revealing no notable differences between them ($\hat{\beta}_{\text{ANIMATE-INANIMATE}}$ = 0.16, 95% CrI = [-0.33, 0.66]).

Table 3.1: Example of the 4 conditions of an experimental item in Experiment 2.

	Conditions		**Sentence Region**				
	Subject Type	**Verb Type**	**Subject Region**	**Verb Region**	**Object Region**	**Post-object Region**	**Last-word Region**
(a)	Animate	*Frighten*-type	El marinero	preocupó	al vendedor	en el amplio puerto de	Bilbao.
			The sailor worried the salesman in the large port of Bilbao.				
(b)	Animate	Agent-patient	El marinero	golpeó	al vendedor	en el amplio puerto de	Bilbao.
			The sailor hit the salesman in the large port of Bilbao.				
(c)	Inanimate	*Frighten*-type	El viento	preocupó	al vendedor	en el amplio puerto de	Bilbao.
			The wind worried the salesman in the large port of Bilbao.				
(d)	Inanimate	Agent-patient	El viento	golpeó	al vendedor	en el amplio puerto de	Bilbao.
			The wind hit the salesman in the large port of Bilbao.				

Table 3.2: Posterior distributions of the naturalness questionnaire model of Experiment 2.

Slopes	Estimate	Standard Error	CrI
Subject Type	0.44	0.10	[0.25, 0.64]
Verb Type	0.08	0.10	[-0.12, 0.28]
Interaction	0.04	0.10	[-0.13, 0.22]

Experimental items were previously normed by naturalness. Forty-two Spanish native speakers filled an online sentence naturalness questionnaire in PCIbex (Zehr & Schwarz, 2022). Participants had to rate the naturalness of sentences on a 5-point Likert scale. I did not find remarkable differences between verb types nor an interaction. However, I found a Subject Type effect showing that sentences with

animate subjects were ranked higher than those with inanimate subjects, independently of the verb type (see Table 3.2).

1.3 Procedure

I used the same procedure as in Experiment 1.

1.4 Data processing and analyses

The same dependent variables, regions within a sentence (see Table 3.1), and data cleaning criteria as in Experiment 1 were used.

Data analysis was done again using R (R Core Team, 2025) and Bayesian Mixed-Effects Models with *brms* function (Bürkner, 2017). The dependent variables had the same likelihood as in Experiment 1. Conditions were sum-coded to get the Subject Type effect, the Verb Type effect and the Interaction of both, which was theoretically relevant (Nicenboim et al., 2025). In the Subject Type condition, the inanimate level was coded as -0.5 and the animate level as 0.5. In the Verb Type condition, the Agent-Patient level was coded as -0.5 and the *Frighten*-type level as 0.5. Here, I did not nest the conditions because I was especially interested in the main effect of Verb Type and in the Interaction.

A key advantage of Bayesian modelling is that it allows cumulative knowledge to be incorporated into statistical inference. For Experiment 1, I did not have any prior knowledge, hence uninformative priors were used. In Experiment 2, however, the posterior distributions obtained from Experiment 1 were used to construct informative priors for the intercept and for the Verb Type slope (Kruschke, 2015; Nicenboim et al., 2025). I selected the mean and the standard deviation values of the posterior distributions of the intercepts and the slopes of the Agt-exp/patient comparison in all analyzed measures and regions. For the slopes of the priors of the Subject Type effect

and the Interaction parameters, as I did not have strong prior belief (since it was not included in Experiment 1), I used uninformative priors *Normal*($\mu = 0$, $\sigma = 2$).

Similarly, I calculated lexical surprisal values for each of the words of the experimental sentences using the same methodology explained in Experiment 1. When the highest-weight model was the one without predictors, I did not report anything. When the highest-weight models included Subject Type and Verb Type predictors, it always included the interaction between both. Model comparisons are shown in Appendix C3.

2. Results

2.1 Surprisal results

As in the previous Experiment 1, here I briefly discuss the lexical surprisal effects in different measures and regions (see Appendix C3). I found that sentences with higher surprisal values involve higher fixation times and regression counts than sentences with lower surprisal values. This effect appeared in the subject region in Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.093$, SE = 0.011, 95% CrI = [0.071, 0.115], $P(\hat{\beta} > 0) = 0.99$), and Total Duration ($\hat{\beta}_{\text{Surprisal}} = 0.077$, SE = 0.013, 95% CrI = [0.052, 0.101], $P(\hat{\beta} > 0) = 0.99$). It also appeared in the object region in Regression In Count ($\hat{\beta}_{\text{Surprisal}} = 0.188$, SE = 0.053, 95% CrI = [0.085, 0.294], $P(\hat{\beta} > 0) = 0.99$) and Total Duration ($\hat{\beta}_{\text{Surprisal}} = 0.066$, SE = 0.019, 95% CrI = [0.028, 0.104], $P(\hat{\beta} > 0) = 0.99$).

Since naturalness of sentences could not be matched between conditions with animate and inanimate subjects, I created an extra model to determine whether there were differences in the surprisal values of animate and inanimate subjects, with the surprisal values as the dependent variable and the animacy condition as the predictor. I found that surprisal values increased when the subject was inanimate compared to

animate subjects ($\hat{\beta}_{\text{Animacy}}$= -0.034, SE = 0.004, 95% CrI = [-0.042, -0.025], P ($\hat{\beta} < 0$) = 0.99).

2.2 Eye-tracking measures and Sentence Reading Times

Table 3.3 shows predicted values of eye-tracking measures, Table 3.4 predicted values of Reading Times measure, and a table with the raw data of all regions and measures is shown in Appendix C4.

In the subject region, the only model including Subject Type and Verb Type and their interaction as predictors with the highest weight was the one of Gaze Duration (see Appendix C3), revealing no Subject Type effect ($\hat{\beta}_{\text{Subject Type}}$ = -0.035, SE = 0.035, 95% CrI = [-0.104, 0.033], P ($\hat{\beta} < 0$) = 0.85), no Verb Type effect ($\hat{\beta}_{\text{Verb Type}}$ = -0.034, SE = 0.022, 95% CrI = [-0.079, 0.010], P ($\hat{\beta} < 0$) = 0.94), and no Interaction ($\hat{\beta}_{\text{Interaction}}$ = 0.027, SE = 0.040, 95% CrI = [-0.050, 0.105], P ($\hat{\beta} > 0$) = 0.76).

In the verb region, the fitted models with the highest weight included Subject Type and Verb Type in the Gaze Duration, Regression Path Duration, Regression Out Count, and Total Duration measures (see Appendix C3).

There were Verb Type effects in Gaze Duration ($\hat{\beta}_{\text{Verb Type}}$ = 0.079, SE = 0.028, 95% CrI = [0.026, 0.134], P ($\hat{\beta} > 0$) = 0.99), Regression Path Duration ($\hat{\beta}_{\text{Verb Type}}$ = 0.073, SE = 0.034, 95% CrI = [0.005, 0.140], P ($\hat{\beta} > 0$) = 0.98), and Total Duration ($\hat{\beta}_{\text{Verb Type}}$ = 0.098, SE = 0.039, 95% CrI = [0.022, 0.177], ($\hat{\beta} > 0$) = 0.99), revealing that participants produced larger fixation times on verbs like *frighten*, than on agent-patient verbs (see Figures 3.1 and 3.2).

The Subject Type effect appeared only in Regression Path Duration ($\hat{\beta}_{\text{Subject Type}}$ = -0.143, SE = 0.042, 95% CrI = [-0.224, -0.060], P ($\hat{\beta} < 0$) = 0.98), and Regression Out Count $\hat{\beta}_{\text{Subject Type}}$ = -0.746, SE = 0.236, 95% CrI = [-1.224, -0.295], ($\hat{\beta} < 0$) = 0.99), showing that participants produced larger fixation times and more regression

counts to the subject before moving to the object with inanimate subjects than with animate ones.

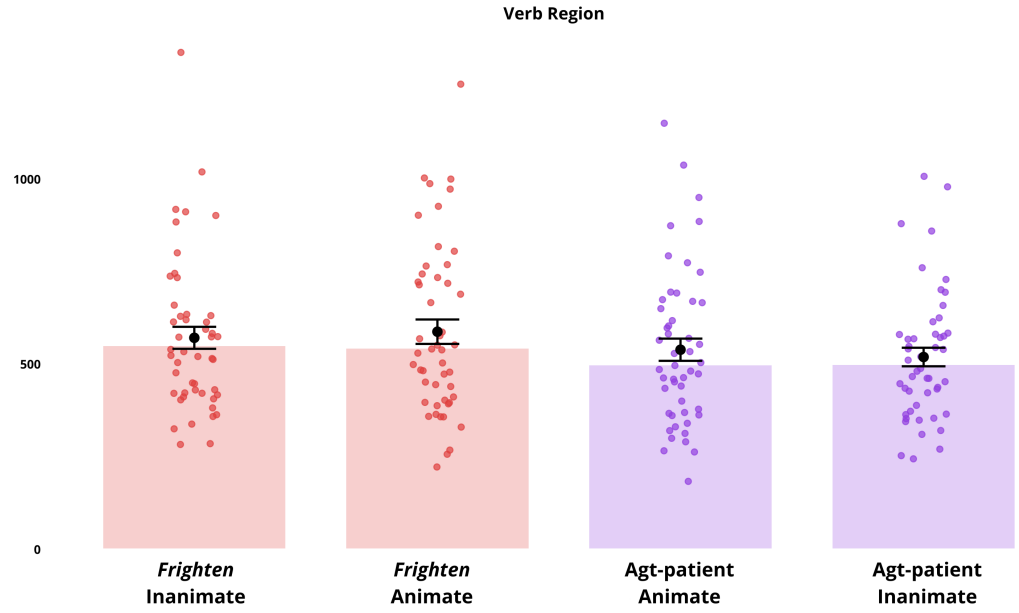

Figure 3.1: The plot shows both observed and predicted means in the verb region in the Total Duration variable per condition. Bars indicate the model-predicted mean, black dots show the overall observed mean, and colored dots show individual participant means. Black vertical lines correspond to the standard error of the mean around the overall observed mean.

Finally, no Interaction was found in any measure (Gaze Durations: $\hat{\beta}_{\text{Interaction}} = 0.007$, SE = 0.047, 95% CrI = [-0.085, 0.101], $P(\hat{\beta} > 0) = 0.56$); Regression Path Duration ($\hat{\beta}_{\text{Interaction}} = 0.009$, SE = 0.060, 95% CrI = [-0.111, 0.127], $P(\hat{\beta} < 0) = 0.43$); Regression Out Count ($\hat{\beta}_{\text{Interaction}} = -0.077$, SE = 0.373, 95% CrI = [-0.834, 0.634], $P(\hat{\beta} < 0) = 0.57$); Total Duration ($\hat{\beta}_{\text{Interaction}} = -0.012$, SE = 0.063, 95% CrI = [-0.138, 0.112], $P(\hat{\beta} < 0) = 0.58$).

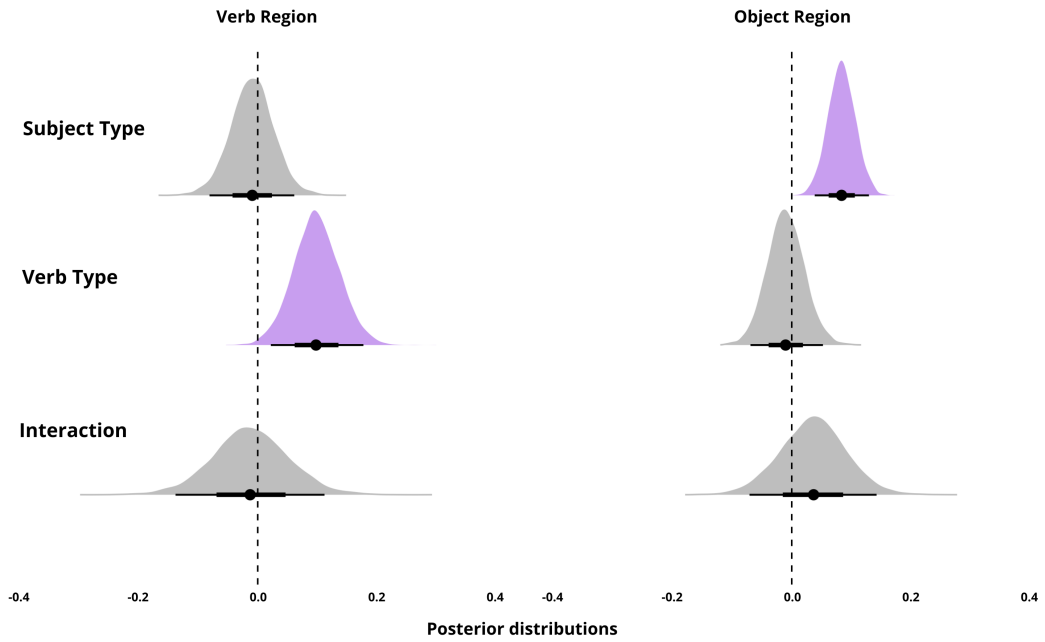

Figure 3.2: Posterior distributions of the models for Total Duration variable across verb and object regions. Notable differences in the Verb Type effect in the verb region and the Subject Type effect in the object with 95% Credible Intervals that do not overlap zero are highlighted in color.

In the object region, the fitted models with the highest weight included Subject Type and Verb Type only in the Regression Out Count and Total Duration measures, showing no effects in any of the other measures (see Appendix C3).

These models only revealed two main effects: in Total Duration, there was a Subject Type effect ($\hat{\beta}_{\text{Subject Type}} = 0.084$, SE = 0.023, 95% CrI = [0.038, 0.129], $P(\hat{\beta} > 0) = 0.99$), showing longer fixation times in sentences with animate subjects than with inanimate ones (see Figure 3.2). In Regression Out Counts, there was a Verb Type effect ($\hat{\beta}_{\text{Verb Type}} = 0.325$, SE = 0.122, 95% CrI = [0.086, 0.566], $P(\hat{\beta} > 0) = 0.99$), showing longer regressions from the object to previous regions in sentences with verbs like *frighten* than with agent-patient verbs.

Table 3.3: Mean predicted values and 95% Credible Intervals (CrI) for eye-tracking measures across sentence regions and conditions of Experiment 2. Values indicate that the highest-weighted models include the predictors of interest for that region and measure. Empty cells show that the highest-weighted models do not include the predictors of interest.

Eye-tracking measures	Subject Region	Verb Region	Object Region	Post-object Region
	Mean [CrI]	Mean [CrI]	Mean [CrI]	Mean [CrI]
Gaze Duration (ms)				
Frighten-type (A)	379 [352, 407]	305 [283, 330]		
Frighten-type (I)	388 [356, 421]	311 [288, 336]		
Agt-pat (A)	387 [356, 419]	284 [264, 307]		
Agt-pat (I)	407 [376, 439]	292 [271, 315]		
Regression Path Duration (ms)				
Frighten-type (A)		339 [300, 382]		
Frighten-type (I)		380 [335, 428]		
Agt-pat (A)		319 [283, 358]		
Agt-pat (I)		359 [317, 407]		
Re-reading Duration (ms)				
Frighten-type (A)			699 [600, 812]	
Frighten-type (I)			612 [510, 723]	
Agt-pat (A)			639 [523, 770]	
Agt-pat (I)			572 [474, 686]	
Regression Out Count (counts)				
Frighten-type (A)		0.06 [0.03, 0.09]	0.17 [0.12, 0.22]	0.13 [0.09, 0.18]
Frighten-type (I)		0.12 [0.08, 0.17]	0.14 [0.10, 0.18]	0.09 [0.06, 0.12]
Agt-pat (A)		0.05 [0.03, 0.08]	0.11 [0.08, 0.15]	0.12 [0.08, 0.16]
Agt-pat (I)		0.11 [0.07, 0.15]	0.11 [0.08, 0.15]	0.13 [0.09, 0.17]
Regression In Count (counts)				
Frighten-type (A)				
Frighten-type (I)				
Agt-pat (A)				
Agt-pat (I)				
Total Duration (ms)				
Frighten-type (A)		540 [479, 605]	586 [499, 693]	
Frighten-type (I)		548 [493, 606]	533 [456, 627]	
Agt-pat (A)		495 [440, 554]	582 [496, 685]	
Agt-pat (I)		496 [446, 550]	547 [467, 642]	

Table 3.4: Mean predicted values and 95% Credible Intervals (CrI) for reading time measure of Experiment 2. The values are in milliseconds.

Sentence Reading Time	All sentence
	Mean [CrI]
Frighten-type Animate	3600 [3321, 3903]
Frighten-type Inanimate	3555 [3291, 3845]
Agt-theme Animate	3602 [3319, 3910]
Agt-theme Inanimate	3589 [3327, 3870]

In the Sentence Reading Time measure, the highest-weighted model included Subject Type and Verb Type predictors (see Appendix C3), revealing no Subject Type effect ($\hat{\beta}_{\text{Subject Type}}$ = 0.011, SE = 0.021, 95% CrI = [-0.030, 0.051], P ($\hat{\beta}$ > 0) = 0.70), no Verb Type effect ($\hat{\beta}_{\text{Verb Type}}$ = -0.007, SE = 0.024, 95% CrI = [-0.054, 0.041], P ($\hat{\beta}$ < 0) = 0.61), and no Interaction ($\hat{\beta}_{\text{Interaction}}$ = 0.012, SE = 0.047, 95% CrI = [-0.078, 0.104], P ($\hat{\beta}$ > 0) = 0.60).

3. Discussion of Experiment 2

In Experiment 2, I replicated previous findings that reading the verb in sentences with verbs like *frighten* involved larger processing costs than reading agent-patient sentences. However, I did not find evidence that the number of entailments of the subject modulates the processing correlates of structures with verbs like *frighten*.

In the subject region, results revealed a surprisal effect showing that participants produced larger fixation times and more regressions on subjects with greater surprisal values than on subjects with lower surprisal values. This reveals an animacy effect, since inanimate subjects had higher surprisal values and are less expected than animate subjects. This result aligns with the animacy effect largely investigated in psycholinguistics that processing inanimate subjects involves higher processing costs

than processing animate subjects (e.g., Bourguignon et al., 2012; Kuperberg et al., 2003; Trueswell et al., 1994; Weckerly & Kutas, 1999).

In the verb and object regions, a Verb Type effect appeared: sentences where argument structures had both arguments with proto-agent entailments (*frighten*-verbs) involved higher processing costs than those with only one argument with proto-agent entailments (agent-patient verbs), replicating findings in Experiment 1 that sentences with competing arguments entail larger processing costs than sentences without them.

In the object region, I also found a Subject Type effect revealing that processing animate objects combined with animate subjects caused larger processing costs than animate objects combined with inanimate subjects independently of the verb type. This evidence aligns with cue-based retrieval models (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006), as the feature similarity between two elements of the sentence – in this case animacy – might cause a similarity-based interference effect (Hofmeister & Vasishth, 2014), reflected in higher processing costs when both elements are animate. However, I did not have specific predictions about this effect as it is not relevant for the research questions of this dissertation.

Lastly, I did not find any interaction in any measure or region between the verb types and the number of entailments. In the verb and object regions, sentences with argument structures having both arguments with proto-agent entailments (*frighten*-verbs) involved higher processing costs than those with only one argument with proto-agent entailments (agent-patient verbs), but independently of the number of proto-agent entailments the subject had. I found that the number of proto-agent entailments of the subject did not modulate either the processing correlates of structures with competing arguments (*frighten*-verbs), or the one of non-competing structures (agent-patient verbs).

Based on the proto-role approach (Dowty, 1991), and making an analogy of similarity-based accounts for agreement processing to those of subjecthood

assignment, I predicted that in sentences with verbs like *frighten* competition for subject assignment should increase when both arguments exhibit the same number of proto-agent entailments compared to when one argument exhibits more proto-agent entailments than the other one. This symmetry in the number of proto-agent entailments of the arguments would be reflected in higher processing costs compared to when there is an asymmetry. Evidence from Experiment 2 showed that sentences with competing arguments incurred similar processing costs, regardless of the number of proto-agent entailments of the subject. If the absence of an interaction were masked by the competition between two animate participants, I would expect to observe both a Subject Type effect and a Verb Type effect in the verb region. However, I only found this animacy competition in the object region without a Verb Type effect. Results show a competition for subjecthood in the verb region and an animacy competition in the object region. These two competitions do not seem to overlap, hence, I consider more likely that the absence of interaction is due to a categorical activation of proto-roles once a threshold of overlap is crossed or due to the prominence of the proto-agent entailment of causation over the other entailments.

The fact that the difference in the number of entailments of the arguments in competing structures does not ease their processing suggests that competition may emerge categorically once a threshold of overlap is crossed. That is, the presence of shared proto-agent entailments between arguments may be sufficient to trigger processing difficulty, without graded modulation based on the number of entailments. This evidence aligns with the inhibitory interference proposed by Lewis and Vasishth (2005) and further developed by Jäger et al. (2020) within cue-based retrieval models, which states that retrieval is hampered when multiple items in memory share overlapping features. This effect can emerge even when the competing item only partially matches the retrieval cues.

Another possible explanation for this result is the higher prominence of the proto-agent entailment of causation. Dowty avoided establishing a hierarchy among proto-

agent entailments, but he admitted that causation may have priority over the proto-agent entailment of movement in subject assignment (Dowty, 1991, p. 574). Several approaches have considered that causation outranks other proto-agent entailments (Ackerman & Moore, 2001; Davis, 2001; Davis & Koenig, 2000; Li, 2020). For example, Davis and Koenig (2000) claimed that an argument with the proto-agent entailment of causation becomes always the subject. Furthermore, Levin (2019), in her critic to the proto-role approach, stated that maybe not all proto-agent entailments contribute equally to subject assignment, emphasizing the prominence of causation over the others. If causation surpasses the other proto-agent entailments in subject assignment, it is expected no processing differences between structures of verbs like *frighten* with distinct number of entailments in the subject. In both cases, the subject has the proto-agent entailment of causation, and the other argument has sentience. The number of proto-agent entailments of the subject is not relevant because in both cases subjects have the causation entailment, which may outrank the other proto-agent entailments, making irrelevant the difference in number of proto-agent entailments as compared to the competing argument.

4. Interim conclusion

Result of Experiment 2 replicated the previous competition effect found in *frighten*-type verbs, providing further evidence of the Proto-Role Hypothesis. However, I did not find any modulation in the processing of these verbs due to the number of entailments of the subject. This lack of modulation may be due to the prominence of the proto-agent entailment of causation over the other entailments, or due to a categorical activation of proto-roles once a threshold of overlap is crossed.

In Chapter 4, I turn to intransitive structures to investigate whether the experiencer role exhibits specific processing correlates, or instead behaves like agents, as I argued in the previous two chapters. This investigation allows to provide further evidence of the conclusions drawn from the results of Experiments 1 and 2.

Chapter 4

Broadening the agent preference hypothesis through experiencers

1. Introduction

In Experiments 1 and 2, I examined the processing correlates of experiencers in transitive structures. The results revealed no processing differences between *fear*-type and agent-patient verbs, whereas *frighten*-type verbs involved higher processing costs than these two, which I interpret as evidence of competition for subject assignment. In Experiments 3 and 4, I directly compared the processing correlates of agents, experiencers, and patients in intransitive structures, allowing for a direct comparison of the three roles within the same syntactic position.

Numerous studies found a strong agent preference in language comprehension, revealing an attentional preference toward agents (Gómez-Vidal et al., 2022), and a preference to transiently interpret the first unmarked noun in a sentence as an agent crosslinguistically (Bickel et al., 2015; Bisang et al., 2013; Bornkessel & Schlesewsky, 2006; Erdocia et al., 2009; Frenzel et al., 2015; Huang et al., 2013; Isasi-Isasmendi, Sauppe, et al., 2023; Laka & Erdozia, 2012; Lamers, 2012; Sauppe et al., 2023; Vela-Plo et al., 2022). All these results align with the Agent Preference Hypothesis which proposes a cognitive preference toward agents over patients (Bornkessel-Schlesewsky & Schlesewsky, 2009; Frenzel et al., 2015; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023; Vela-Plo et al., 2022), potentially shared with non-human

apes (Brocard et al., 2024, 2025; V. Wilson et al., 2022, 2024). Despite the strong and reliable evidence for agent and patient roles (Rissman & Majid, 2019), there is no evidence for the experiencer role as a specific role category within the event role repertoire.

Here, I further test the Proto-Role Hypothesis by investigating the processing of experiencer arguments. I ask whether they display specific processing correlates, as agents and patients do, or whether they show similar processing correlates as agents and different from patients due to their proto-agent entailment, based on the proto-role approach (Dowty, 1991). I conducted an eye-tracking reading task (Experiment 3) and an EEG reading task (Experiment 4) using the same materials in both experiments. I decided to use intransitive structures because they allow to directly compare the processing correlates of agents (1.a), experiencers (1.b), and patients (1.c) in the same subject position. Particularly, Spanish language allows minimal differentiation of the three roles without immediate consequences for surface syntax (in terms of case marking, expletive pronouns, reflexivization, word order, or agreement):

(1) a. *María bailó.*
"Mary$_{\text{AGENT}}$ danced."
b. *María disfrutó.*
"Mary$_{\text{EXPERIENCER}}$ enjoyed."
c. *María tropezó.*
"Mary$_{\text{PATIENT}}$ stumbled."

Based on the Proto-Role Hypothesis and the results of Experiments 1 and 2, I expected that experiencers would have parallel processing correlates as agents and different from patients at the verb position, since experiencers are characterized by the proto-agent entailment of sentience. Otherwise, based on the Experiencer Role Hypothesis, I predicted that the experiencer would show a specific processing pattern, different

from both agents and patients, as they would constitute a specific category within the event role repertoire different from agents and patients.

2. Experiment 3

2.1 Participants

Thirty native Spanish speakers (6 = male; age range:18-34; mean age = 21.13; *SD* = 3.95) participated in the eye-tracking experiment. All participants had normal or corrected to normal vision. This study was approved by the Ethics Committee for Research Involving Human Beings of the University of the Basque Country (CEISH-UPV/EHU: M10_2023_290).

2.2 Materials

The experiment had a repeated measures design with the Event Role condition comprising three levels: Agent, Experiencer, and Patient. Ninety-six experimental items were created (see Appendix D2), each appearing in three different sentence versions corresponding to the three conditions (see Table 4.1). Sentences were distributed across three counterbalanced lists following a Latin Square design; each participant only saw one of the versions of each experimental item. Experimental sentence versions differed solely in the verb used to manipulate the Event Role. The experiment included ten practice items, ninety-six experimental sentences, and ninety-six fillers. Comprehension questions were added to thirty-three percent of the items, resulting in sixty-four items with comprehension questions: thirty-two experimental items and thirty-two fillers. Comprehension questions referred to the semantic content of different parts of the sentence, and their answers were balanced: thirty-two questions had *yes* correct answer and thirty-two had *no* correct answer.

Table 4.1: Example of the 3 conditions of an experimental item in Experiments 1 and 2.

	Event role	**Subject Region**	**Preverb Region**	**Verb Region**	**Post-verb Region**	**Last-word Region**
(a)	Agent	*La conductora*	*el jueves*	*se esforzó*	*durante el*	*examen.*
		"The driver on Thursday made an effort during the exam."				
(b)	Experiencer	*La conductora*	*el jueves*	*se sorprendió*	*durante el*	*examen.*
		"The driver on Thursday was surprised during the exam."				
(c)	Patient	*La conductora*	*el jueves*	*se desorientó*	*durante el*	*examen.*
		"The driver on Thursday became disoriented during the exam."				

Sixteen different verbs per condition were selected to create the different versions of experimental items (each verb was repeated six times to get ninety-six experimental items) (see Appendix D1). For each condition, eight verbs had the *se* morpheme and eight without *se,* with no difference in meaning, used simultaneously within items. The length (in number of letters in the conjugated form used in the experimental sentences) and the frequency of verbs (in the infinitive form due to the lack of frequency of some verbs in their conjugated form) was controlled using the SUBTLEX-ESP corpus (Cuetos et al., 2011). As in previous experiments, Bayesian one-sample models revealed no differences in either length or frequency among conditions (all posterior differences have a 95% credible interval closely around zero; see Table 4.2).

Experimental items were previously normed for naturalness. Forty-four native speakers of Spanish filled an online sentence naturalness questionnaire in PCIbex (Zehr & Schwarz, 2022), and they had to rate the naturalness of sentences on a 5-point

Table 4.2: Pairwise comparisons of length and frequency of verbs used in Experiments 3 and 4.

Δ	Length Estimate [CrI]	Frequency Estimate [CrI]
Agent – experiencer	0.22 [-0.85, 1.25]	0.04 [-0.23, 0.33]
Agent – patient	0.03 [-1.18, 1.25]	-0.03 [-0.22, 0.31]
Experiencer – patient	-0.15 [-1.38, 1.05]	-0.01 [-0.31, 0.28]

Likert scale. All conditions were rated above 3.5 (Agent: mean = 3.92, *SD* = 1.16; Experiencer: mean = 3.74, *SD* = 1.23; Patient: mean = 3.80, *SD* = 1.23). Acceptability rating differences appeared between Agent and Experiencer conditions, Agent condition being rated as more natural than Experiencer condition. No rating differences were found between Agent and Patient, or between Experiencer and Patient (see Table 4.3).

Table 4.3: Posterior distributions of the naturalness questionnaire model of Experiments 3 and 4.

Slopes	Estimate	Standard Error	CrI
Agent – experiencer	-0.03	0.01	[-0.58, -0.12]
Agent – patient	-0.02	0.01	[-0.45, 0.06]
Experiencer – patient	0.01	0.01	[-0.07, 0.37]

Additionally, to control the cloze predictability of experimental sentences as a potential confound of N400 signals (Frank et al., 2015; Michaelov et al., 2024), their surprisal values were calculated, like in Experiments 1 and 2, using a pretrained GPT-2 model from HuggingFace and a library provided by Remo Nitschke (2024). I obtained the surprisal values of each word of experimental sentences as the sentence unfolds. I compared the surprisal values of experimental sentences across the three

conditions and found no notable differences among them either in the verb region, or in the post-verb region (see Table 4.4).

Table 4.4: Posterior distributions of the surprisal value model of Experiments 3 and 4.

	Slopes	Estimate	Standard Error	CrI
Verb	Agent – experiencer	0.41	0.46	[-0.50, 1.32]
	Agent – patient	-0.16	0.46	[-1.05, 0.74]
	Experiencer – patient	-0.55	0.45	[-1.44, 0.33]
Post-verb	Agent – experiencer	0.27	0.32	[-0.36, 0.90]
	Agent – patient	0.22	0.32	[-0.85, 0.39]
	Experiencer – patient	0.49	0.32	[-1.11, 0.14]

2.3 Procedure

I used the same procedure used in Experiments 1 and 2. The only difference was that trials were presented in five blocks of 38/39 trials, with four pauses for participants to rest. The entire session lasted around 60 minutes.

2.4 Data processing and analyses

The dependent variables were the same as in Experiments 1 and 2. Experimental items were split into five regions: subject region, preverb region, verb region, post-verb region, and last-word region (see Table 4.1). The last-word region was included to avoid wrap-up effects (Warren et al., 2009).

As for previous experiments, fixations shorter than 80 ms and longer than 800 ms were removed using DataViewer software (SR Research Ltd, 2022). No participant was excluded due to accuracy criteria, since all participants showed accuracy rates over 80% in the comprehension questions.

Data analysis was conducted in R (R Core Team, 2025), using Bayesian Mixed-Effects Models with *brms* function (Bürkner, 2017). For Gaze Duration, Regression Path Duration, Re-reading Duration and Total Duration measures, I created Bayesian Mixed-Effects Models with a Shifted-lognormal likelihood. For Regression Out Count and Regression In Count variables a Poisson likelihood was used.

For the present experiment I could draw on information from previous experiments. Although the materials differ substantially across experiments, prior eye-tracking reading data provided a basis for specifying priors. Hence, I specified semi-uninformative normally distributed priors based on this information for intercepts and slopes, but reflecting plausible uncertainty, allowing the data to drive estimates (Kruschke, 2015; Nicenboim et al., 2025).

To specify the prior distributions of the parameters of models with a Shifted log-normal likelihood, I chose normal distributions for the intercept ($\mu = 5$, $\sigma = 1$ for Gaze Duration and Regression Path Duration; $\mu = 6$, $\sigma = 1$ for Re-reading Duration; and $\mu = 6$, $\sigma = 1$ for Total Durations) and for the slopes ($\mu = 0$, $\sigma = 2$ for all measures). For models with a Poisson likelihood, I opted for normal distributions for the intercept ($\mu = -1$, $\sigma = 2$ for Regression In Count; $\mu = -3$, $\sigma = 2$ for Regression Out Count) and slopes ($\mu = 0$, $\sigma = 2$) parameters due to convergence issues with the conjugate Gamma distribution.

To account for sentence predictability, I included surprisal values as a predictor in the models (Huber et al., 2024), as I did for previous experiments. This ensured that any observed effects were not solely driven by difference in the lexical predictability. I compared models using leave-one-out cross-validation (loo-cv) (McElreath, 2020; Vehtari et al., 2017), with the stacking technique for model weighting (Yao et al., 2018).

For each region and dependent variable, I fitted and compared four models: a null model without predictors, a model with only surprisal, a model with only Event Role predictor, and a model with surprisal and Event Role predictors. The stacking weights

derived from loo-cv reflect each model's relative performance, based on how well it predicts left-out observations (Vehtari et al., 2017). When the highest-weight model was the null model, as in the previous experiments, I did not report anything. Model comparisons are shown in Appendix D3.

I reported the marginal comparisons from the highest-weight model for each region and variable. These comparisons estimate the average difference in the predicted outcome between levels, averaging over the random effect structure (Arel-Bundock et al., 2024). I opted for this coding because it directly returns the contrast of the three conditions, without the need for releveling. Because marginal comparisons provide summary estimates and credible intervals rather than the full posterior distributions of the contrasts, I did not report posterior probabilities for these effects. Instead, inference is based on whether the credible intervals include or exclude zero, which provides an appropriate criterion for assessing the direction and uncertainty of the estimated contrasts.

3. Results

3.1 Surprisal results

As in the previous experiments, in this section, I briefly discuss the effect of lexical surprisal values. All these models reveal a positive surprisal effect showing that participants made higher fixation times, and more regression counts with higher surprisal values than with lower surprisal values. This effect appeared in the preverb region in Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.04$, 95% CrI = [0.01, 0.06]), in the verb region in Gaze Duration ($\hat{\beta}_{\text{Surprisal}} = 0.07$, 95% CrI = [0.04, 0.10]) ($\hat{\beta}_{\text{Surprisal}} = 15.1$, 95% CrI = [15.1, 49.1]), Regression Path Duration ($\hat{\beta}_{\text{Surprisal}} = 0.08$, 95% CrI = [0.05, 0.12]), and Total Duration ($\hat{\beta}_{\text{Surprisal}} = 0.07$, 95% CrI = [0.03, 0.10]), and in the post-verb region in Gaze Duration ($\hat{\beta}_{\text{Surprisal}} = 0.05$, 95% CrI = [0.02, 0.09]), Re-reading Duration ($\hat{\beta}_{\text{Surprisal}} = 0.08$, 95% CrI = [0.02, 0.15]), Regression In Count ($\hat{\beta}_{\text{Surprisal}} =$

0.17, 95% CrI = [0.09, 0.25]), and Total Duration ($\hat{\beta}_{\text{Surprisal}}$ = 0.09, 95% CrI = [0.07, 0.12]).

3.2 Eye-tracking measures

Table 4.5 shows predicted values of eye-tracking measures and a table with the raw data of all regions and measures is shown in Appendix D4.

Marginal comparisons revealed that agents involved longer fixation times than patients in the verb region in Gaze Duration ($\hat{\beta}_{\text{Agent-Patient}}$ = -15, CrI = [-27,14, -2.71]), Regression Path Duration ($\hat{\beta}_{\text{Agent-Patient}}$ = -22.97, CrI = [-38.3, -6.96]), Regression In Count ($\hat{\beta}_{\text{Agent-Patient}}$ = -0.0574, CrI = [-0.1068, -0.00749]), and Total Duration ($\hat{\beta}_{\text{Agent-Patient}}$ = -48.6, CrI = [-70, -27.24]). I found this same effect in the post-verb region in Regression Path Duration ($\hat{\beta}_{\text{Agent-Patient}}$ = -36.5, CrI = [-65.783, -6.7]), and Regression Out Count ($\hat{\beta}_{\text{Agent-Patient}}$ = -0.0364, CrI = [-0.0697, -0.00231]) (see Figure 4.1).

Experiencers started showing higher fixation times than patients in the post-verb region in Regression Path Duration ($\hat{\beta}_{\text{Experiencer-Patient}}$ = -70, CrI = [-102.082, -36.8]). Experiencers also displayed more regressions out than patients from the post-verb region to a previous region, as shown in Regression Out Count ($\hat{\beta}_{\text{Experiencer-Patient}}$ = -0.0578, CrI = [-0.0940, -0.02320]). In the verb region, aligning with the effects found in the post-verb region, experiencers showed more regressions to the verb region from regions to the right than patients, as shown in Regression In Count ($\hat{\beta}_{\text{Experiencer-Patient}}$ = -0.0710, CrI = [-0.1231, -0.02037]). This effect results in a less robust but similar effect in Total Duration ($\hat{\beta}_{\text{Experiencer-Patient}}$ = -16.5, CrI = [-37.4, 4.87]). Although the credible interval overlaps 0, the direction of the effect and the credible interval indicate a higher probability that experiencers elicited longer total fixation times than patients (see Figure 4.1).

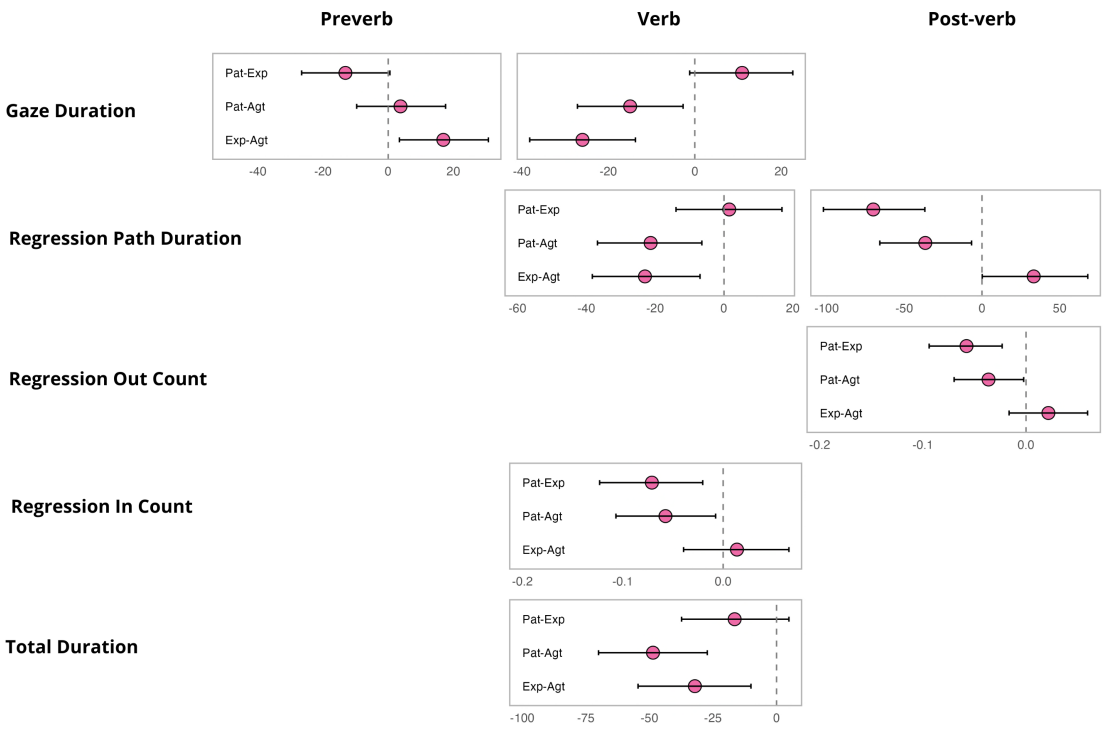

Figure 4.1: Marginal estimates of pairwise condition contrasts for eye-tracking measures across sentence regions. Each row corresponds to a different eye-tracking measure. Each column represents a sentence region. For each region and measure, estimated differences between conditions (Pat-Exp, Pat-Agt, Exp-Agt) are shown as dots, with horizontal lines indicating 95% credible intervals. The x axe is in milliseconds (ms), except for Regression In Count and Regression Out Count that is in counts.

When comparing agents and experiencers, the effect and its directions are not as clear as in the other two comparisons. In the preverb region, in Gaze Duration, experiencers showed longer fixation times than agents ($\hat{\beta}_{\text{Agent-Experiencer}}$ = 16.91, CrI = [3.42, 30.734]). In the verb region, the direction of the effect shifted revealing longer fixation times for agents compared to experiencers in Gaze Duration ($\hat{\beta}_{\text{Agent-Experiencer}}$ = -26, CrI = [-38.19, -13.73]), Regression Path Duration ($\hat{\beta}_{\text{Agent-Experiencer}}$ = -21.32, CrI = [-36.8, -6.43]), and Total Duration ($\hat{\beta}_{\text{Agent-Experiencer}}$ = -32.1, CrI = [-54.5, -10.05]).

Table 4.5: Mean predicted values and 95% Credible Intervals (CrI) for eye-tracking measures across sentence regions and conditions of Experiment 3. Values indicate that the highest-weighted models include the predictors of interest for that region and measure. Empty cells show that the highest-weighted models do not include the predictors of interest.

Eye-tracking measures	Subject Region	Pre-verb Region	Verb Region	Post-verb Region
	Mean [CrI]	Mean [CrI]	Mean [CrI]	Mean [CrI]
Gaze Duration (ms)				
Agent		361 [335, 388]	340 [289, 401]	
Experiencer		374 [342, 407]	321 [274, 377]	
Patient		364 [337, 393]	334 [286, 392]	
Regression Path Duration (ms)				
Agent			337 [318, 448]	433 [384, 488]
Experiencer			361 [304, 427]	456 [402, 517]
Patient			366 [311, 433]	400 [356, 450]
Re-reading Duration (ms)				
Agent			377 [318, 448]	
Experiencer			361 [304, 427]	
Patient			366 [311, 433]	
Regression Out Count (counts)				
Agent				0.11 [0.08, 0.15]
Experiencer				0.12 [0.08, 0.16]
Patient				0.07 [0.04, 0.10]
Regression In Count (counts)				
Agent			0.30 [0.23, 0.37]	
Experiencer			0.30 [0.23, 0.38]	
Patient			0.24 [0.17, 0.31]	
Total Duration (ms)				
Agent			491 [416, 580]	
Experiencer			469 [400, 548]	
Patient			453 [387, 533]	

In the post-verb region, in Regression Path Duration, the direction of the effect changed again showing longer fixation times for the experiencer than for the agent condition ($\hat{\beta}_{\text{Agent-Experiencer}}$ = 33.3, CrI = [0.159, 68.1]). Differences between both disappear in the verb region in Regression In Count ($\hat{\beta}_{\text{Agent-Experiencer}}$ = 0.0138, CrI = [-0.0394, 0.06551]), and in the post-verb region in Regression Out Count ($\hat{\beta}_{\text{Agent-Experiencer}}$ = -0.0216, CrI = [-0.0597, 0.01649]) (see Figure 4.1).

4. Discussion of Experiment 3

In the eye-tracking reading experiment, several measures revealed a consistent pattern: agents and experiencers involved longer fixation times and regression counts than patients, though the differences between agents and experiencers varied depending on the measure and region.

Agents involved longer fixation times and regression counts than patients. This effect began in the verb region, as reflected in the Gaze Duration measure, and continued in Regression Path Duration, across both the verb and post-verb regions. It also appeared in Regression Out Count in the post-verb region and finished with a difference in the verb region in both Regression In Count and Total Duration measures.

Experiencers also showed longer fixation times and more regression counts than patients. This difference emerged slightly later than the difference between agents and patients. It began in the post-verb region in Regression Path Duration, continued in Regression Out Count in the same region, and extended to the verb region in both Regression In Count and Total Duration, although the latter showed a weak effect.

In contrast to the previous two comparisons, the contrast between agents and experiencers did not reveal a consistent pattern of results. Experiencers initially showed longer fixation times than both agents and patients in the preverb region, as reflected in Gaze Duration. In the same measure, in the verb region, the direction of

the effect reversed, with both agents and patients displaying longer fixation times than experiencers. Agents continued involving higher fixation times than experiencers in the verb region for Regression Path Duration, but changed again in the post-verb region in Regression Path Duration, where experiencers showed longer fixation times than agents. The effect disappeared in Regression Out Count in the post-verb region, and in Regression In Count in the verb region. In Total Duration, in the verb region, the direction of the effect shifted once more, with agents showing longer fixation times than experiencers.

These eye-tracking results reveal an attentional preference toward proto-agents compared to proto-patients. Agents and experiencers, both arguments characterized by proto-agent entailments, involved higher fixation times than patients. This result aligns with the evidence found by Gómez-Vidal et al. (2022): an attentional preference to fixate agents compared to patients. Furthermore, these findings suggest that this attentional preference is stronger with prototypical proto-agents – agents with more than one proto-agent entailment – compared to less prototypical proto-agents – experiencers with only the sentience entailment. This is reflected in the delay of the higher fixation times for experiencers compared to patients.

In Experiment 4, I recorded the EEG responses elicited while different participants read the same materials as in Experiment 3. This methodology allowed to measure the transient interpretation of ambiguous arguments and their recategorization. In Experiment 3, I obtained results related to the attentional preference of event roles. By contrast, in Experiment 4, I aimed to report the N400 effect previously found in the literature associated with a recategorization toward patients (Bickel et al., 2015; Haupt et al., 2008; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023), and to see whether this recategorization also emerges toward experiencers or not.

5. Experiment 4

5.1 Participants

Thirty native speakers of Spanish participated in the EEG experiment. They were all right-handed and between 18-34 years old (8 = male, mean age = 20.43; *SD* = 2.66). This study was approved by the Ethics Committee for Research Involving Human Beings of the University of the Basque Country (CEISH-UPV/EHU: M10_2023_290).

5.2 Materials

I used the same material as in Experiment 3.

5.3 Procedure

Stimuli were presented on a PC using E-prime 3.0 (version 3.0.3.80) (W. Schneider et al., 2002). The sentences were displayed word by word at the center of the screen in Arial Bold font type, size 40. For verbs with *se* (e.g., *se despertó*), both words were shown together. Each word was presented for 450 ms, followed by a 350 ms inter-stimulus interval. A fixation cross lasting 1000 ms indicated the beginning of each sentence trial. As in the eye-tracking experiment, participants saw comprehension questions after thirty-three percent of the sentences. They pressed 1 on the keyboard to respond *yes*, and 2 to respond *no*.

All 192 sentences were randomly distributed in 5 blocks. Prior to the sentence comprehension task, participants received instructions about the EEG procedure. The experimental session was preceded by ten practice items. EEG resting-state activity was recorded both before and after the sentence comprehension task to extract individual peak alpha frequencies for specifying individual frequency bands. The

entire experiment lasted about 120 minutes, including electrode-cap application and removal.

Electrophysiological activity was recorded using 32 active electrodes secured in an elastic cap (Acticap System, Brain Products), positioned according to the extended international 10-20 system. All recording were referenced online to the right mastoid electrode and re-referenced off-line to the linked mastoids. Vertical and horizontal eye movements and blinks were monitored using two electrodes placed below and to the right of the right eye. Electrode impedances were kept below 5 Ω. The electrical signals were digitalized online at a sampling rate of 500 Hz using a Brain Vision amplifier system.

5.4 Data processing and analyses

EEG data were preprocessed using EEGLAB (Delorme & Makeig, 2004), FieldTrip (Oostenveld et al., 2011) and R (R Core Team, 2025). Continuous EEG signals were band-pass filtered between 0.1 and 30 Hz, down-sampled to 250 Hz, and re-referenced offline to the average of the left and right mastoids. Artifactual channels were automatically excluded if their kurtosis or probability deviated by more than five standard deviations from the mean of all channels. Independent components were computed on a 1 Hz high-pass filtered copy of the data.

Artifactual independent components were identified using the SASICA algorithm (Semi-Automated Selection of Independent Components of the electroencephalogram for Artifact correction) (Chaumon et al., 2015; Nolan et al., 2010) and excluded if they were spatially limited to single electrodes or showed high correlation with the activity of EOG electrodes. Previously rejected channels were spherically interpolated after removal of the artifactual components from the EEG data.

For the ERP analyses, EEG data were epoched from -200 to 900 ms relative to the critical word (the verb). For event-related power analyses, epochs ranged from -1500

to 1200 ms relative to the critical word. In both analyses, epoch-level artifact detection and trial-wise interpolation were performed to clean the data of temporary artifacts, using the Trial-By-Trial (TBT) interpolation method. For time-frequency analysis, single-trial data were transformed into time-frequency representations in 0.5 Hz steps using wavelet decomposition via the multi-taper method convolution with Hanning-tapered time-windows. Each window had a length of 3 cycles and advanced in steps of 50 ms. Power spectra were transformed into decibel (dB) values relative to the median power in a baseline period between -800 and -500 ms before the critical word, allowing for direct comparison across frequencies (Cohen, 2014). To reduce data dimensionality, power was then averaged within predefined frequency bands.

Frequency bands were defined for each participant (Klimesch, 1999) according to their individual peak alpha frequency (IAF), following the method proposed by Corcoran et al. (2018), which estimates IAFs from resting-state EEG data. The theta band was set from IAF-6 Hz to IAF-4 Hz, alpha band from IAF-4 Hz to IAF+2 Hz (Klimesch, 1999), and the lower beta band from IAF+2 Hz to IAF+10 Hz (Bice et al., 2020).

Statistical analyses were conducted in R using the packages *brms* (Bürkner, 2017) and *mgcv* (Wood, 2004, 2011) for modelling, and the *ggplot2* (Wickham et al., 2007) and *itsadug* packages (van Rij et al., 2020) for plotting. I analyzed the topographies of event-related potentials and event-related power changes using single-trial Generalized Additive Mixed Models (GAMMs). These models extend generalized linear models by enabling the modelling of non-linear relations between variables. In analyses, GAMMs were used to model amplitude or power differences between experimental conditions as a function of electrode position on the scalp, represented by x and y coordinates. For event-related potentials, I used Bayesian GAMMs. However, for event-related power changes, I employed Frequentist GAMMs, as the Bayesian models faced exceedingly high computing times due to the large data volume.

For ERP analyses, the mean amplitude was modelled within a 300-500 ms time-window after the critical word onset. An additional analysis was conducted for a later window, 600-800 ms after the critical word. These time-windows were selected based on prior literature (Aurnhammer et al., 2021; Bornkessel et al., 2003; Frenzel et al., 2015; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023) and supported by a supplementary time-course analysis (see Appendix D5). The statistical modelling approach was identical for both time-windows. The amplitude during a baseline period (averaged from -100 to 0 ms before critical word; Alday, 2019) was included as a parametric predictor. To account for potential non-linear relations between variables, a smooth term was added to model amplitude differences between conditions across the x and y scalp coordinates. Random slopes for electrode coordinates were included by participant and by item.

The statistical modelling for time-frequency analyses (TFA) closely mirrored that used for the ERPs, with two differences: the response variable was power deviations from the baselines in decibels per trial. Models were fitted separately for each frequency band. The time-windows analyzed were the same as in the ERP analyses: 300-500 ms post-critical word onset for the early window, and 600-800 ms for the late time-window.

As in the previous experiments, I compared Bayesian models using leave-one-out cross-validation (McElreath, 2020; Vehtari et al., 2017), applying the stacking technique for model weighting (Yao et al., 2018). Each model comparison involved four versions: a null model without predictors, a model including only the Event Role predictor, a model including only the predictor of lexical surprisal values, and a model including both Event Role and surprisal value predictors. For Frequentist models, I used the Akaike information criterion (AIC) for model comparison (Akaike, 1974). See Appendix D6 for both ERP and TFA model comparisons.

For both ERP and event-related power models, statistical significance was assessed by inspecting non-overlapping confidence intervals in the (smooth) difference

surfaces. Because GAMMs model non-linear effects that cannot be captured by a single summary statistic, I followed standard procedure (Wood, 2004) and report effect sizes graphically, as model-fitted response values. Effects are reported in terms of 95% intervals (credible intervals in Bayesian models, confidence intervals in Frequentist models) around the fitted differences between critical conditions (i.e. $\Delta\mu V$ and ΔdB) visualized across the spatially smoothed electrode array.

6. Results

Figure 4.2 presents the time course of ERPs time-locked to the verb position for all electrodes; Figure 4.3 displays ERP pairwise comparisons of experimental conditions; Figures 4,4, 4.5 and 4.6 show power pairwise comparisons of experimental conditions.

In ERPs, in the 300-500 ms time-window, patients elicited a larger negativity over posterior electrodes compared to agents (Figure 4.3A, B, C) and experiencers (Figure 4.3F, G, H). Agents elicited a frontal negativity compared to experiencers (Figure 4.3K, L, M). In the 600-800 ms time-window, results did not indicate a distinct ERP component; rather, they reflected a sustained activity from the N400 time-window. I found that patients elicited a widespread negativity compared to both agents (Figure 4.3A, D, E) and experiencers (Figure 4.3F, I, J). No difference appeared when comparing agents and experiencers in this time-window (Figure 4.3O).

In the theta band, in the early time window, patients showed a power increase compared to agents over central electrodes (Figure 4.4B) and compared to experiencers over central and frontal electrodes (Figure 4.4C). Agents also revealed a power increase over left-frontal and right-frontal electrodes compared to experiencers (Figure 4.4A). By contrast, experiencers elicited a power increase over posterior electrodes compared to both agents and patients (Figures 4.4A, C). Agents also showed this power increase compared to patients but revealing a smaller increase only

over right-posterior sites. In the late time-window, patients revealed a highly widespread power increase compared to agents (Figure 4.4E) and experiencers (Figure 4.4F). The differences found in the early time-window between agents and experiencers were reduced, showing agents a power increase over central electrodes and experiencers a reduced power increase over posterior sites (Figure 4.4D).

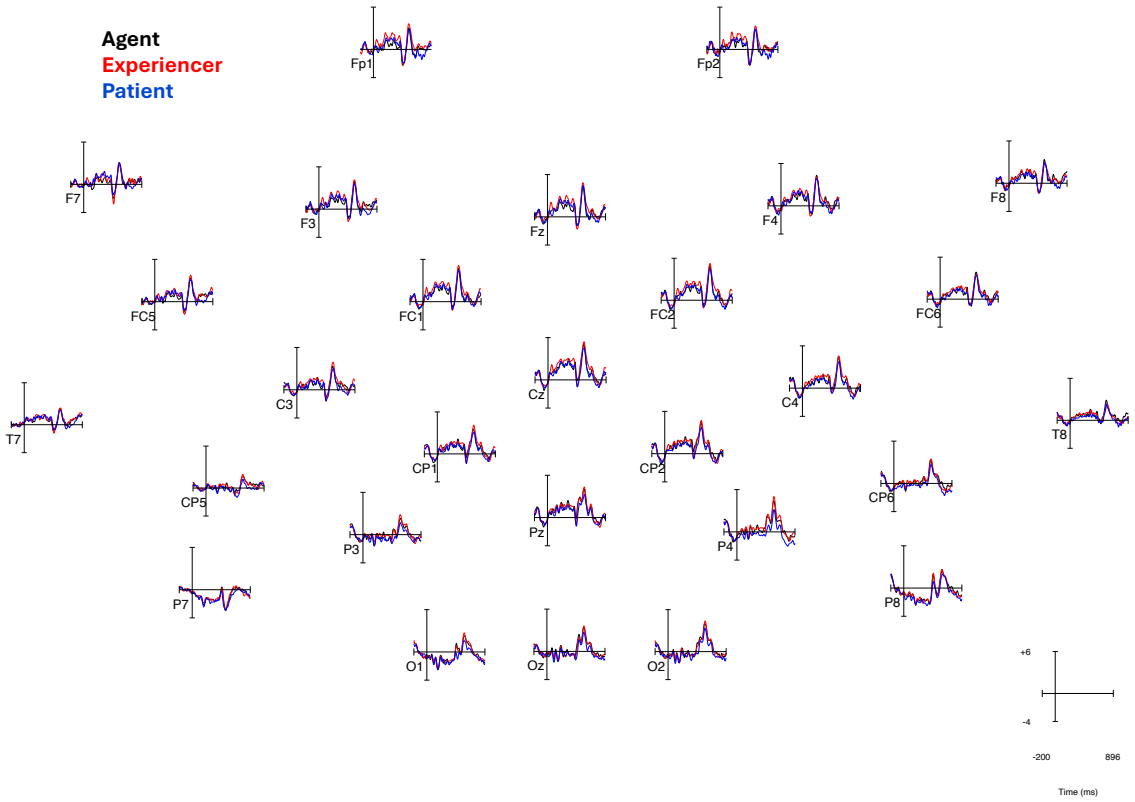

Figure 4.2: Grand average event-related potentials at the verb region.

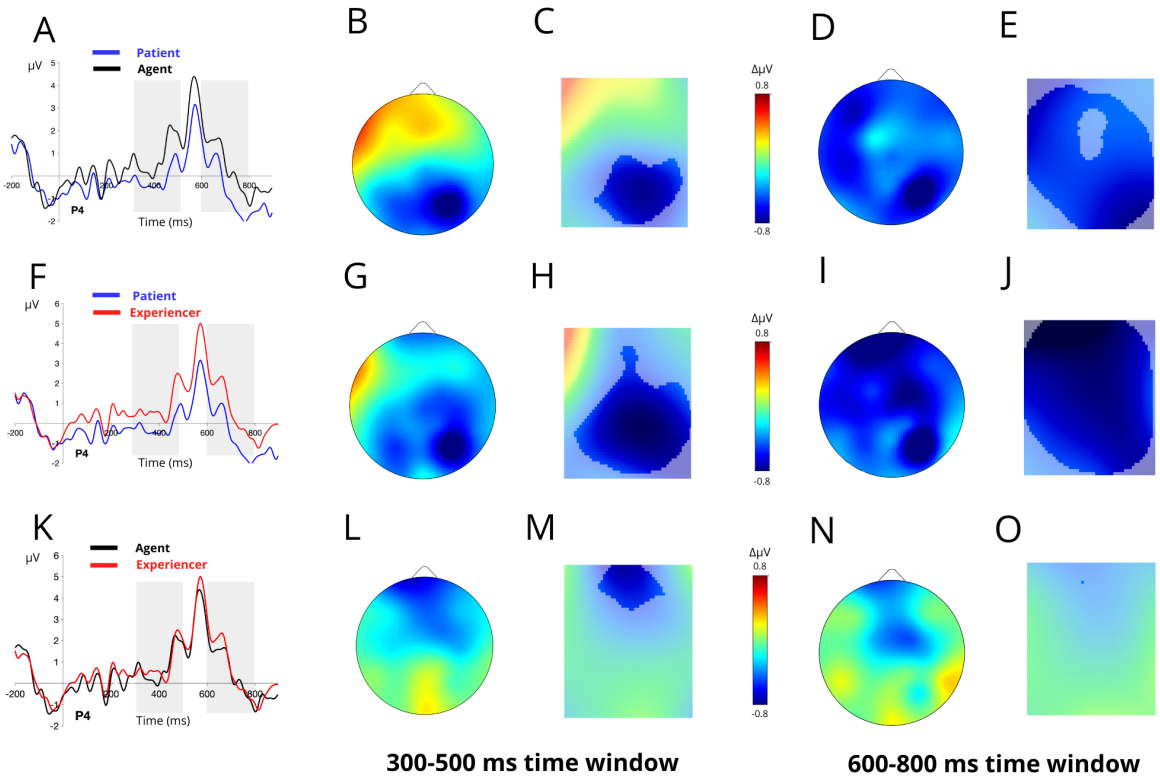

Figure 4.3: Pairwise comparisons of ERP differences between conditions at the verb region. The first row (A, B, C, D, E) shows the contrast between Patient and Agent conditions (ΔμV = μV(Patient) – μV(Agent)). The second row (F, G, H, I, J) compares Patient and Experiencer conditions (ΔμV = μV(Patient) – μV(Experiencer)). The third row (K, L, M, N, O) shows the comparison between Agent and Experiencer conditions (ΔμV = μV(Agent) – μV(Experiencer)). Within each row, left figures (A, F, K) display grand mean ERP time courses at the P4 electrode. Columns B, G, L show the topographical distribution of the grand mean differences between conditions across the scalp for the 300-500 ms time-window and columns D, I, N for the 600-800 ms time-window. Columns C, H, M display GAMM-derived surface maps of condition differences from the highest-weighted model during the 300-500 ms time-window and columns E, J, O during the 600-800 ms time-window. In the GAMM plots, bright areas indicate differences whose 95% credible interval excludes zero.

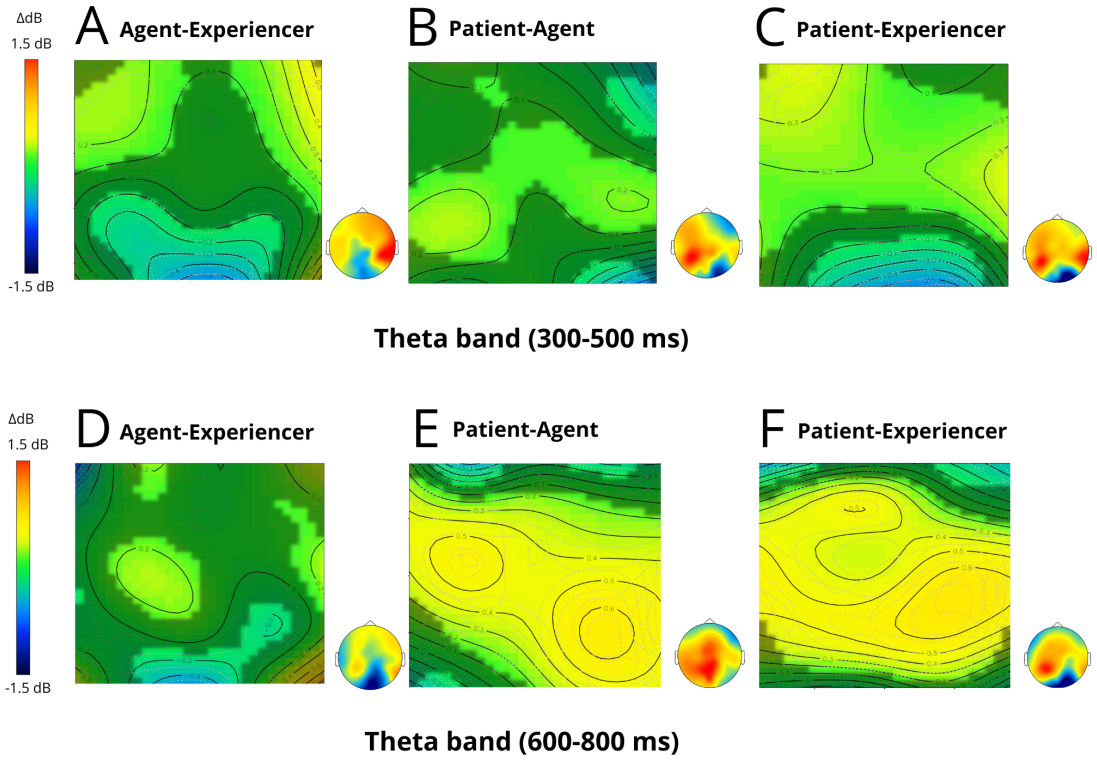

Figure 4.4: Comparison of power differences in individually defined theta band in the 300-500 ms time-window (A, B, C) and in the 600-800 ms time-window (D, E, F) after critical word presentation. Non-shaded (bright) areas indicate significant differences. Adjacent small scalp plots show the grand-average at the time-frequency point of maximal difference between conditions within each band and time-window.

In the alpha band, in the early time-window, patients elicited a power decrease compared to both agents and experiencers over right posterior electrodes (Figure 4.5B, C). By contrast, experiencers elicited both power decrease and increase over central and frontal electrodes compared to both agents and patients (Figures 4.5A, C). In the late time-window, experiencers elicited a similar pattern than the one found in the early time-window compared to agents and patients: experiencers elicited a power decrease over frontal and left-posterior electrodes, and a power increase over frontal, central and right-posterior electrodes compared to both agents and patients (Figures 4.5D, F). The differences found in the early time-window between agents and patients

vanished, revealing only a power decrease of patients over right-frontal electrodes (Figure 4.5E).

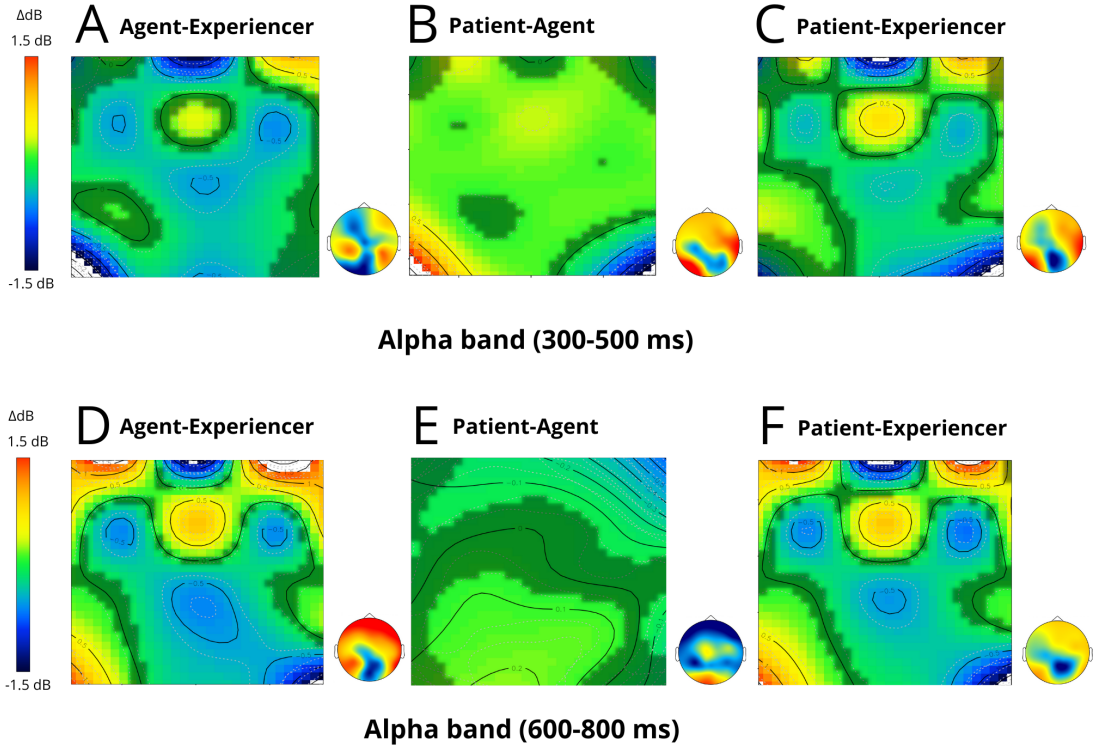

Figure 4.5: Comparison of power differences in individually defined alpha band in the 300-500 ms time-window (A, B, C) and in the 600-800 ms time-window (D, E, F) after critical word presentation. Non-shaded (bright) areas indicate significant differences. Adjacent small scalp plots show the grand-average at the time-frequency point of maximal difference between conditions within each band and time-window.

In the low beta band, there was a power decrease for patients compared to agents (Figure 4.6B) and experiencers (Figure 4.6C) over frontal and central electrodes, and a power increase over frontal, right, and left-posterior electrodes compared to agents (Figure 4.6B) and over frontal and right electrodes compared to experiencers (Figure 4.6C). Experiencers showed a power decrease over right-posterior sites and a power increase over left electrodes compared to agents (Figure 4.6A). In the late time-

window, patients elicited a power decrease over frontal electrodes compared to agents (Figure 4.6E), and over left-frontal electrodes compared to experiencers (Figure 4.6F). Experiencers elicited a power decrease over frontal and posterior electrodes compared to agents (Figure 4.6D).

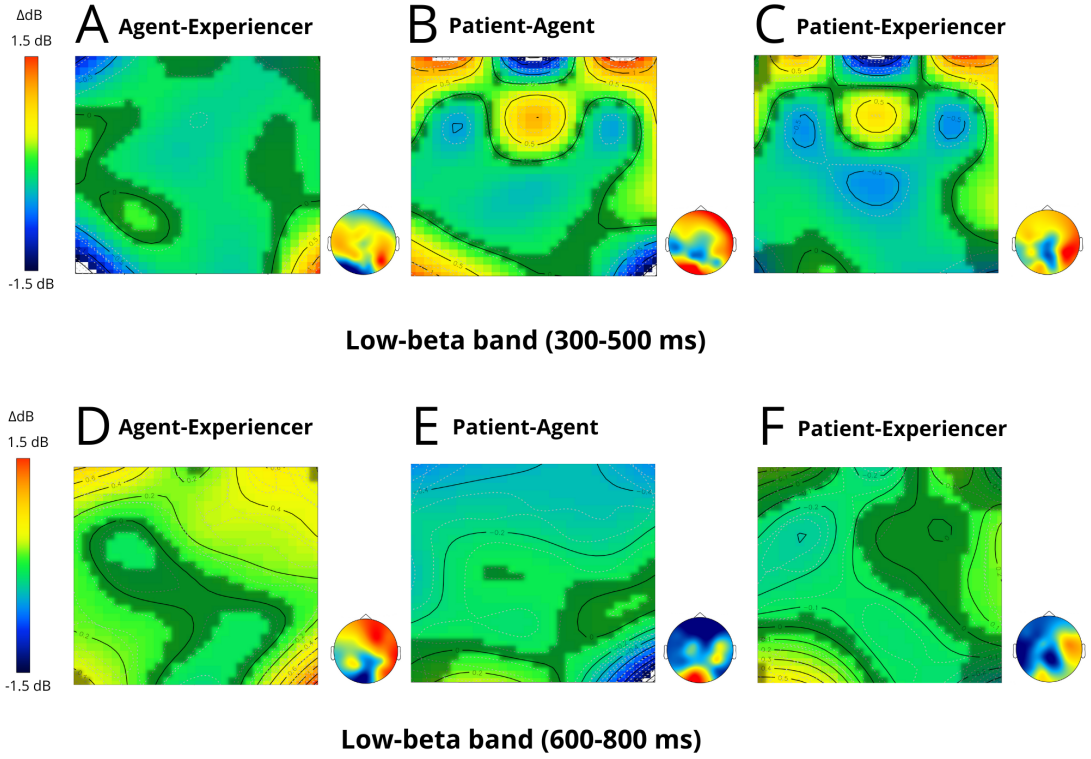

Figure 4.6: Comparison of power differences in individually defined low-beta band in the 300-500 ms time-window (A, B, C) and in the 600-800 ms time-window (D, E, F) after critical word presentation. Non-shaded (bright) areas indicate significant differences. Adjacent small scalp plots show the grand-average at the time-frequency point of maximal difference between conditions within each band and time-window.

7. Discussion of Experiment 4

In this section, I begin by discussing the ERP results, then the TFA results, and finally, I briefly interpret the main pattern of results. In the early time-window (300-500 ms), I found that patients elicited a larger negativity compared to both agents and experiencers over posterior electrodes. In previous studies, this N400 component has been associated with a recategorization of the event role category (Bickel et al., 2015; Haupt et al., 2008; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023): since the first argument was transiently interpreted as an agent, when the verb assigns the patient role, the argument needs to be recategorized as a patient. In this work, I replicated the previous N400 effect found between agents and patients, and interestingly, I found the same effect between experiencers and patients. I also found a sustained negativity elicited by patients compared to both agents and experiencers in the 600-800 ms time-window. This negativity was previously reported in event role processing studies (Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023), and in other studies of sentence processing (J. M. Schneider & Maguire, 2018; Wang et al., 2012), revealing that N400 effects are not necessarily restricted to the 300-500 ms time-window. These findings align with the proto-role approach (Dowty, 1991), suggesting that both agents and experiencers are grouped into the proto-agent category.

Effects in the time-frequency analysis also support this finding: agents exhibiting similar patterns than experiencers and both different from patients. I found a similar pattern in the TFA results to that observed in the ERP results in theta band during the late time-window: patients elicited a power increase compared to agents and experiencers. In alpha band, in the early time-window, I observed that patients elicited a power decrease over right-posterior electrodes compared to both agents and experiencers, replicating the results found by Isasi-Isasmendi et al. (2023) for the agent vs. patient ambiguous comparison and extending the finding to experiencers. In low beta band, patients revealed a power decrease over central and right-posterior

electrodes and a power increase over frontal sites compared to agents and experiencers, in the early time-window. In the next section I discuss in detail the observed patterns of both Experiments 3 and 4.

8. Discussion of Experiments 3 and 4

In an eye-tracking reading task and in an EEG reading task, I investigated the processing correlates of experiencers in intransitive sentences in Spanish. I included three conditions: agent, experiencer, and patient subjects. I asked whether experiencers reveal specific processing correlates as agents and patients do, or whether they show similar processing correlates to agents. In the eye-tracking reading experiment, I found that both agents and experiencers display larger fixation times in the verb and post-verb regions and more regression counts to the verb than patients. In the EEG experiment, results showed that patients elicited a larger N400 component compared to both agents and experiencers. Furthermore, I observed an increase in theta band and a decrease in alpha and low beta bands compared to both agents and experiencers.

Although larger fixation times and higher regression counts have typically been associated with higher processing costs in eye-tracking (Conklin et al., 2018), more fixations have also been related to an attentional preference toward an stimulus (Cohn & Paczynski, 2013; Galazka & Nyström, 2016; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023). In Experiment 3, findings support the latter interpretation: agents and experiencers elicited longer fixation times than patients in the verb and post-verb region, and more regressions to the verb. These results are consistent with previous evidence that intransitive verbs with agents led to longer reaction times than those with patients in acceptability tasks (Martinez De La Hidalga et al., 2019), and to longer regression counts in eye-tracking reading tasks (Zeyrek & Acarturk, 2014). Furthermore, they align with prior evidence showing an attentional

preference toward agents, both in language processing (Gómez-Vidal et al., 2022) and in event processing (Cohn & Paczynski, 2013; Isasi-Isasmendi, Andrews, et al., 2023).

A detailed examination of eye-movement patterns revealed that experiencers involved longer fixation times than agents and patients in the preverbal region in Gaze Duration measure. In contrast, in the verb region, experiencers showed shorter fixation times than agents and patients, in the same measure. Since Gaze Duration is associated with early word recognition and lexical access processes (Conklin et al., 2018), this pattern suggests that the processing of prototypical event roles (i.e., agents and patients) differs from that of less prototypical event roles (i.e., experiencers). Experiencers initially involved longer fixation times than agents, and they quickly elicited shorter fixation times than both agents and patients. The fact that this effect appears first in the preverbal region suggests a parafoveal effect, as participants had not seen yet the verb region (Schotter & Dillon, 2025). This initial relation between agents and patients in comparison to experiencers may be related to the prototypicality of the arguments. Agents and patients are the two prototypical event roles, whereas experiencers are less prototypical (Dowty, 1991; Levin & Rappaport Hovav, 2005; Li, 2020; Van Valin, 2004). Based on the proto-role approach (Dowty, 1991), experiencer-arguments only have the proto-agent entailment of sentience, hence they are less prototypical agents than those arguments with all proto-agent entailments (Dowty, 1991).

The next measure, Regression Path Duration, is an intermediate measure, between lexical access and integration processes, which displays the time participants have been looking at a specific region before looking at the next one to the right (Conklin et al., 2018). I found that agents involved larger fixation times than patients and experiencers in the verb region. However, in the postverbal region, this pattern shifted and now both agents and experiencers showed longer fixation times than patients. The delayed increase for experiencers may reflect a later categorization as proto-agents,

due to their unique proto-agent entailment, the one of sentience (Dowty, 1991). This later activation of experiencers converges with Gómez-Vidal's (2024) Visual World Paradigm results. In her PhD thesis, she statistically compared her data from different experiments getting a comparison of agent, experiencer, and patient subjects. She found that experiencers and agents in intransitive sentences elicited equivalent proportion of fixations, and both larger than patients. However, regarding the time course of the proportion of fixations to pictures semantically related to the subject (as compared to unrelated ones), both agents and patients involved first an increase of fixations, followed by a decrease, and ending with an increase, whereas experiencers displayed first a decrease, next an increase, and finally a decrease. These results align with eye-tracking reading results of Experiment 3 showing that experiencers behave like agents but involve an activation delay.

In Regression In Count, Regression Out Count, and Total Duration measures, all late measures linked to integration processes (Conklin et al., 2018), agents and experiencers displayed larger regression counts and fixation times than patients. Altogether, these results suggest that both agents and experiencers received greater attentional focus, evidenced by longer fixation durations and regression counts than patients, with experiencers showing a delayed attentional effect consistent with their non-prototypical status as proto-agents.

In the EEG reading task, patients elicited a larger ERP negativity over posterior electrodes compared to both agents and experiencers starting in the early time-window and remaining in the late time-window. This finding replicates previous research (Bickel et al., 2015; Haupt et al., 2008; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023) and broadens it to experiencers. A larger negativity in the early time-window has been associated with a reanalysis of the event role, and it has been shown to be extended into the late time-window (Isasi-Isasmendi, Sauppe, et al., 2023; Reid & Striano, 2008; Sauppe et al., 2023; J. M. Schneider & Maguire, 2018; Wang et al., 2012), as also shown here. According to the Agent Preference Hypothesis, the initial

ambiguously case-marked (or, in this case, unmarked) argument is temporarily interpreted as an agent. When a verb requires a patient instead, a recategorization emerges, reflected in an N400 component. The interesting aspect of this result is that patients elicited this larger negativity compared to both agents and experiencers. This provides evidence that agents and experiencers are processed similarly in the integration of event roles into the syntactic structure. Moreover, this finding aligns with the Proto-Role Hypothesis, which holds that both agents and experiencers are arguments with proto-agent entailments, and are thus grouped within the proto-agent role category, avoiding the need for reanalysis.

In ERPs, I also found that experiencers elicited a frontal positivity compared to agents over frontal electrodes only in the early time-window. Since experiencers did not elicit the posterior negativity associated with event role recategorization, this frontal positivity may correspond to another processing mechanism, probably due to the lower prototypicality of experiencers compared to agents (Dowty, 1991; Levin & Rappaport Hovav, 2005; Li, 2020; Van Valin, 2004), since this specific pattern only appears between these two conditions and only in the early time-window.

Furthermore, in the time-frequency analysis, in the theta band, I found that patients elicited a power increase as compared to both agents and experiencers in central electrodes in the early time-window. This increase was stronger and highly widespread in the late time-window. An increase in theta band appears with unexpected words and with semantic processing demands (Klimesch, 1999; Mellem et al., 2013; Rommers et al., 2017; Weiss et al., 2000). This result in the theta band can be linked to a reanalysis when encountering a verb selecting a patient role, as the same pattern is found when comparing patients with both agents and experiencers. The processing of a verb selecting a patient elicited a power increase compared to those selecting agent or experiencer, since this event role does not match with the expectation to be an argument with proto-agent entailments.

In alpha band, in the early time-window, patients showed a power decrease over right-posterior electrodes in comparison to agents and experiencers. Additionally, agents and patients elicited a power decrease over more central sites in comparison to experiencers. This effect was more pronounced in the late time-window than in the early time-window. Alpha band has been related to inhibition (Klimesch, 2012; Meyer, 2018), and a power decrease in this band with a release from inhibiting alternative and competing interpretations (Isasi-Isasmendi, Sauppe, et al., 2023). According to my results, two types of inhibition could be reflected in the power decrease of alpha band. On the one hand, the elicitation of a power decrease of the patient would be related to the reanalysis previously mentioned. Isasi-Isasmendi et al. (2023) particularly found the same power decrease elicited by ambiguous patients compared to ambiguous agents in Basque. They related this result with a release of inhibiting the patient category. On the other hand, the power increase showed by experiencers would align with an inhibition of a prototypical representation of event roles, agents and patients (Dowty, 1991; Levin & Rappaport Hovav, 2005; Li, 2020; Van Valin, 2004). Since no previous studies have investigated the power elicitation associated with experiencers, the explanation I offer for this former unexpected pattern should be considered tentative.

In low beta band, in the early time-window, I found that patients elicited a power decrease compared to agents and experiencers over central electrodes. This pattern did not appear when comparing agents and experiencers. A power decrease in this frequency band has been linked to a change in the current cognitive set to upcoming words that does not match the predicted word, or to semantic violations (Isasi-Isasmendi, Sauppe, et al., 2023; Lewis & Bastiaansen, 2015; Meyer, 2018). Moreover, beta oscillations relate to the N400 component during language processing (Wang et al., 2012). The findings in this band replicate the same power decrease, in the same time-window, found in Isasi-Isasmendi et al. (2023), which they associated with a recategorization of the event role category. This power decrease suggests that the

processing of patients involves a change in the current active set compared to both agents and experiencers, as it does not fit within the category of proto-agent.

All in all, these results provide further evidence of the Agent Preference Hypothesis. During sentence processing, the first argument is interpreted as an agent, which involves a recategorization toward a patient when the verb does not select an agent role. I replicated the previously found N400 effect associated with this event role recategorization (Bickel et al., 2015; Haupt et al., 2008; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023). Interestingly, I found the same effect when comparing both agents vs. patients, and experiencers vs. patients.

The processing of agents and experiencers differs in some eye-tracking measures and in alpha band, which suggests that these differences may be linked to the prototypicality of the event roles. Even if both argument types have proto-agent entailments, experiencers are less prototypical as they only have the proto-agent entailment of sentience (Dowty, 1991). These differences in prototypicality are reflected in different processing correlates.

This evidence is consistent with the proto-role approach (Dowty, 1991) and with findings of Experiments 1 and 2. In the syntax-semantics interface, two broad categories of proto-roles are needed, proto-agent and proto-patient. Arguments with proto-agent entailments fit within the proto-agent role; hence, both agents and experiencers are categorized as proto-agents in the interaction with syntax. This evidence broadens the Agent Preference Hypothesis to less prototypical proto-agents, those with the proto-agent entailment of sentience: experiencers.

9. Interim conclusion

Findings from Experiment 3 showed that agents and experiencers elicited an attentional preference compared to patients. In Experiment 4, patients elicited a recategorization of the event role category driven by the agent preference, whereas no

such recategorization appeared when comparing agents and experiencers. This pattern aligns with the well-establish N400 effect associated with event role recategorization. Overall, the results from both experiments converge with the hypothesis that agents and experiencers are grouped under the category of proto-agent as both argument types have proto-agent entailments (Dowty, 1991). Furthermore, these findings converge with the competition effect observed in the previous two experiments. In Chapter 5, I discuss the findings of Experiments 1, 2, 3, and 4, and suggest future research directions on event role processing.

Chapter 5

General conclusions

The present dissertation investigated the processing of experiencers in Spanish, in both transitive and intransitive structures. The overall goal was to examine whether the experiencer role exhibits specific processing correlates, in order to determine whether this role constitutes a distinct role category within the event role repertoire (Belletti & Rizzi, 1988; Fillmore, 1971), or is better characterized as a proto-agent due to its sentience entailment (Dowty, 1991). After conducting four reading tasks recorded with either eye-tracking or EEG, the general pattern of results reveals that experiencers exhibit more closely related processing correlates with agents, than with patients. This evidence aligns with the Proto-Role Hypothesis (Dowty, 1991) which states that experiencers are arguments with the proto-agent entailment of sentience, rather than a specific role category. In summary, the main contributions of this dissertation are the following:

1. I provided novel evidence that *frighten*-type verbs involve higher processing costs than both *fear*-type and agent-patient verbs, all in transitive constructions. This evidence converges with the hypothesis that *frighten*-type verbs select two arguments with proto-agent entailments, which leads to a competition for subject assignment. In contrast, *fear*-type and agent-patient verbs only select one argument with proto-agent entailments – the subject – which aligns with the absence of processing differences between these two verb types.

2. I showed that *fear*-type verbs do not exhibit distinct processing correlates than perceptual verbs. This result converges with the Non-Psychological Verb Hypothesis, which states that *fear*-type verbs select distinct argument structure than *frighten*-type verbs. I found that *fear*-type verbs behave similarly to perceptual verbs – with whom share the same argument structure – but differently from *frighten*-type verbs.
3. I failed to find evidence of a modulation in the processing of *frighten*-type verbs due to the number of entailments of the subject. This result is not compatible with the predictions I made based on the similarity-based interference effect. By contrast, I found that *frighten*-type verbs involve higher processing costs than agent-patient verbs, independently of the number of entailments of the subject. This evidence suggests that causation entailment may be more salient than other proto-agent entailments, or that once an argument is activated as a proto-agent, competition emerges, independently of the number of entailments the argument has.
4. I provided evidence that agent and experiencer subjects of intransitive structures involve higher fixation times and regression counts compared to patient subjects in late eye-tracking measures. This result reflects an attentional preference to fixate subjects with proto-agent entailments instead of subjects without them.
5. I showed for the first time an N400 component when processing patient subjects compared to experiencer subjects in intransitive structures. I also replicated the same effect when comparing patient with agent subjects, which constitutes a well-established result in the psycholinguistic literature. This result converges with the theta power increase and the alpha and low-beta power decrease elicited by patients compared to both agents and experiencers. These findings align with the Agent Preference Hypothesis, revealing that participants processed the first ambiguous argument as an

agent. Importantly, the novel finding broadens the previous hypothesis to experiencer arguments, showing that agents and experiencers are processed similarly in comparison to patients.

6. I showed that experiencers displayed different fixation times than both agents and patients in early eye-tracking measures, and a power increase in alpha band compared to both agents and patients. These results suggest that experiencers are less prototypical than agents and patients, which aligns with the Proto-Role Hypothesis that experiencers are proto-agents characterized exclusively by the proto-agent entailment of sentience.

In the next section, I provide a detailed discussion of these findings by summarizing each experimental chapter.

1. Main findings

In Chapter 2, I explored two key hypotheses for the development of this dissertation: the Psychological Verb Hypothesis (Belletti & Rizzi, 1988) and the Proto-Role Hypothesis (Dowty, 1991). As I explained in Chapter 1, I introduced these hypothesis labels to reflect the theoretical frameworks from which these hypotheses originate and to facilitate references across the dissertation. I asked whether (i) psychological verbs elicit processing specificities, and (ii) whether the experiencer role exhibits specific processing correlates.

Regarding the first research question, the Psychological Verb Hypothesis states that both *fear*-type and *frighten*-type verbs belong to the category of psychological verbs, as they select the same event participants (experiencer, theme). Soon after the proposal of this hypothesis, an alternative hypothesis for these verbs appeared, the Non-Psychological Verb Hypothesis (Grimshaw, 1990; Dowty, 1991; Parodi-Lewin, 1991; Zaenen, 1993; Pesetsky, 1995; Arad, 1998; Pylkkanen, 1999; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller, 2013; Fábregas & Marín, 2015, *inter*

alia). This second hypothesis claims that these two verb types differ in the selection of event participants: *fear*-type verbs select experiencer-theme, whereas *frighten*-type verbs agent/cause-experiencer. This distinction is because *frighten*-type verbs denote causation, while *fear*-type verbs do not.

To test the two hypotheses regarding the specificity of the psychological verb category, I compared the processing of *fear*-type verbs with both *frighten*-type and perceptual verbs. Based on the Psychological Verb Hypothesis, I predicted processing differences between *fear*-type and perceptual verbs, but no differences between *fear*-type and *frighten*-type verbs, since both belong to the same verb category. Based on the Non-Psychological Verb Hypothesis, conversely, I predicted processing differences between *fear*-type and *frighten*-type verbs, but no differences between *fear*-type and perceptual verbs, as they both select the same event participants. Eye-tracking reading data of Experiment 1 converge with the predictions of the Non-Psychological Verb Hypothesis showing that *frighten*-type verbs involve higher Regression Path Duration times than *fear*-type verbs in the object region of the sentences. Furthermore, no differences appeared between *fear*-type and perceptual verbs in any region or measure. These results provide evidence that *fear*-type and *frighten*-type verbs exhibit distinct processing correlates which aligns with the selection of different argument structures, as proposed by the Non-Psychological Verb Hypothesis.

Regarding the second research question, the Proto-Role Hypothesis (Dowty, 1991) posits that there is no category of experiencer role, but arguments traditionally named as *experiencers* are included in the proto-agent category, as they are characterized by the proto-agent entailment of sentience. The proto-role approach claims that *frighten*-type verbs select two arguments with proto-agent entailments, which should involve a competition for subject assignment, since both arguments are possible candidates for subjecthood (i.e., agents and experiencers). This competition should not appear in *fear*-type verbs or in agent-patient verbs because they only select one argument with

proto-agent entailments. Eye-tracking data showed that *frighten*-type verbs display higher fixation times than both *fear*-type and agent-patient verbs, with no difference between the last two verb types. These findings support the competition effect and the Proto-Role Hypothesis.

In Chapter 3, I further investigated the processing of *frighten*-type verbs by modulating the number of entailments of their subjects. In Experiment 1, subjects of these verbs had all three proto-agent entailments (causation, volition, and sentience). In Experiment 2, I asked whether the number of proto-agent entailments of the subject of these verbs modulates their processing. To this aim, I conserved previous subjects with three proto-agent entailments and added subjects with only one proto-agent entailment – causation. I also included this modulation in the control condition with agent-patient verbs. I based my predictions on the similarity-based interference effect (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006), which posits that the more matching features an argument has, the higher is its activation, and the faster its retrieval. In the case of *frighten*-type verbs, I predicted that subjects with three proto-agent entailments would facilitate processing in comparison to subjects with only one proto-agent entailment. This is because, in the first case, the subject clearly has more proto-agent entailments than the other argument, which should facilitate subject assignment. I replicated the higher fixation times of *frighten*-type verbs compared to agent-patient verbs found in Experiment 1, but results revealed no modulation due to the number of proto-agent entailments of subjects, in either *frighten*-type verbs or agent-patient verbs. I consider that this lack of modulation may be due to two possibilities: (i) due to the prominence of the causation entailment among the proto-agent entailments, or (ii) because competition emerges categorically once a threshold of overlap is crossed. This means that proto-role assignment may rely on the type of proto-agent entailments, and not in the number.

In Chapter 4, I again asked whether the experiencer role exhibits specific processing correlates. However, in this case, instead of comparing the processing of transitive structures with experiencer role, I used intransitive verbs selecting it, as it allowed a direct comparison among agents, experiencers and patients. In two separate sentence reading experiments, I compared the eye-tracking and EEG processing correlates of agent, experiencer, and patient subjects. Based on the Agent Preference Hypothesis (Bornkessel-Schlesewsky & Schlesewsky, 2009; Frenzel et al., 2015; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023; Vela-Plo et al., 2022, *inter alia*), I expected to replicate the N400 component found in previous psycholinguistic literature when encountering temporarily ambiguous patients in comparison to agents in the subject position (Bickel et al., 2015; Haupt et al., 2008; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023). This effect has been interpreted as a preference to interpret the first argument as an agent; therefore, when the subject results to be a patient instead of an agent, a recategorization of the event role category emerges, reflected in an elicitation of an N400. Regarding the processing of the experiencer role, I expected, based on the previous experiments of this dissertation, to exhibit similar processing correlates to agents and different from patients. Eye-tracking data revealed that agents and experiencers elicited longer fixation times and regression counts than patients, in both the verb and post-verb regions. EEG data showed that processing patients elicited an N400 component compared to both agents and experiencers. Furthermore, patients displayed a power increase in the theta band compared to both agents and experiencers, and a power decrease in the alpha and low-beta bands. These findings align with the Agent Preference Hypothesis and broaden it to experiencer arguments, since the recategorization of event role only appears when processing patient subjects.

2. Can other event role approaches explain these results?

Overall, my findings converge with the proto-role approach (Dowty, 1991), as I did not find specific processing correlates for the experiencer role category. Results show that they behave like agents, and different from patients, in the syntax-semantic interface.

Through all experimental chapters of this dissertation, I have opted for testing the proto-role approach instead of other theoretical approaches of event roles. This choice has been mainly motivated by (i) previous experimental evidence showing only evidence for agents and patients, with no psycholinguistic evidence for the experiencer role category (Bickel et al., 2015; Bornkessel-Schlesewsky & Schlesewsky, 2009; Gómez-Vidal et al., 2022; Huber et al., 2024; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; Rissman & Majid, 2019; Sauppe et al., 2023; Vela-Plo et al., 2022; *inter alia*), and by (ii) the psycholinguistic evidence of proto-role entailments (Kako, 2006; Rissman & Lupyan, 2022; Vernice & Hartsuiker, 2019). However, in this section, I discuss whether my results fit within the other theoretical approaches presented in Chapter 1.

Thematic role list approaches propose an extensive list of event role categories, among which the experiencer role is included (Belletti & Rizzi, 1988; Fillmore, 1971). These approaches claim that thematic roles are hierarchically organized, and that the highest-ranked role becomes the subject. Considering the verbs included in Experiments 1 and 2, *fear*-type verbs select experiencer-theme, *frighten*-type verbs agent/cause-experiencer (based on the Non-Psychological Verb Hypothesis that these verbs involve causation), and agent-patient verbs, obviously, agent-patient roles. The hierarchical order of these roles is agent > experiencer > theme/patient (Belletti & Rizzi, 1988; Fillmore, 1971). In all these verbs, the highest-ranked role – either the agent or the experiencer – becomes the subject, and the other argument is mapped onto the object position.

Therefore, the result that *frighten*-type verbs display higher processing costs than both *fear*-type and agent-patient verbs remains unexplained under this framework because there is no prediction that some combinations of thematic roles imply higher processing costs than others. Such prediction also fails to explain this result because thematic roles are considered discrete primitive notions that are not decomposed into smaller semantic properties (Levin & Rappaport Hovav, 2005). Based on this, agents and experiencers do not share any semantic property that could approximate them compared to patients or to other roles. Hence, thematic role list approaches fail to explain why the combination of agent-experiencer implies higher processing costs than experiencer-theme or agent-patient combinations, if the highest-ranked role becomes the subject in all cases.

Furthermore, if experiencer role constitutes an independent category from the one of agent and patient, as thematic role list approaches consider, the attentional preference for both agents and experiencers over patients observed in Experiment 3, as well as the recategorization effect found in Experiment 4, would remain unexplained. Previous research has shown that agents display an attentional preference towards agents reflected in higher fixation times (Cohn & Paczynski, 2013; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023) and regression counts (Zeyrek & Acarturk, 2014). Results of Experiment 3 show that experiencers are also attentionally preferred over patients. In addition, it has been widely established that recategorization toward a patient elicits an N400 component, indicating that agent and patient roles are two distinct role categories with specific processing correlates each. In Experiment 4, I found that patients also elicit this N400 effect compared to experiencers. This finding provides key evidence for a no specific category of experiencer role.

As opposed to thematic role list approaches, the Theta System (Reinhart, 2000, 2002, 2016) claims that event roles are decomposed into semantic features. Agents are characterized by causation and mental state [+c, +m], experiencers of *fear*-type

and perceptual verbs by mental state with causation unspecified [+m], experiencers of *frighten*-type verbs by mental state with the specification of non-causation [-c, +m], and themes/patients by the absence of these two features [-c, -m]. In this list of roles, agents and experiencers of *fear*-type and perceptual verbs always become subjects, whereas themes always become objects in transitive structures. The experiencer of *frighten*-type verbs becomes object only when it appears with an agent (i.e., in transitive active structures).

This approach explains the no processing differences found between *fear*-type and perceptual verbs, since both select the same roles with the same features. It could also explain the higher processing cost of *frighten*-type verbs, relying on the fact that their experiencer has the mental feature [-c, +m], then this argument has one positive feature, which means that it could become a subject. This could be interpreted as the competition effect that I proposed. Crucially, it cannot explain the elicitation of the N400 component when processing patients, compared to both agents and experiencers. Reinhart argued that these roles are distinct role categories, which means that if a recategorization emerges with patient subjects, a recategorization should also appear when processing experiencers, since agents and experiencers do not belong to the same role category.

Lastly, the macrorole approach (Foley & Van Valin, 1984; Van Valin, 1999, 2004, 2006; Van Valin & LaPolla, 1997), as the proto-role framework, proposes the existence of two macroroles, *actor* and *undergoer*. Contrary to the Theta System and the proto-role approach, macroroles are not decomposed into semantic entailments or features, instead they are generalizations of thematic relations of events. They are characterized by the position they occupy in the logical structure of the event. Macroroles are discrete categories – unlike proto-roles – and therefore do not allow overlap between roles, as verbs can only select one actor and one undergoer. The left-most argument in the logical structure becomes the actor, with no possibility of two arguments appearing in the same logical structure position. This suppresses the

competition for subject assignment proposed for *frighten*-type verbs, because it is not possible that two actors appear in the same logical structure. Although agent and experiencer roles are grouped under the actor macrorole, because both tend to be the left-most argument in the logical structure, when both agent and experiencer roles appear together, the agent is the one that occupies the left-most logical structure position, becoming the actor and leaving the experiencer the undergoer role, without possibility of competition. Regarding the attentional preference of agents and experiencers and the N400 recategorization effect, the macrorole approach can explain them, arguing that agents and experiencers are grouped into the actor category; hence, actors are attentionally preferred over undergoers, and the N400 effect appears when recategorization toward undergoer role.

These theoretical approaches can partially explain some of the results I obtained through this dissertation. However, exclusively the proto-role approach (Dowty, 1991) can fully account for these results based on the Non-psychological Verb Hypothesis. Thematic role list approaches and the macrorole framework can explain the increased processing cost of *frighten*-type verbs relying on the Psychological Verb Hypothesis, but cannot fully account for the data of the four experiments.

3. What if *frighten*-type verbs do not denote causation?

Based on the Psychological Verb Hypothesis, thematic role list approaches and the macrorole approach can explain the increased processing cost of *frighten*-type verbs because of the misalignment in the prominence of the syntactic and semantic structures, as it has been discussed in previous psycholinguistic studies (Do & Kaiser, 2021; M. Wilson & Dillon, 2022). If *frighten*-type verbs do not denote causation, thematic role list approaches propose that *frighten*-type verbs map the highest-ranked thematic role – the experiencer– onto the lowest syntactic position – the object (Belletti & Rizzi, 1988). This misalignment causes the higher processing cost of these

verbs compared to both *fear*-type and agent-patient verbs. Also, if *frighten*-type verbs do not denote causation, the macrorole approach claims that these verbs assign undergoer to the first argument which also involves a misalignment, since it does not occupy its canonical position – the one of the second argument, the object.

As discussed in detail in Chapter 1, this misalignment is claimed to disappear in OVS structures with *frighten*-type verbs, since the highest-ranked role – the experiencer – is mapped onto the highest syntactic position – the subject. Previous studies investigating *frighten*-type verbs in Spanish reported that these verbs were easier to process with OVS word order than with SVO compared to agent-patient verbs (Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015). However, their ERP results did not show this pattern (Gattei, Tabullo, et al., 2015): in the 600-750 ms time-window, *frighten*-type verbs elicited a broadly distributed positivity in sentences with SVO word order, with no significant differences in sentences with OVS word order. Moreover, in German, it was shown that these verbs involve an increased processing cost independently of the word order (Bornkessel et al., 2002, 2003).

If the higher processing cost of *frighten*-type verbs in SVO structures is explained by a preference to produce them in OVS structures in Spanish, then the only effect I would expect would be the one of lexical surprisal values, showing that sentences with these verbs are less frequent than sentences with other verbs in SVO structures. In all the experiments of this dissertation I included the lexical surprisal values of the experimental sentences in the Mixed-Effects Models to determine whether results could be explained simply by the predictability of the sentence. However, as I have largely discussed throughout the chapters, sentence predictability cannot account for the data without including the event role variables of each experiment. In most analyzed measures, the highest-weighted models included the event role variables corresponding to each experiment. This indicates that the frequency of these structures is not enough to explain this effect, suggesting that the processing difficulty of

frighten-type verbs cannot be fully accounted for by the preference for the OVS word order.

The Extended Argument Dependency Model (henceforth eADM) (Bornkessel & Schlesewsky, 2006), a well-known model of sentence comprehension, also relies on the Psychological Verb Hypothesis to explain the processing of *frighten*-type verbs. This model postulates that the processing of core constituents proceeds in three hierarchically organized phases: (1) the processing of constituents without any relation interpretation, (2) event role assignment, and (3) completion of argument interpretation process by taking information from further domains (e.g., plausibility, context). As this dissertation is focused on event roles, I discuss exclusively the second phase of the model, event role assignment.

Bornkessel and Schlesewsky (2006) also adopted two generalized semantic roles (actor and undergoer) due to the theoretical disagreement regarding the precise characterization of event roles. Specifically, they chose to work with macroroles rather than proto-roles. Although they did not explicitly justify their choice, it was likely motivated by their reliance on decomposition-based structures, consistent with the approach of Van Valin and colleagues (Foley & Van Valin, 1984; Van Valin, 1999, 2004; Van Valin & LaPolla, 1997). For example, they considered that the actor macrorole is the argument occupying the x position of a do' predicate (do'(x, [follow' (y)]).

The eADM relies on the prominence hierarchy for the assignment of macroroles. That is, the parser ranks the arguments according to prominence features such as person, animacy, definiteness, etc. The most prominent argument is predicted to become the actor. Macroroles are assigned by matching these prominence features. The model predicts processing difficulties when prominence-based expectations do not converge with the requirements of verbs, as it happens with *frighten*-type verbs.

Bornkessel and Schlesewsky (2006) proposed that real *frighten*-type verbs are those that select dative experiencers, such as *auffällt* ("to strike") in German (1). As

explained in Chapter 1 for the Misalignment Hypothesis, these verbs assign a nonmacrorole to the dative argument (experiencer) and an undergoer (theme) to the nominative one. The authors interpreted their previous findings – an early parietal positivity when processing *frighten*-type verbs compared to agent-patient verbs independently of word order (Bornkessel et al., 2002, 2003) – as evidence of a reanalysis or recategorization of the nominative argument. Upon encountering the nominative argument, the parser initially predicts that it will fulfil the actor role; however, once the verb is processed, the argument is reinterpreted as an undergoer, leading to increased processing cost.

(1) … *dass der Dirigent den Sängerinnen auffällt.*
… that [the conductor]$_{NOM}$ [the singer]$_{DAT}$ is-striking-to
"… that the conductor is striking to the singers."
(Bornkessel & Schlesewsky, 2006, p. 799)

This explanation relies on the Psychological Verb Hypothesis that *frighten*-type verbs do not denote causation (Belletti & Rizzi, 1988). However, considering the Non-Psychological Verb Hypothesis, a reanalysis should not appear, since the first argument would be an actor.

It is true that they explicitly mention that *frighten*-type verbs do not denote causation in German, whereas they admit that in English, these verbs denote it. As discussed in the discussion of Chapter 2, evidence from active-passive alternation paradigms aligns with this idea that *frighten*-type verbs denote causation in English, since results show no differences between *frighten*-type and agent-patient verbs in passives, but they do reveal differences with *fear*-type verbs, which do not denote causation (Bidgood et al., 2020; Do & Kaiser, 2021).

Soon after the proposal of the Psychological Verb Hypothesis (Belletti & Rizzi, 1988), several theoretical approaches started challenging this hypothesis by proposing the causal denotation of *frighten*-type verbs (Grimshaw, 1990; Dowty, 1991; Parodi-

Lewin, 1991; Zaenen, 1993; Pesetsky, 1995; Arad, 1998; Pylkkanen, 1999; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller, 2013; Fábregas & Marín, 2015; *inter alia*). Through different theoretical syntactic tests such as the progressive tense associated with causative event, Grimshaw (1990) and Pesetsky (1995) started proposing a causative structure for *frighten*-type verbs, since these verbs allow the progressive tense, whereas *fear*-type verbs do not. Later, Arad (1998) claimed that although these verbs denote always causation, they may denote agentive reading (with intentional agent) (2.a), eventive reading (without intentional agent) (2.b.) or stative reading (2.c).

(2) a. *Mary frightens John.*
b. *The noise frightens John.*
c. *Dogs frighten John.*

Levin and Grafmiller further posited (2013) that most *fear*-type verbs lack *frighten*-type verb counterparts referring to the same emotion and vice versa, contrary to Belletti and Rizzi's (1988) original proposal. *Fear*-type verbs do not involve a direct causal relation between the stimulus and the experiencer; rather, *frighten*-type verbs do show this causal relation. As they said, "you can indeed be frightened by things you do not fear" (Levin & Grafmiller, 2013, p. 31).

Taken together, these approaches clearly agree on the Non-Psychological Verb Hypothesis which states that *frighten*-type verbs denote causation, whereas *fear*-type do not. Hence, the consideration of the Psychological Verb Hypothesis for explaining the processing of these verbs does not converge with current theoretical approaches.

To date, only Hartshorne et al. (2016) tested experimentally whether *frighten*-type verbs involve different semantics than *fear*-type verbs. They asked native speakers of English, Mandarin, and Korean their intuitions as to who caused the mental state in sentences like *Agnes feared/frightened Bartholomew*. Participants reported that the subject was the cause in the case of verbs like *frighten*, but they did not show a clear

preference to identify a cause in the case of verbs like *fear*. This evidence supports the hypothesis that *frighten*-type verbs involve causation, even though this study does not provide processing correlates, and no subsequent studies have followed this research question to my knowledge. Hartshorne et al.'s (2016) results align with both previous studies with passives which provide indirect evidence that both *frighten*-type and agent-patient verbs involve causation (Bidgood et al., 2020; Do & Kaiser, 2021), and with theoretical approaches in favor of the Non-Psychological Verb Hypothesis (Grimshaw, 1990; Dowty, 1991; Parodi-Lewin, 1991; Zaenen, 1993; Pesetsky, 1995; Arad, 1998; Pylkkanen, 1999; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller, 2013; Fábregas & Marín, 2015; *inter alia*).

4. The proto-role approach and future research directions

As I have previously explained, the proto-role approach (Dowty, 1991) is the theoretical framework that better accounts for my results, and the one that better converges with previous psycholinguistic evidence.

This approach explains the higher processing cost of *frighten*-type verbs compared to both *fear*-type and agent-patient verbs due to the non-discreetness property of proto-roles. Dowty (1991) stated that both arguments in the same structure can exhibit entailments of the same proto-role (Dowty, 1991). He also proposed that experiencer thematic roles are arguments characterized by the proto-agent entailment of sentience. Based on this, *frighten*-type verbs select two arguments with proto-agent entailments (e.g., *Mary*$_{CAUSATION\text{-}SENTIENCE\text{-}VOLITION}$ *frightened John*$_{SENTIENCE}$), which involves a competition for subject assignment reflected in an increased processing cost.

Proto-roles also align with the attentional preference of proto-agents found in Experiment 3, as well as with the N400 recategorization effect found in Experiment 4. Since there is no distinct category for the experiencer role, these arguments are subsumed under the proto-agent role category, given their proto-agent entailment of

sentience. This explains the higher fixation times and regression counts found for agents and experiencers compared to patients and the elicitation of an N400 component by patient subjects as compared to both agent and experiencer subjects. According to the Agent Preference Hypothesis, agents are attentionally preferred, and the parser initially assigns the agent role to the first ambiguous noun phrase, until verb information forces reanalysis. Among agents, experiencers and patients, only patients trigger this event role recategorization, as they are the only participants lacking proto-agent entailments.

Regarding previous psycholinguistic evidence, Dowty's (1991) approach converges with the agent preference evidence (Bornkessel-Schlesewsky & Schlesewsky, 2009; Frenzel et al., 2015; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023; Vela-Plo et al., 2022), as arguments with the highest number of proto-agent entailments become the subject. Hence, it aligns with the expectancy that the subjects tend to be arguments with proto-agent entailments. It aligns with studies showing that speakers rely on proto-role entailments for subject and object identification (Kako, 2006; Rissman & Lupyan, 2022; Vernice & Hartsuiker, 2019), suggesting that event roles are not primitive notions. Moreover, as I discussed in detail in Chapter 2, the proto-role approach can also explain the results found in active-passive and word-order alternation studies with *frighten*-type verbs.

However, this framework is not without limitations. Some issues remain concerning the current empirical evidence, particularly regarding the relative prominence of semantic entailments and the possible existence of a third role category.

If event roles are indeed decomposed into semantic entailments, as Dowty (1991) proposed and experimental evidence suggests (Kako, 2006; Rissman & Lupyan, 2022; Vernice & Hartsuiker, 2019), much more research is required to better understand how these entailments are used in the syntax-semantics interface. Evidence from

Experiment 2 aligns with the hypothesis that causation is the most prominent proto-agent entailment (Ackerman & Moore, 2001; Davis, 2001; Davis & Koenig, 2000; Levin, 2019; Li, 2020). However, Rissman and Lupyan (2022) found that English native speakers rely more on the volition entailment in the subject and object identification. Future work should investigate the saliency of proto-role entailments to determine whether all entailments contribute equally to subject and object assignment, or whether the inventory of entailments should be revised, either reduced or expanded.

It would be valuable to test the prominence of proto-role entailments using diverse methodologies and across different populations. A promising line of research would be to investigate this issue in autistic children and adults, since they may rely on different semantic cues for subject and object assignment. Given documented Theory of Mind (ToM) difficulties in inferring others' mental states (Colle et al., 2008; Kenan et al., 2019), these populations might rank proto-role entailments differently from neurotypical adults, particularly the proto-agent entailment of volition. Such evidence would offer a broader perspective on how humans use semantic entailments to determine subjects and objects, contributing to a deeper understanding of the cognitive mechanisms underlying event representation.

Furthermore, a key question for future research concerns how proto-role entailments guide the parser during sentence comprehension. In Chapter 3, I proposed that this mechanism might resemble the one proposed in cue-based retrieval models (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006). Nevertheless, I did not find evidence that the number of proto-agent entailments modulates the processing costs of either *frighten*-type or agent-patient verbs. This absence of modulation could mean that competition effects arise only after a categorical threshold of semantic overlap is crossed. Alternatively, it might reflect limitations of the current methodology, and the expected modulation could become apparent under different experimental techniques.

Another limitation of the proto-role approach (Dowty, 1991) is the lack of a third proto-role category, even though psycholinguistic evidence suggests a third proto-role category (Dobel et al., 2007; Goldin-Meadow & Mylander, 1984; Lakusta et al., 2017; Tatone et al., 2015; Ünal et al., 2024; Yin & Csibra, 2015; Ziegler & Snedeker, 2018). However, the scope of this third proto-role remains still unclear: whether it encompasses only recipients and goals, extends to instruments, or is restricted to instruments alone. The experimental evidence concerning this role is mixed: some studies report no processing differences between patients, goals, sources, and instruments (Andreu et al., 2016), others no differences between goals and instruments in a visual search task (Ünal et al., 2024), and still others find no differences between patients and goals in children in change blindness tasks (Ünal et al., 2021), but a clear distinction in adults in the same task (Ünal et al., 2024). For goals and recipients specifically, some studies support the hypothesis that they conform the same category (Zheng & Goldin-Meadow, 2002), whereas others do not (Goldin-Meadow & Mylander, 1984; Ziegler & Snedeker, 2018).

A crucial first step would be to specify which are the semantic entailments that characterize this role category. Primus (1999), building on the proto-role framework, proposed a third category of proto-recipient, which encompasses *recipients*, *addressees*, and *benefactives*. The proto-recipient role should minimally involve a participant who receives something from another participant. Yet this characterization places this role between proto-agents and proto-patients: recipients should be sentient (a proto-agent entailment) but may be also affected by another participant's action (a proto-patient entailment) (Primus, 1999). Another property of this role would be to not involve volition, since the act of receiving something does not entail intentionality. Primus (1999) also stated that proto-recipients depend on a proto-agent involving causation and volition.

Goals, such as the one in *Mary sent the package to the shop*$_{GOAL}$, may also be treated as proto-recipients, since there is always a sentient participant behind this goal

role, in this example, it is assumed that someone in this shop would receive the package. However, it cannot be said *Mary sent the package to the chair*$_{GOAL}$ because *the chair* does not involve an institution or a place where there is a person who can receive the package. Moreover, both recipients and goals share the same syntactic realizations. For example, instead of *the shop,* it can be said *Mary sent the package to John*$_{RECIPIENT,}$ without any change in meaning or in the syntactic configuration. They both can also be subjects with verbs such as *receive,* or *inherit* (e.g., *Mary/The shop received the package*). Dowty (1991) specifically suggested that these verbs seem to have goals as subjects, without making any differentiation between goals or recipients, whereas Van Valin (2004, 2006) considered these arguments as recipients instead of goals; importantly, however, neither author divided this role into two separate categories.

Based on this, the differences found between goals and recipients in experimental studies may be due to the animacy of these roles. To my knowledge, recipients and goals together have not been investigated in comparison to other roles, such as patients, although for example Jackendoff (1990) grouped both patients and recipients together. Recipients have been compared to agents, and goals with both agents and patients, founding evidence that recipients and agents involve distinct processing correlates (Dobel et al., 2007), that goals and agents do so as well (Ünal et al., 2021, 2024), and that comparisons between goals and patients have produced mixed results (Andreu et al., 2016; Ünal et al., 2021). If goals and recipients belong to the same role category, the differences found between them may be due to their animacy, an effect that has been shown when comparing animate and inanimate subjects (e.g., Bourguignon et al., 2012; Kuperberg et al., 2003; Trueswell et al., 1994; Weckerly & Kutas, 1999), and not to the fact that they belong to different role categories. Hence, the comparison of these roles together with patients may provide evidence of whether goals and recipients constitute a different role category from patients, whether only recipients and patients belong to the same category, goals constituting another

independent role, or whether patients, goals, and recipients are grouped into the same event role category.

Regarding instruments and sources, the question of whether these roles are assigned to arguments or to adjuncts rises. Both instruments and sources can generally be omitted without rendering a sentence ungrammatical, which suggests that they function as adjuncts (Ackema, 2015), possibly belonging to a distinct event-role category specific to non-core participants. For instance, in *Mary cut the bread (with a knife*$_{INSTRUMENT}$*)* or in *John ran (from the house*$_{SOURCE}$*),* the phrases *with a knife* and *from the house* provide instrumental and source information, respectively, but their omission does not affect the grammaticality of the sentence. These roles therefore provide additional, circumstantial information that enriches the description of the event without defining its core structure (Ackema, 2015). Nevertheless, other studies have shown that the status of instruments may vary across languages and verbs, since in some contexts, instruments behave as arguments (Suozzi et al., 2024), and exhibit processing similarities to goals (Andreu et al., 2016; Ünal et al., 2024), which are considered to be arguments. However, there is also experimental evidence that instruments tend to be omitted in production tasks (Grigoroglou & Papafragou, 2019; Lockridge & Brennan, 2002). Determining whether instruments and sources are conceptually peripheral is crucial for understanding how these roles map onto syntax.

All in all, a deeper investigation of the proto-role approach will provide valuable insights into the mechanisms underlying language and event processing. Future research should examine in greater detail the individual semantic entailments that constitute proto-roles and clarify the possible existence of a third proto-role category. Equally important is the replication of key processing effects, such as the N400 effect associated with event role recategorization, across other languages and experimental methodologies. Such cross-linguistic and methodological validation is essential to determine whether these effects reflect universal cognitive principles – such as the

agent preference – ultimately leading to a more comprehensive understanding of how humans represent and process events in real time.

5. Conclusion

Overall, results from this doctoral dissertation show that the experiencer role does not constitute a role category within the event role repertoire, since I did not find evidence of specific processing correlates for this role, but I found that experiencers pattern with agents. This suggests that although agents and experiencers are semantically different, they are grouped within the proto-agent role category, exhibiting similar processing correlates between them and different from patients. Hence, only proto-agent and proto-patient roles are needed within the syntax-semantic interface for subject and object assignment.

Agents and experiencers appear to dance to the same rhythm – both act and feel. Even when the agent performs the solo and the experiencer takes the role of the observer, they remain the true protagonists of the event – those whom the spectator cannot look away from.

Data accessibility

The data, analysis scripts, and materials can be accessed at the following OSF repository: 10.17605/OSF.IO/WNAR8

Appendix A. Resumen en castellano

La investigación psicolingüística ha investigado extensamente los correlatos de procesamiento de los agentes y de los pacientes (Bickel et al., 2015; Gómez-Vidal et al., 2022; Haupt et al., 2008; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; *inter alia*). Sin embargo, poco se sabe sobre el procesamiento de los experimentantes. En esta tesis doctoral, investigo su procesamiento en estructuras transitivas e intransitivas en español para determinar si este rol constituye una categoría específica dentro del repertorio de papeles temáticos (Fillmore, 1971), como los agentes y los pacientes, o si este tipo de argumentos se agrupan dentro de la categoría de proto-agente (Dowty, 1991). En el Capítulo 2, investigué los verbos donde aparece el rol experimentante, así como este rol en sí, preguntando si los verbos psicológicos muestran correlatos de procesamiento específicos y si los experimentantes los muestran. En un experimento de grabación de movimientos oculares, los participantes produjeron mayores tiempos de fijación en verbos tipo *asustar* que en verbos tipo *temer* o que en verbos agente-paciente. Interpreté ese resultado como evidencia a favor de la teoría de proto-roles donde los experimentantes son considerados proto-agentes con el entrañamiento de *sentience*[7]. Por lo tanto, los verbos tipo *asustar* conllevan una competición para la asignación de sujeto, ya que seleccionan dos argumentos con entrañamientos de proto-agente. En el Capítulo 3, sigo investigando la teoría de proto-roles modulando el número de entrañamientos de los sujetos de los verbos tipo *asustar.* De nuevo, en el mismo tipo de experimento con estructuras transitivas, replico el mayor costo de procesamiento de los verbos tipo *asustar* en comparación con los verbos agente-paciente, sin ninguna modulación por el número de entrañamientos de los sujetos. En el Capítulo 4, investigué los correlatos de procesamiento de los experimentantes en estructuras intransitivas. En

[7] He optado por no traducir este término por la ausencia de un término equivalente en castellano.

experimentos separados de grabación de movimientos oculares y de medidas electrofisiológicas (EEG por sus siglas en inglés), observé que los sujetos agentes y experimentantes mostraban mayores tiempos de fijación que los sujetos pacientes, y que estos generaban un componente N400, un aumento en el poder de theta, y una reducción en el poder de alfa y beta-baja en comparación con los sujetos agentes y experimentantes, mientras que este patrón no aparecía entre sujetos agentes y experimentantes. En términos generales, estos resultados son consistentes con la teoría de proto-roles, sugiriendo que los experimentantes no constituyen una categoría diferente, ya que los agentes y los experimentantes parecen comportarse de manera similar en la interfaz sintáctico-semántica y ambos diferentes a los pacientes.

1. Introducción

Un mecanismo clave en el procesamiento del lenguaje es la identificación de *quién está haciendo qué a quién.* Por ejemplo, al procesar la frase *María golpea el balón,* identificamos que *María* es la participante que golpea *el balón,* y no al revés. En cuestión de milisegundos, somos capaces de reconocer el número de participantes involucrados en un evento determinado y el rol que desempeña cada uno; estos roles son conocidos como *roles eventivos.*

A lo largo de los años, se han propuesto numerosas categorías de estos roles sin llegar a un acuerdo sobre el número existente de estas (Dowty, 1989, 1991; Levin & Rappaport Hovav, 2005; Newmeyer, 2010). Los primeros intentos en la lingüística contemporánea de establecer cuántas categorías existen ocurrieron en los enfoques del listado de papeles temáticos. Estos propusieron diferentes listas, pero todas difieren en el número de roles y en el tipo de roles que las conforman (Belletti & Rizzi, 1988; Fillmore, 1968, 1971; Jackendoff, 1990). Por ejemplo, autores como Fillmore (1971) y Belletti y Rizzi (1988) incluían el rol de experimentante, mientras que otros como Baker (1997) o Jackendoff (1990) no. Estos enfoques consideraban que los roles

eventivos constituyen categorías discretas y que se organizan jerárquicamente, siendo el argumento con el rol más alto en esta jerarquía el que acaba como sujeto.

Dentro de estos enfoques, aparecieron también las primeras descripciones teóricas de los verbos psicológicos, los cuales asignan el rol de experimentante a uno de sus argumentos. Belletti y Rizzi (1988) propusieron que los verbos tipos *asustar* y *temer* seleccionan los mismos tipos de roles – experimentantes y temas – pero que difieren en la asignación de los mismos. Los verbos tipo *temer* asignan el rol de experimentante al sujeto y el tema al objeto, mientras que los verbos tipo *asustar* asignan el rol de experimentante al objeto y el tema al sujeto. Esto conlleva una desalineación entre la prominencia de la estructura sintáctica y de la semántica en los verbos de tipo *asustar*, ya que estos asignan el rol más alto jerárquicamente – el experimentante – en la posición sintáctica más baja – la de objeto. Poco después de la propuesta de Belletti y Rizzi (1988) surgieron otras proponiendo que estos dos tipos de verbos seleccionan roles diferentes ya que los verbos tipo *asustar* conllevan causalidad y los tipo *temer* no (Grimshaw, 1990; Dowty, 1991; Parodi-Lewin, 1991; Zaenen, 1993; Pesetsky, 1995; Arad, 1998; Pylkkanen, 1999; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller, 2013; Fábregas & Marín, 2015; *inter alia*). Por lo tanto, los verbos tipo *asustar* seleccionan agente/causa para el sujeto y experimentante para el objeto, mientras que los de tipo *temer* seleccionan experimentante para el sujeto y tema para el objeto.

Volviendo a los enfoques de roles eventivos, ante la falta de acuerdo respecto al número y al tipo de categorías existentes en los enfoques de listado de papeles temáticos, otros enfoques aparecieron, proponiendo que estos roles no son nociones primitivas, sino que se descomponen en propiedades semánticas.

El enfoque de proto-roles (Dowty, 1991) propone solo dos categorías, proto-agente y proto-paciente. Cada una se descompone en una serie de entrañamientos semánticos y el argumento con mayores entrañamientos de proto-agente acaba como sujeto. Una de las novedades de este enfoque es que los proto-roles no son categorías discretas, lo

que hace que, en una estructura transitiva, dos argumentos puedan tener entrañamientos de proto-agente. Esto sucede, por ejemplo, en los verbos tipo *asustar* que seleccionan dos argumentos con entrañamientos de proto-agente (agente y experimentante), ya que, en este enfoque, el experimentante no constituye una categoría independiente, sino que se agrupa dentro de la categoría de proto-agente por su entrañamiento de *sentience.* En cambio, los verbos tipo *temer* solo seleccionan un argumento con entrañamientos de proto-agente, el experimentante.

Contrario al enfoque de proto-roles, el sistema theta, propuesto por Reinhart (2000, 2002, 2016), sigue manteniendo un extenso listado de roles, similar al de los enfoques del listado de papeles temáticos. Aunque a diferencia de estos y semejante al enfoque de proto-roles, Reinhart propone que los roles se descomponen en dos propiedades semánticas: estado mental y causar un cambio. Así, los agentes se caracterizan por ambas propiedades, los experimentantes por la propiedad de estado mental y los pacientes/temas por la ausencia de ambas.

Parecido al enfoque de proto-roles, el enfoque de macroroles (Foley & Van Valin, 1984; Van Valin & LaPolla, 1997) propone dos macroroles, actor y paciente. Pero a diferencia de los dos enfoques anteriores, los macroroles no se descomponen en propiedades semánticas, sino que es el predicado en sí el que se descompone, lo cual se refleja en la estructura lógica. Entonces, los macroroles se caracterizan por la posición que ocupan dentro de estas estructuras lógicas, donde el argumento más a la izquierda se convierte en actor y el más a la derecha en paciente.

La evidencia psicolingüística ha demostrado que las categorías de agente y de paciente constituyen dos categorías utilizadas en procesos cognitivos (Rissman & Majid, 2019), mientras que no hay evidencia clara para el resto de categorías propuestas. Además, existe evidencia de una preferencia agentiva respecto a los pacientes (Bornkessel-Schlesewsky & Schlesewsky, 2009; Frenzel et al., 2015; Gómez-Vidal et al., 2022; Isasi-Isasmendi, Andrews, et al., 2023; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023; Vela-Plo et al., 2022), y que incluso es

compartida con simios no-humanos (Brocard et al., 2024, 2025; V. Wilson et al., 2022, 2024). Esta preferencia agentiva consiste en mayores fijaciones a agentes que a pacientes en procesamiento lingüístico (Gómez-Vidal et al., 2022) y en procesamiento de eventos (Webb et al., 2010), y en una preferencia por asignar el rol de agente al primer argumento, si este es ambiguo en caso, reflejado en un componente N400 al desambiguar hacia el paciente en la región del verbo (Bickel et al., 2015; Haupt et al., 2008; Isasi-Isasmendi, Sauppe, et al., 2023; Sauppe et al., 2023; Wang et al., 2009).

Sin embargo, ningún estudio previo ha investigado específicamente si el rol experimentante constituye una categoría dentro del inventario de roles eventivos. Investigaciones psicolingüísticas previas han investigado el procesamiento de verbos psicológicos mostrando que verbos como *asustar* conllevan una mayor carga de procesamiento que verbos tipo *temer* en inglés en estructuras activas transitivas (Do & Kaiser, 2021; M. Wilson & Dillon, 2022) y que verbos tipo agente-paciente en estructuras con el orden subjeto-verbo-objeto en español (Gattei, Dickey, et al., 2015; Gattei et al., 2017; Gattei, Tabullo, et al., 2015) y en alemán (Bornkessel et al., 2002, 2003). Estos estudios explican el mayor costo de procesamiento de verbos tipo *asustar* por la desalineación entre las prominencias semántica y sintáctica basada en la propuesta de Belletti y Rizzi (1988).

A través de tres experimentos de lectura con grabación de movimientos oculares y uno de EEG, en esta tesis doctoral investigo si el rol experimentante muestra correlatos de procesamiento específicos, como los agentes y los pacientes, o los muestra similares a los agentes ya que ambos pertenecen a la categoría de proto-agente (Dowty, 1991).

2. Capítulo 2

En un experimento de lectura con grabación de movimientos oculares, investigué los correlatos de procesamiento de oraciones con verbos que seleccionan el rol

experimentante: verbos tipo *temer,* verbos tipo *asustar*, y verbos perceptuales. Preguntaba (i) si la categoría de verbos psicológicos (formada por verbos tipo *temer* y tipo *asustar*) muestra correlatos de procesamiento específicos, y si (ii) el rol experimentante constituye una categoría dentro del repertorio de roles, mostrando correlatos de procesamiento específicos.

Para la primera pregunta de investigación, consideré la Hipótesis de Verbos Psicológicos – nombrada así por mí en base a la propuesta de Belletti y Rizzi (1988). Esta hipótesis sostiene que los verbos tipo *temer* y *asustar* constituyen la categoría de verbos psicológicos y predice correlatos de procesamiento similares entre estos verbos. Además, aunque los verbos perceptuales comparten la misma estructura argumental que los verbos tipo *temer* (experimentante-tema) (Levin, 1993; Van Valin, 1999, 2004), al no pertenecer a la misma categoría, esta hipótesis predice diferencias en el procesamiento entre estos dos tipos de verbos.

Por el contrario, la Hipótesis de No-Verbos Psicológicos – nombrada así también por mí en base a las propuestas de que los verbos tipo *asustar* denotan causalidad, mientras que los tipo *temer* no (Grimshaw, 1990; Dowty, 1991; Parodi-Lewin, 1991; Zaenen, 1993; Pesetsky, 1995; Arad, 1998; Pylkkanen, 1999; Van Valin, 2004; Landau, 2010; Croft, 2012; Levin & Grafmiller, 2013; Fábregas & Marín, 2015; *inter alia*) – predice diferencias en el procesamientos de los verbos tipo *asustar* y tipo *temer* ya que tienen una estructura argumental diferente: los verbos tipo *asustar* seleccionan agente/causa-experimentante, mientras que los verbos tipo *temer* experimentante-tema. Además, predice correlatos de procesamiento similares entre los verbos tipo *temer* y los perceptuales ya que seleccionan la misma estructura argumental.

Adultos hablantes nativos de español no produjeron diferencias en ninguna medida o región entre los verbos tipo *temer* y los perceptuales. Sin embargo, produjeron mayores tiempos de fijación en la región del objeto en los verbos tipo *asustar* que en los de *temer.* Estos resultados convergen con la Hipótesis de No-Verbos Psicológicos.

Respecto a la segunda pregunta de investigación, consideré el enfoque de proto-roles (Dowty, 1991), el cual establece que el rol experimentante no constituye una categoría específica dentro del inventario de roles, sino que se agrupa dentro de la categoría de proto-agente. Para testear este enfoque, comparé los correlatos de procesamiento de verbos tipo *asustar* con los de verbos tipo *temer* y verbos agente-paciente. Si el rol experimentante se agrupa dentro de la categoría de proto-agente, esperaba un mayor costo de procesamiento en oraciones con dos argumentos con entrañamientos de proto-agente (con verbos tipo *asustar*) que en aquellas con solo uno (con verbos tipo *temer* y con verbos agente-paciente), debido a la competición por la asignación de sujeto.

Los participantes produjeron mayores tiempos de fijación en verbos tipo *asustar* que en verbos tipo *temer* y verbos agente-paciente. Este resultado coincide con las predicciones hechas en base al enfoque de proto-roles (Dowty, 1991): los verbos tipo *asustar* conllevan una competición por la asignación de sujeto ya que selecciona dos argumentos con entrañamientos de proto-agente.

3. Capítulo 3

En base a los resultados obtenidos en el Experimento 1 (Capítulo 2), en el Experimento 2 continué testando el enfoque de proto-roles (Dowty, 1991) con los verbos tipo *asustar.* En esta ocasión, pregunté si el coste asociado a la competición por la asignación de sujeto se modula según el número de entrañamientos de proto-agente del sujeto. Para ello, modulé el número de entrañamientos del sujeto de verbos tipo *asustar* y de verbos agente-paciente, seleccionando sujetos animados e inanimados para cada verbo. Los sujetos animados, como en el Experimento 1, tenían tres entrañamientos de proto-agente (intencionalidad, *sentience*, y causalidad), mientras que los inanimados solo uno (causalidad).

En base a los modelos de *cue-based retrieval* y en su efecto de interferencia por similitud (R. L. Lewis & Vasishth, 2005; Nicenboim & Vasishth, 2018; Van Dyke, 2003; Van Dyke & McElree, 2006), predije que el procesamiento de verbos tipo *asustar* sería más costoso cuando ambos argumentos tienen el mismo número de entrañamientos (con sujetos inanimados), que cuando el sujeto tiene claramente más entrañamientos que el objeto (con sujetos animados), y que esta modulación no afectaría a los verbos agente-paciente, ya que estos seleccionan un objeto sin entrañamientos de proto-agente, por lo que no hay competición.

En otra tarea de lectura con grabación de movimientos oculares, hablantes nativos de español produjeron, al igual que en el Experimento 1, mayores tiempos de fijación en verbos tipo *asustar* que en verbos agente-paciente, sin ninguna modulación por el número de entrañamientos de los sujetos.

Este resultado replica los resultados del Experimento 1, mostrando una competición por la asignación de sujeto en verbos tipo *asustar*. Sin embargo, no aporta evidencia de una modulación por el número de entrañamientos del sujeto. Esto puede deberse a una mayor prominencia del entrañamiento de causalidad dentro de la categoría de proto-agente, lo que implicaría que una vez que un argumento tiene este entrañamiento, este sea suficiente para acabar como sujeto. Entonces, en el enfoque de proto-roles, la asignación de sujeto podría depender del tipo de entrañamientos de proto-agente y no del número. Otra explicación alternativa a esta ausencia de modulación podría ser la activación categórica; es decir, una vez que un argumento tiene entrañamientos de proto-agente, este es considerado para ser sujeto, independientemente del número de entrañamientos.

4. Capítulo 4

Tras estos dos experimentos, volví a una de las preguntas del Experimento 1, investigando si el rol experimentante muestra correlatos de procesamiento

específicos. Sin embargo, en esta ocasión, en lugar de utilizar estructuras transitivas, recurrí a las intransitivas para comparar directamente los roles de agente, experimentante y paciente en la misma posición de sujeto. Esta comparación permite determinar si los experimentantes muestran correlatos de procesamiento similares a los agentes y diferentes de los pacientes, lo cual convergería con los resultados previos, o si muestran correlatos de procesamiento específicos y diferentes a los agentes y a los pacientes.

Llevé a cabo dos experimentos separados, uno de lectura con grabación de movimientos oculares y otro con grabación de EEG. En el primero, hablantes nativos de español produjeron mayores fijaciones en medidas tardías en agentes y experimentantes que en pacientes en la región del verbo y la del post-verbo. En el segundo experimento, observé que el procesamiento de verbos seleccionando pacientes causaba una mayor negatividad que los verbos que seleccionan agentes y experimentantes en la ventana temporal temprana (300-500 ms), extendida en la ventana temporal tardía (700-800 ms). Además, el procesamiento de verbos seleccionando pacientes conllevaba un aumento en el poder de la frecuencia theta, y una reducción en las frecuencias alfa y beta-baja. Aparecieron algunas diferencias en el procesamiento de experimentantes en comparación con el de agentes y pacientes en medidas de movimientos oculares, al igual que un aumento de poder en la frecuencia alfa.

Estos resultados convergen con el enfoque de proto-roles (Dowty, 1991), donde agentes y experimentantes son agrupados dentro de la misma categoría de proto-agente. Los resultados de los movimientos oculares reflejan una preferencia atencional hacia sujetos agentes y experimentantes en comparación con sujetos pacientes. Los resultados de EEG, en cambio, muestran una preferencia por asignar al primer argumento ambiguo el rol de proto-agente, ya que los pacientes causan una recategorización reflejada en el N400. Los resultados también muestran que los

experimentantes son menos prototípicos que los agentes y pacientes ya que encuentro diferencias entre experimentantes en comparación con agentes y pacientes.

5. Conclusiones generales

En resumen, las principales contribuciones de esta tesis doctoral son:

1. He aportado nueva evidencia de que los verbos tipo *asustar* conllevan mayores costos de procesamiento que los verbos tipo *temer* y que los tipo agente-paciente. Esta evidencia converge con el enfoque de proto-roles ya que los verbos tipo *asustar* seleccionan dos argumentos con entrañamientos de proto-agente, lo que implica una competición por la asignación de sujeto, aumentando su costo de procesamiento en comparación con verbos que no tienen esa competición (verbos tipo *temer* y verbos tipo agente-paciente).
2. He mostrado que los verbos tipo *temer* no conllevan correlatos de procesamiento diferentes que los verbos perceptuales, lo que converge con las predicciones de la Hipótesis de No-Verbos Psicológicos: los verbos tipo *temer* muestran correlatos de procesamiento similares a los de los verbos perceptuales ya que tienen la misma estructura argumental, y diferentes a los de verbos tipo *asustar*, los cuales seleccionan un sujeto agente.
3. No he encontrado evidencia de una modulación en el procesamiento de verbos tipo *asustar* por el número de entrañamientos del sujeto. Esto puede significar que el entrañamiento de causalidad es más prominente que el resto de entrañamientos de proto-agente, o que una vez que un argumento es activado como proto-agente, la competición aparece, independientemente del número de entrañamientos.
4. He aportado nueva evidencia de que los sujetos agentes y experimentantes de estructuras intransitivas conllevan mayores fijaciones y regresiones en comparación con los sujetos pacientes en medidas tardías. Este resultado

muestra una preferencia atencional para fijar sujetos con entrañamientos de proto-agente en lugar de sujetos sin ellos.

5. He mostrado por primera vez un componente N400 causado por el procesamiento de un sujeto paciente en comparación con un sujeto experimentante. Además, he replicado el robusto efecto N400 de sujetos pacientes en comparación con sujetos agentes, reportado en estudios psicolingüísticos previos. Esta evidencia converge con la preferencia agentiva, que establece que se prefiere asignar el rol de agente a un argumento, si este es ambiguo, en lugar del rol de paciente, siendo importante resaltar que esta preferencia se extiende a los experimentantes, ya que se agrupan dentro de la categoría de proto-agente.
6. He encontrado que los sujetos experimentantes conllevan mayores tiempos de fijación que sujetos agentes y pacientes en medidas tempranas de movimientos oculares y un aumento en el poder de la frecuencia alfa en EEG. Estos resultados sugieren que los experimentantes son menos prototípicos que los agentes y que los pacientes, lo cual encaja dentro del enfoque de proto-roles, donde los experimentantes son considerados proto-agentes por poseer un único entrañamiento de proto-agente.

En general, los resultados de esta tesis doctoral muestran que el rol de experimentante no constituye una categoría independiente dentro del inventario de roles eventivos, ya que no he encontrado evidencia de correlatos de procesamiento específicos para este rol, como sí los hay para los agentes y los pacientes. Esto sugiere que, en la interfaz sintáctico-semántica, únicamente los roles de proto-agente y proto-paciente son necesarios para la asignación de sujeto y objeto.

Appendix B. Supplementary materials to Chapter 2

1. Verbs used in Experiment 1

***Fear*-type verbs**	***Frighten*-type verbs**	**Perceptual verbs**	**Agent-patient verbs**
amar	preocupar	detectar	coger
temer	atraer	distinguir	defender
admirar	asustar	observar	despertar
detestar	divertir	notar	regañar
odiar	gustar	contemplar	atar
culpar	encantar	oler	pisar
despreciar	alterar	descubrir	empujar
menospreciar	interesar	examinar	abandonar
anhelar	impresionar	ojear	levantar
adorar	enamorar	atender	asesinar
querer	enloquecer	investigar	abanicar
envidiar	molestar	espiar	mentir
desear	sorprender	aguardar	rescatar
apreciar	intimidar	desconocer	morder
idolatrar	seducir	vigilar	sobornar
necesitar	fastidiar	reconocer	torturar
estimar	distraer	evaluar	agredir
respetar	calmar	rememorar	abrazar
valorar	animar	ignorar	acariciar
apoyar	enfadar	juzgar	masajear

2. Experimental sentences used in Experiment 1

(1) a) El luchador aprecia al oponente después de la gran pelea.
b) El luchador ignora al oponente después de la gran pelea.
c) El luchador altera al oponente después de la gran pelea.
d) El luchador agrede al oponente después de la gran pelea.

(2) a) La alumna adora a la profesora cada día de la semana.
b) La alumna atiende a la profesora cada día de la semana.
c) La alumna fastidia a la profesora cada día de la semana.
d) La alumna abraza a la profesora cada día de la semana.

(3) a) El cliente admira al arquitecto durante todo el proyecto.
b) El cliente juzga al arquitecto durante todo el proyecto.
c) El cliente impresiona al arquitecto durante todo el proyecto.
d) El cliente miente al arquitecto durante todo el proyecto.

(4) a) El sirviente apoya al rey desde hace mucho tiempo.
b) El sirviente aguarda al rey desde hace mucho tiempo.
c) El sirviente distrae al rey desde hace mucho tiempo.
d) El sirviente abanica al rey desde hace mucho tiempo.

(5) a) La presidenta respeta al secretario durante la reunión trimestral.
b) La presidenta ignora al secretario durante la reunión trimestral.
c) La presidenta enfada al secretario durante la reunión trimestral.
d) La presidenta miente al secretario durante la reunión trimestral.

(6) a) El artista idolatra a la modelo durante la sesión de fotos.
b) El artista aguarda a la modelo durante la sesión de fotos.
c) El artista seduce a la modelo durante la sesión de fotos.
d) El artista abraza a la modelo durante la sesión de fotos.

(7) a) El padre admira al hijo durante la carrera del colegio.
b) El padre detecta al hijo durante la carrera del colegio.

c) El padre altera al hijo durante la carrera del colegio.

d) El padre coge al hijo durante la carrera del colegio.

(8) a) El chico ama a la chica durante un día soleado.

b) El chico rememora a la chica durante un día soleado.

c) El chico gusta a la chica durante un día soleado.

d) El chico acaricia a la chica durante un día soleado.

(9) a) El niño teme a la niña durante la hora del recreo.

b) El niño atiende a la niña durante la hora del recreo.

c) El niño enamora a la niña durante la hora del recreo.

d) El niño tortura a la niña durante la hora del recreo.

(10) a) La señora culpa al joven durante el viaje en tren.

b) La señora evalúa al joven durante el viaje en tren.

c) La señora encanta al joven durante el viaje en tren.

d) La señora empuja al joven durante el viaje en tren.

(11) a) El futbolista anhela al compañero antes del partido de fútbol.

b) El futbolista investiga al compañero antes del partido de fútbol.

c) El futbolista impresiona al compañero antes del partido de fútbol.

d) El futbolista abanica al compañero antes del partido de fútbol.

(12) a) La diseñadora menosprecia a la modista durante el desfile de moda.

b) La diseñadora descubre a la modista durante el desfile de moda.

c) La diseñadora calma a la modista durante el desfile de moda.

d) La diseñadora defiende a la modista durante el desfile de moda.

(13) a) El policía desprecia al ladrón en las fiestas del pueblo.

b) El policía detecta al ladrón en las fiestas del pueblo.

c) El policía sorprende al ladrón en las fiestas del pueblo.

d) El policía ata al ladrón en las fiestas del pueblo.

(14) a) La tía ama al sobrino todos los días del año.

b) La tía observa al sobrino todos los días del año.

c) La tía asusta al sobrino todos los días del año.

d) La tía regaña al sobrino todos los días del año.

(15) a) El capitán detesta al pirata durante la travesía atlántica.

b) El capitán distingue al pirata durante la travesía atlántica.

c) El capitán preocupa al pirata durante la travesía atlántica.

d) El capitán despierta al pirata durante la travesía atlántica.

(16) a) La ciega valora al cocinero desde hace varios meses.

b) La ciega nota al cocinero desde hace varios meses.

c) La ciega gusta al cocinero desde hace varios meses.

d) La ciega pisa al cocinero desde hace varios meses.

(17) a) El enfermero teme al paciente justo antes del baño.

b) El enfermero huele al paciente justo antes del baño.

c) El enfermero molesta al paciente justo antes del baño.

d) El enfermero coge al paciente justo antes del baño.

(18) a) El anciano odia al jardinero desde hace unos cuantos meses.

b) El anciano ojea al jardinero desde hace unos cuantos meses.

c) El anciano interesa al jardinero desde hace unos cuantos meses.

d) El anciano empuja al jardinero desde hace unos cuantos meses.

(19) a) El niño quiere al monitor durante el campamento de verano.

b) El niño espía al monitor durante el campamento de verano.

c) El niño divierte al monitor durante el campamento de verano.

d) El niño muerde al monitor durante el campamento de verano.

(20) a) El soldado respeta al coronel durante la primera batalla.

b) El soldado rememora al coronel durante la primera batalla.

c) El soldado intimida al coronel durante la primera batalla.

d) El soldado asesina al coronel durante la primera batalla.

(21) a) El peluquero necesita a la clienta durante la gran inauguración.

b) El peluquero reconoce a la clienta durante la gran inauguración.

c) El peluquero atrae a la clienta durante la gran inauguración.

d) El peluquero acaricia a la clienta durante la gran inauguración.

(22) a) La mujer anhela al hombre durante un día lluvioso.

b) La mujer examina al hombre durante un día lluvioso.

c) La mujer seduce al hombre durante un día lluvioso.

d) La mujer masajea al hombre durante un día lluvioso.

(23) a) La cantante desea al poeta durante el recital de poesía.

b) La cantante contempla al poeta durante el recital de poesía.

c) La cantante enamora al poeta durante el recital de poesía.

d) La cantante abandona al poeta durante el recital de poesía.

(24) a) El detective envidia al sospechoso desde hace dos meses.

b) El detective investiga al sospechoso desde hace dos meses.

c) El detective enfada al sospechoso desde hace dos meses.

d) El detective soborna al sospechoso desde hace dos meses.

(25) a) La cuidadora necesita al anciano desde hace varios años.

b) La cuidadora vigila al anciano desde hace varios años.

c) La cuidadora encanta al anciano desde hace varios años.

d) La cuidadora levanta al anciano desde hace varios años.

(26) a) El socorrista idolatra al nadador durante la competición.

b) El socorrista evalúa al nadador durante la competición.

c) El socorrista anima al nadador durante la competición.

d) El socorrista rescata al nadador durante la competición.

(27) a) El profesor apoya al bailarín durante la actuación anual.

b) El profesor distingue al bailarín durante la actuación anual.

c) El profesor anima al bailarín durante la actuación anual.

d) El profesor defiende al bailarín durante la actuación anual.

(28) a) La madre valora a la hija antes del examen final.

b) La madre juzga a la hija antes del examen final.

c) La madre divierte a la hija antes del examen final.

d) La madre despierta a la hija antes del examen final.

(29) a) El fontanero estima al ayudante desde hace cinco años.

b) El fontanero reconoce al ayudante desde hace cinco años.

c) El fontanero calma al ayudante desde hace cinco años.

d) El fontanero regaña al ayudante desde hace cinco años.

(30) a) El príncipe estima al caballero después del consejo real.

b) El príncipe vigila al caballero después del consejo real.

c) El príncipe fastidia al caballero después del consejo real.

d) El príncipe abandona al caballero después del consejo real.

(31) a) El vecino aprecia a la florista desde hace años y años.

b) El vecino contempla a la florista desde hace años y años.

c) El vecino molesta a la florista desde hace años y años.

d) El vecino masajea a la florista desde hace años y años.

(32) a) La vendedora desea al repartidor durante el mes de abril.

b) La vendedora examina al repartidor durante el mes de abril.

c) La vendedora sorprende al repartidor durante el mes de abril.

d) La vendedora soborna al repartidor durante el mes de abril.

(33) a) El entrenador envidia al atleta casi siempre en la pista.

b) El entrenador ojea al atleta casi siempre en la pista.

c) El entrenador preocupa al atleta casi siempre en la pista.

d) El entrenador rescata al atleta casi siempre en la pista.

(34) a) La hermana detesta al hermano durante el paseo por el monte.

b) La hermana observa al hermano durante el paseo por el monte.

c) La hermana distrae al hermano durante el paseo por el monte.

d) La hermana pisa al hermano durante el paseo por el monte.

(35) a) El peatón odia al ciclista todas las mañanas lluviosas.

b) El peatón nota al ciclista todas las mañanas lluviosas.

c) El peatón intimida al ciclista todas las mañanas lluviosas.

d) El peatón agrede al ciclista todas las mañanas lluviosas.

(36) a) El delincuente desprecia al hombre una tarde de invierno.

b) El delincuente espía al hombre una tarde de invierno.

c) El delincuente enloquece al hombre una tarde de invierno.

d) El delincuente asesina al hombre una tarde de invierno.

(37) a) El paciente adora al psicólogo durante la consulta matutina.

b) El paciente huele al psicólogo durante la consulta matutina.

c) El paciente interesa al psicólogo durante la consulta matutina.

d) El paciente muerde al psicólogo durante la consulta matutina.

(38) a) La mujer quiere al marido durante la clase de salsa.

b) La mujer descubre al marido durante la clase de salsa.

c) La mujer atrae al marido durante la clase de salsa.

d) La mujer levanta al marido durante la clase de salsa.

(39) a) El espía culpa al político antes del secuestro.

b) El espía desconoce al político antes del secuestro.

c) El espía enloquece al político antes del secuestro.

d) El espía tortura al político antes del secuestro.

(40) a) El payaso menosprecia al malabarista durante el espectáculo circense.

b) El payaso desconoce al malabarista durante el espectáculo circense.

c) El payaso asusta al malabarista durante el espectáculo circense.

d) El payaso ata al malabarista durante el espectáculo circense.

3. Model comparison of Experiment 1

As discussed in Chapter 2, models were compared with leave-one-out cross-validation (LOO-CV) (McElreath, 2020; Vehtari et al., 2017) using the stacking technique (Yao et al., 2018). Four fitted Bayesian Mixed-Effects Models were created per each region and variable: a model without any predictor (Null model), a model with only surprisal values as predictor (Model surprisal), a model with Verb Type and Argument Structure Type predictors (Model predictors), and a model with surprisal values, Verb Type and Argument Structure Type predictors (Full Model) (see the table below).

The result of this comparison gave the weight of each model, which reflects the relative predictive performance of each model in explaining the data. These weights are derived from the posterior predictive performance of the models, where each observation is iteratively excluded, and the ability of the model to predict that left-out observation is evaluated (Vehtariet al., 2017). The model with the highest stacking weight is considered the one with the best predictive performance for the data. This model comparison technique has been used in the other experiments.

For each region and measure, I included a "Verb Type" section and an "Argument Structure Type" section. In the "Verb Type" section, I compared all the models mentioned previously, using a nesting structure where the Argument Structure Type predictor is nested within the Verb Type predictor. In the "Argument Structure" section, I again compared the same models, but applied the reverse nesting: the Verb Type predictor is nested within the Argument Structure Type predictor

Weights smaller than 0.001 were rounded to zero for ease of presentation.

(1) Syntax of the Verb Type Models with Argument Structure Type predictor is nested within the Verb Type predictor:
Null model: Total Duration ~ 1
Model surprisal: Total Duration ~ Surprisal values
Model predictors: Total Duration ~ Verb Type/Argument Structure Type
Full model: Total Duration ~ Verb Type/Argument Structure Type + Surprisal values

(2) Syntax of the Argument Structure Type Models with Verb Type predictor is nested within the Argument Structure Type predictor:
Null model: Total Duration ~ 1
Model surprisal: Total Duration ~ Surprisal values
Model predictors: Total Duration ~ Argument Structure Type /Verb Type
Full model: Total Duration ~ Argument Structure Type /Verb Type + Surprisal values

Verb Type

Measure	Null model	Model surprisal	Model predictors	Full model
Gaze Duration				
Subject region	0.281	0.223	0.000	**0. 496**
Verb region	0.000	0.252	**0.644**	0.104
Object region	0.491	**0.508**	0.000	0.000
Post-object region	**0.808**	0.000	0.191	0.001
Regression Path Duration				
Subject region	0.283	**0.465**	0.000	0.252
Verb region	0.000	0.199	0.369	**0.432**
Object region	0.160	0.043	0.000	**0.797**
Post-object region	0.417	**0.436**	0.147	0.000
Re-Reading Duration				
Verb region	**0.894**	0.106	0.000	0.000
Object region	**0.629**	0.313	0.000	0.058
Post-object region	0.381	0.000	**0.618**	0.000
Regression Out Count				
Verb region	**0.983**	0.000	0.017	0.000
Object region	0.000	0.284	0.000	**0.716**
Post-object region	0.078	**0.922**	0.000	0.000
Regression In Count				
Subject region	0.186	**0.814**	0.000	0.000
Verb region	0.214	0.130	**0.657**	0.000
Object region	0.016	0.438	**0.546**	0.000
Post-object region	**1.000**	0.000	0.000	0.000
Total Duration				
Subject region	0.345	**0.593**	0.000	0.062
Verb region	0.049	0.020	0.000	**0.931**
Object region	0.000	0.431	0.044	**0.525**
Post-object region	**0.364**	0.295	0.341	0.000
Reading Times	0.000	0.372	0.000	**0.628**

Argument Structure Type

Measure	Null model	Model surprisal	Model predictors	Full model
Gaze Duration				
Subject region	0.354	**0.482**	0.022	0.141
Verb region	0.000	0.221	**0.434**	0.345
Object region	0.482	**0.518**	0.000	0.000
Post-object region	**0.566**	0.001	0.433	0.000
Regression Path Duration				
Subject region	0.024	**0.855**	0.122	0.000
Verb region	0.000	0.226	0.330	**0.444**
Object region	0.154	0.060	0.000	**0.786**
Post-object region	0.229	0.350	**0.422**	0.000
Re-Reading Duration				
Verb region	**0.999**	0.001	0.000	0.000
Object region	**0.633**	0.322	0.000	0.045
Post-object region	0.353	0.000	**0.647**	0.000
Regression Out Count				
Verb region	**1.000**	0.000	0.000	0.000
Object region	0.000	0.331	0.018	**0.651**
Post-object region	0.066	**0.934**	0.000	0.000
Regression In Count				
Subject region	0.180	**0.820**	0.000	0.000
Verb region	0.155	0.094	**0.751**	0.000
Object region	0.003	**0.514**	0.483	0.000
Post-object region	**0.736**	0.264	0.000	0.000
Total Duration				
Subject region	0.359	**0.421**	0.000	0.220
Verb region	0.000	0.081	0.451	**0.468**
Object region	0.000	0.386	0.001	**0.613**
Post-object region	**0.621**	0.219	0.159	0.000
Reading Times	0.000	0.427	0.000	**0.573**

4. Raw data of Experiment 1

Eye-tracking measures	Subject Region	Verb Region	Object Region	Post-object Region
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Gaze Duration				
Exp-theme (psych)	428 (203)	297 (150)	387 (192)	555 (273)
Exp-theme (non-psych)	412 (135)	284 (149)	389 (189)	558 (279)
Agt-exp	420 (160)	301 (145)	376 (182)	559 (262)
Agt-pat	421 (165)	288 (138)	371 (176)	544 (265)
Regression Path Duration				
Exp-theme (psych)	240 (178)	364 (286)	484 (346)	759 (568)
Exp-theme (non-psych)	234 (127)	354 (302)	495 (481)	807 (676)
Agt-exp	244 (148)	356 (234)	537 (475)	747 (568)
Agt-pat	240 (150)	347 (263)	463 (315)	742 (501)
Re-reading Duration				
Exp-theme (psych)		609 (432)	647 (552)	945 (731)
Exp-theme (non-psych)		652 (541)	780 (978)	1169 (888)
Agt-exp		570 (258)	808 (697)	927 (701)
Agt-pat		626 (407)	654 (564)	854 (549)
Regression Out Count				
Exp-theme (psych)		0.10 (0.32)	0.17 (0.41)	0.21 (0.51)
Exp-theme (non-psych)		0.12 (0.40)	0.15 (0.41)	0.21 (0.52)
Agt-exp		0.10 (0.29)	0.22 (0.47)	0.18 (0.43)
Agt-pat		0.09 (0.30)	0.15 (0.39)	0.21 (0.45)
Regression In Count				
Exp-theme (psych)	0.91 (0.89)	0.52 (0.70)	0.29 (0.56)	0.34 (0.53)
Exp-theme (non-psych)	0.97 (0.95)	0.48 (0.69)	0.23 (0.48)	0.33 (0.53)
Agt-exp	0.97 (1.05)	0.56 (0.82)	0.21 (0.46)	0.29 (0.53)
Agt-pat	0.84 (0.90)	0.50 (0.67)	0.27 (0.52)	0.31 (0.49)
Total Duration				
Exp-theme (psych)	707 (438)	554 (371)	630 (390)	820 (434)
Exp-theme (non-psych)	735 (504)	552 (368)	628 (398)	836 (450)
Agt-exp	764 (690)	623 (494)	647 (502)	813 (486)
Agt-pat	698 (438)	520 (340)	582 (400)	802 (467)

Sentence Reading Time	All sentence
	Mean (sd)
Exp-theme (psych)	3595 (1752)
Exp-theme (non-psych)	3688 (1814)
Agt-exp	3785 (2407)
Agt-pat	3461 (1739)

Appendix C. Supplementary materials to Chapter 3

1. Verbs used in Experiment 2

***Frighten*-type verbs**	**Agent-patient verbs**
preocupar	mojar
fascinar	frenar
asustar	grabar
divertir	golpear
irritar	ensuciar
encantar	destrozar
alterar	empujar
interesar	lastimar
impresionar	levantar
enamorar	detener
enloquecer	alimentar
molestar	desplazar
sorprender	perjudicar
intimidar	manchar
seducir	sujetar
fastidiar	aplastar
distraer	despertar
calmar	salpicar
animar	proteger
enfadar	empapar

2. Experimental sentences used in Experiment 2

(1) a) La cocinera alteró al cómico durante el espectáculo de ayer.
b) La cámara alteró al cómico durante el espectáculo de ayer.
c) La cocinera grabó al cómico durante el espectáculo de ayer.
d) La cámara grabó al cómico durante el espectáculo de ayer.

(2) a) El marinero preocupó al vendedor en el amplio puerto de Bilbao.
b) El viento preocupó al vendedor en el amplio puerto de Bilbao.
c) El marinero golpeó al vendedor en el amplio puerto de Bilbao.
d) El viento golpeó al vendedor en el amplio puerto de Bilbao.

(3) a) La cantante fascinó al fotógrafo durante la sesión en el campo.
b) La cascada fascinó al fotógrafo durante la sesión en el campo.
c) La cantante ensució al fotógrafo durante la sesión en el campo.
d) La cascada ensució al fotógrafo durante la sesión en el campo.

(4) a) El ciclista asustó al niño en el horrible y oscuro parque.
b) El columpio asustó al niño en el horrible y oscuro parque.
c) El ciclista levantó al niño en el horrible y oscuro parque.
d) El columpio levantó al niño en el horrible y oscuro parque.

(5) a) El luchador divirtió al entrenador en el gimnasio grande del barrio.
b) El ejercicio divirtió al entrenador en el gimnasio grande del barrio.
c) El luchador destrozó al entrenador en el gimnasio grande del barrio.
d) El ejercicio destrozó al entrenador en el gimnasio grande del barrio.

(6) a) El señor irritó al futbolista durante el partido de la mañana.
b) El vendaval irritó al futbolista durante el partido de la mañana.
c) El señor empujó al futbolista durante el partido de la mañana.
d) El vendaval empujó al futbolista durante el partido de la mañana.

(7) a) La bailarina encantó a la actriz durante el desarrollo de la obra.
b) La coreografía encantó a la actriz durante el desarrollo de la obra.

c) La bailarina lastimó a la actriz durante el desarrollo de la obra.

d) La coreografía lastimó a la actriz durante el desarrollo de la obra.

(8) a) La vecina interesó al anciano durante los meses de pandemia.

b) La huerta interesó al anciano durante los meses de pandemia.

c) La vecina alimentó al anciano durante los meses de pandemia.

d) La huerta alimentó al anciano durante los meses de pandemia.

(9) a) La empleada impresionó al pescador en el viejo y pequeño barco azul.

b) La resaca impresionó al pescador en el viejo y pequeño barco azul.

c) La empleada desplazó al pescador en el viejo y pequeño barco azul.

d) La resaca desplazó al pescador en el viejo y pequeño barco azul.

(10) a) El bombero molestó al joven durante las fiestas del pueblo.

b) La discusión molestó al joven durante las fiestas del pueblo.

c) El bombero perjudicó al joven durante las fiestas del pueblo.

d) La discusión perjudicó al joven durante las fiestas del pueblo.

(11) a) La chica enloqueció al estudiante en la clase de pintura de la academia.

b) La acuarela enloqueció al estudiante en la clase de pintura de la academia.

c) La chica manchó al estudiante en la clase de pintura de la academia.

d) La acuarela manchó al estudiante en la clase de pintura de la academia.

(12) a) La duquesa enamoró al marqués en el elegante palacete de Salamanca.

b) La barandilla enamoró al marqués en el elegante palacete de Salamanca.

c) La duquesa sujetó al marqués en el elegante palacete de Salamanca.

d) La barandilla sujetó al marqués en el elegante palacete de Salamanca.

(13) a) La violinista sorprendió a la señora en un vagón del metro de Madrid.

b) El violonchelo sorprendió a la señora en un vagón del metro de Madrid.

c) La violinista aplastó a la señora en un vagón del metro de Madrid.

d) El violonchelo aplastó a la señora en un vagón del metro de Madrid.

(14) a) El inspector distrajo al director en el despacho de Sevilla.

b) El taladro distrajo al director en el despacho de Sevilla.

c) El inspector despertó al director en el despacho de Sevilla.

d) El taladro despertó al director en el despacho de Sevilla.

(15) a) La enfermera intimidó al cirujano durante la complicada operación.

b) La sangre intimidó al cirujano durante la complicada operación.

c) La enfermera salpicó al cirujano durante la complicada operación.

d) La sangre salpicó al cirujano durante la complicada operación.

(16) a) El ingeniero sedujo al científico durante la expedición en la Antártida.

b) El glaciar sedujo al científico durante la expedición en la Antártida.

c) El ingeniero protegió al científico durante la expedición en la Antártida.

d) El glaciar protegió al científico durante la expedición en la Antártida.

(17) a) La nadadora fastidió a la socorrista tras la exhibición de natación sincronizada.

b) La manguera fastidió a la socorrista tras la exhibición de natación sincronizada.

c) La nadadora empapó a la socorrista tras la exhibición de natación sincronizada.

d) La manguera empapó a la socorrista tras la exhibición de natación sincronizada.

(18) a) La florista calmó al filósofo en el porche de la gran casa.

b) La tempestad calmó al filósofo en el porche de la gran casa.

c) La florista mojó al filósofo en el porche de la gran casa.

d) La tempestad mojó al filósofo en el porche de la gran casa.

(19) a) La mujer animó al inversor durante una subasta en Barcelona.

b) La noticia animó al inversor durante una subasta en Barcelona.

c) La mujer frenó al inversor durante una subasta en Barcelona.

d) La noticia frenó al inversor durante una subasta en Barcelona.

(20) a) La peluquera enfadó a la novia justo el día antes de la boda.

b) La tormenta enfadó a la novia justo el día antes de la boda.

c) La peluquera detuvo a la novia justo el día antes de la boda.

d) La tormenta detuvo a la novia justo el día antes de la boda.

(21) a) La buceadora molestó al surfista en el entramiento en Tarifa.

b) La corriente molestó al surfista en el entramiento en Tarifa.

c) La buceadora empujó al surfista en el entramiento en Tarifa.

d) La corriente empujó al surfista en el entramiento en Tarifa.

(22) a) La jueza preocupó al secretario durante las largas vacaciones.

b) La multa preocupó al secretario durante las largas vacaciones.

c) La jueza destrozó al secretario durante las largas vacaciones.

d) La multa destrozó al secretario durante las largas vacaciones.

(23) a) El pastelero sedujo al turista en el chiringuito de la playa.

b) El gazpacho sedujo al turista en el chiringuito de la playa.

c) El pastelero mojó al turista en el chiringuito de la playa.

d) El gazpacho mojó al turista en el chiringuito de la playa.

(24) a) La abogada calmó a la clienta en la cafetería de la clínica.

b) La situación calmó a la clienta en la cafetería de la clínica.

c) La abogada frenó a la clienta en la cafetería de la clínica.

d) La situación frenó a la clienta en la cafetería de la clínica.

(25) a) El reportero fascinó al ladrón en una calle muy concurrida de Barcelona.

b) El teléfono fascinó al ladrón en una calle muy concurrida de Barcelona.

c) El reportero grabó al ladrón en una calle muy concurrida de Barcelona.

d) El teléfono grabó al ladrón en una calle muy concurrida de Barcelona.

(26) a) La teniente distrajo al coronel en la última misión en Madagascar.

b) La liana distrajo al coronel en la última misión en Madagascar.

c) La teniente golpeó al coronel en la última misión en Madagascar.

d) La liana golpeó al coronel en la última misión en Madagascar.

(27) a) El gerente enamoró al empleado en la fiesta de después de la reunión.

b) El chocolate enamoró al empleado en la fiesta de después de la reunión.

c) El gerente ensució al empleado en la fiesta de después de la reunión.

d) El chocolate ensució al empleado en la fiesta de después de la reunión.

(28) a) El obrero enloqueció al arquitecto durante el proyecto para la catedral.

b) El andamio enloqueció al arquitecto durante el proyecto para la catedral.

c) El obrero lastimó al arquitecto durante el proyecto para la catedral.

d) El andamio lastimó al arquitecto durante el proyecto para la catedral.

(29) a) El profesor irritó a la niña durante una tarde de marzo.

b) El balancín irritó a la niña durante una tarde de marzo.

c) El profesor levantó a la niña durante una tarde de marzo.

d) El balancín levantó a la niña durante una tarde de marzo.

(30) a) El detective asustó a la deportista durante el paseo por el monte.

b) El socavón asustó a la deportista durante el paseo por el monte.

c) El detective detuvo a la deportista durante el paseo por el monte.

d) El socavón detuvo a la deportista durante el paseo por el monte.

(31) a) La ayudante divirtió al mecánico en el taller de la calle principal.

b) La avería divirtió al mecánico en el taller de la calle principal.

c) La ayudante salpicó al mecánico en el taller de la calle principal.

d) La avería salpicó al mecánico en el taller de la calle principal.

(32) a) El rival animó a la ganadora justo al final de la larga competición.

b) El oleaje animó a la ganadora justo al final de la larga competición.

c) El rival empapó a la ganadora justo al final de la larga competición.

d) El oleaje empapó a la ganadora justo al final de la larga competición.

(33) a) La piloto encantó al aventurero durante el viaje por el Amazonas.

b) La fruta encantó al aventurero durante el viaje por el Amazonas.

c) La piloto alimentó al aventurero durante el viaje por el Amazonas.

d) La fruta alimentó al aventurero durante el viaje por el Amazonas.

(34) a) El hombre enfadó al luchador durante el último asalto del combate.

b) El golpe enfadó al luchador durante el último asalto del combate.

c) El hombre desplazó al luchador durante el último asalto del combate.

d) El golpe desplazó al luchador durante el último asalto del combate.

(35) a) La dentista alteró al pediatra durante la excursión al lago.

b) La humedad alteró al pediatra durante la excursión al lago.

c) La dentista perjudicó al pediatra durante la excursión al lago.

d) La humedad perjudicó al pediatra durante la excursión al lago.

(36) a) El artista interesó al ojeador durante la exposición en el museo.

b) El sello interesó al ojeador durante la exposición en el museo.

c) El artista manchó al ojeador durante la exposición en el museo.

d) El sello manchó al ojeador durante la exposición en el museo.

(37) a) La supervisora impresionó al geólogo en la excavación en Segovia.

b) La estructura impresionó al geólogo en la excavación en Segovia.

c) La supervisora sujetó al geólogo en la excavación en Segovia.

d) La estructura sujetó al geólogo en la excavación en Segovia.

(38) a) El ganadero fastidió al pastor en el prado cerca del pueblo.

b) El tractor fastidió al pastor en el prado cerca del pueblo.

c) El ganadero aplastó al pastor en el prado cerca del pueblo.

d) El tractor aplastó al pastor en el prado cerca del pueblo.

(39) a) La anfitriona sorprendió al invitado en la increíble fiesta de disfraces.

b) La charanga sorprendió al invitado en la increíble fiesta de disfraces.

c) La anfitriona despertó al invitado en la increíble fiesta de disfraces.

d) La charanga despertó al invitado en la increíble fiesta de disfraces.

(40) a) El militar intimidó al caminante durante aquella noche de tormenta.

b) El bosque intimidó al caminante durante aquella noche de tormenta.

c) El militar protegió al caminante durante aquella noche de tormenta.

d) El bosque protegió al caminante durante aquella noche de tormenta.

3. Model comparison of Experiment 2

I used the same model comparison methodology as in Experiment 1, but employed different syntax to modelling:

(1) Example of model syntax:

Null model: Total Duration ~ 1

Model surprisal: Total Duration ~ Surprisal values

Model predictors: Total Duration ~ Subject Type *Verb Type

Full model: Total Duration ~ Subject Type *Verb Type + Surprisal values

Measure	Null model	Model surprisal	Model predictors	Full model
Gaze Duration				
Subject region	0.000	0.384	**0.446**	0.170
Verb region	0.006	0.400	**0.594**	0.000
Object region	**0.501**	0.000	0.003	0.496
Post-object region	**0.554**	0.000	0.446	0.000
Regression Path Duration				
Subject region	0.000	**0.415**	0.402	0.182
Verb region	0.134	0.000	0.186	**0.679**
Object region	**0.446**	0.000	0.342	0.211
Post-object region	**0.510**	0.000	0.267	0.223
Re-Reading Duration				
Verb region	**0.521**	0.000	0.479	0.000
Object region	0.000	0.472	**0.528**	0.000
Post-object region	0.000	**0.476**	0.385	0.139
Regression Out Count				
Verb region	0.113	0.014	**0.873**	0.000
Object region	0.249	0.192	**0.558**	0.000
Post-object region	0.000	0.374	**0.625**	0.001
Regression In Count				
Subject region	**0.753**	0.247	0.000	0.000
Verb region	**0.531**	0.000	0.000	0.469
Object region	0.000	**0.803**	0.168	0.029
Post-object region	0.074	**0.926**	0.000	0.000
Total Duration				
Subject region	0.000	**0.521**	0.479	0.000
Verb region	0.000	0.224	**0.776**	0.000
Object region	0.219	0.000	0.354	**0.428**
Post-object region	**0.520**	0.163	0.000	0.317
Reading Times	0.080	0.242	**0.679**	0.000

4. Raw data of Experiment 2

Eye-tracking measures	Subject Region	Verb Region	Object Region	Post-object Region
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Gaze Duration				
Frighten-type (A)	388 (154)	317 (176)	385 (186)	707 (340)
Frighten-type (I)	408 (196)	328 (190)	381 (184)	690 (304)
Agt-pat (A)	411 (209)	295 (159)	400 (194)	702 (325)
Agt-pat (I)	427 (221)	299 (146)	404 (180)	719 (360)
Regression Path Duration				
Frighten-type (A)	388 (154)	370 (241)	538 (392)	947 (665)
Frighten-type (I)	408 (196)	421 (276)	496 (336)	901 (659)
Agt-pat (A)	411 (209)	342 (210)	506 (442)	967 (737)
Agt-pat (I)	427 (221)	392 (264)	495 (355)	962 (627)
Re-reading Duration				
Frighten-type (A)		535 (307)	747 (498)	1166 (942)
Frighten-type (I)		588 (267)	707 (420)	1253 (984)
Agt-pat (A)		470 (195)	764 (857)	1294 (1002)
Agt-pat (I)		577 (285)	671 (584)	1132 (724)
Regression Out Count				
Frighten-type (A)		0.11 (0.33)	0.23 (0.49)	0.17 (0.44)
Frighten-type (I)		0.17 (0.40)	0.17 (0.41)	0.12 (0.35)
Agt-pat (A)		0.10 (0.31)	0.15 (0.40)	0.16 (0.43)
Agt-pat (I)		0.16 (0.38)	0.14 (0.37)	0.16 (0.40)
Regression In Count				
Frighten-type (A)	0.79 (0.82)	0.48 (0.70)	0.23 (0.46)	0.39 (0.57)
Frighten-type (I)	0.85 (0.84)	0.40 (0.63)	0.20 (0.44)	0.42 (0.57)
Agt-pat (A)	0.83 (0.83)	0.45 (0.66)	0.26 (0.51)	0.41 (0.58)
Agt-pat (I)	0.83 (0.82)	0.40 (0.67)	0.22 (0.48)	0.39 (0.60)
Total Duration				
Frighten-type (A)	630 (368)	587 (414)	628 (389)	1057 (616)
Frighten-type (I)	669 (404)	570 (357)	568 (346)	1083 (585)
Agt-pat (A)	662 (421)	540 (384)	630 (398)	1036 (568)
Agt-pat (I)	685 (400)	519 (319)	587 (337)	1057 (551)

Sentence Reading Time	All sentence
	Mean (sd)
Frighten-type Animate	3930 (1900)
Frighten-type Inanimate	3845 (1747)
Agt-theme Animate	3963 (1987)
Agt-theme Inanimate	3846 (1577)

Appendix D. Supplementary materials to Chapter 4

1. Verbs used in Experiments 3 and 4

Agent	Experiencer	Patient
involucrarse	aburrirse	fallecer
esforzarse	alegrarse	desplomarse
implicarse	enfadarse	resbalarse
comprometerse	ilusionarse	desorientarse
encargarse	preocuparse	caerse
responsabilizarse	sorprenderse	tropezarse
arriesgarse	disgustarse	desmayarse
rebelarse	divertirse	sentarse
bailar	gozar	crecer
navegar	creer	desaparecer
correr	amar	nacer
bucear	desconfiar	envejecer
entrenar	temer	despertarse
saltar	disfrutar	enfermar
cantar	enfurecer	aparecer
dimitir	confiar	venir
involucrarse	aburrirse	fallecer
esforzarse	alegrarse	desplomarse
implicarse	enfadarse	resbalarse
comprometerse	ilusionarse	desorientarse

2. Experimental sentences used in Experiments 3 and 4

(1) a) El estudiante como siempre se involucró durante la carrera.
b) El estudiante como siempre se aburrió durante la carrera.
c) El estudiante como siempre se tropezó durante la carrera.

(2) a) La cantante en Granada se esforzó durante la actuación.
b) La cantante en Granada se alegró durante la actuación.
c) La cantante en Granada se desplomó durante la actuación.

(3) a) El abogado a menudo se implicó durante el caso.
b) El abogado a menudo se preocupó durante el caso.
c) El abogado a menudo desapareció durante el caso.

(4) a) La jugadora en Pamplona se implicó durante el partido.
b) La jugadora en Pamplona temió durante el partido.
c) La jugadora en Pamplona se tropezó durante el partido.

(5) a) El deportista en octubre corrió por la ciudad.
b) El deportista en octubre disfrutó por la ciudad.
c) El deportista en octubre se desorientó por la ciudad.

(6) a) La alcaldesa en verano se encargó de las fiestas.
b) La alcaldesa en verano gozó de las fiestas.
c) La alcaldesa en verano vino de las fiestas.

(7) a) La ingeniera en julio navegó con la familia.
b) La ingeniera en julio se enfadó con la familia.
c) La ingeniera en julio apareció con la familia.

(8) a) El artista en Verona bailó como un adolescente.
b) El artista en Verona amó como un adolescente.
c) El artista en Verona apareció como un adolescente.

(9) a) La costurera en invierno se implicó con la alfombra.
b) La costurera en invierno se ilusionó con la alfombra.
c) La costurera en invierno se resbaló con la alfombra.

(10) a) El bailarín el viernes saltó durante el espectáculo.
b) El bailarín el viernes se divirtió durante el espectáculo.
c) El bailarín el viernes se desmayó durante el espectáculo.

(11) a) La bióloga hace años buceó en el Mediterráneo.
b) La bióloga hace años se divirtió en el Mediterráneo.
c) La bióloga hace años creció en el Mediterráneo.

(12) a) El militar muy probablemente se esforzó durante la batalla.
b) El militar muy probablemente desconfió durante la batalla.
c) El militar muy probablemente enfermó durante la batalla.

(13) a) La investigadora el miércoles navegó con un compañero.
b) La investigadora el miércoles se disgustó con un compañero.
c) La investigadora el miércoles se sentó con un compañero.

(14) a) El corredor el sábado entrenó con un colega.
b) El corredor el sábado disfrutó con un colega.
c) El corredor el sábado se despertó con un colega.

(15) a) La psicóloga el lunes se arriesgó en la terapia.
b) La psicóloga el lunes creyó en la terapia.
c) La psicóloga el lunes falleció en la terapia.

(16) a) El presidente en Salamanca dimitió durante la campaña.
b) El presidente en Salamanca se disgustó durante la campaña.
c) El presidente en Salamanca se resbaló durante la campaña.

(17) a) La nadadora en Australia buceó con el experto.
b) La nadadora en Australia se enfadó con el experto.
c) La nadadora en Australia se sentó con el experto.

(18) a) El secretario en abril dimitió durante la reunión.
b) El secretario en abril se preocupó durante la reunión.
c) El secretario en abril se desmayó durante la reunión.

(19) a) La gimnasta al final saltó durante la exhibición.

b) La gimnasta al final se aburrió durante la exhibición.

c) La gimnasta al final se desorientó durante la exhibición.

(20) a) El escritor hace poco corrió como un lunático.

b) El escritor hace poco amó como un lunático.

c) El escritor hace poco vino como un lunático.

(21) a) La señora en otoño se encargó de la azotea.

b) La señora en otoño se sorprendió de la azotea.

c) La señora en otoño se cayó de la azotea.

(22) a) El criminal en prisión entrenó sin razón aparente.

b) El criminal en prisión enfureció sin razón aparente.

c) El criminal en prisión se desplomó sin razón aparente.

(23) a) La anciana hace bastante bailó en una secta.

b) La anciana hace bastante creyó en una secta.

c) La anciana hace bastante nació en una secta.

(24) a) El veterinario muchas veces se rebeló por los animales.

b) El veterinario muchas veces temió por los animales.

c) El veterinario muchas veces se despertó por los animales.

(25) a) La cocinera justo ayer se responsabilizó del nuevo restaurante.

b) La cocinera justo ayer se sorprendió del nuevo restaurante.

c) La cocinera justo ayer desapareció del nuevo restaurante.

(26) a) El pescador hace tiempo se comprometió con la tripulación.

b) El pescador hace tiempo se sorprendió con la tripulación.

c) El pescador hace tiempo falleció con la tripulación.

(27) a) La florista el jueves se involucró en la replantación.

b) La florista el jueves confió en la replantación.

c) La florista el jueves se cayó en la replantación.

(28) a) El ganadero hace mucho cantó en el pueblo.

b) El ganadero hace mucho se ilusionó en el pueblo.

c) El ganadero hace mucho nació en el pueblo.

(29) a) La periodista estos meses se responsabilizó con mucha elegancia.

b) La periodista estos meses enfureció con mucha elegancia.

c) La periodista estos meses envejeció con mucha elegancia.

(30) a) El actor hace años cantó en la ópera.

b) El actor hace años gozó en la ópera.

c) El actor hace años creció en la ópera.

(31) a) La científica al principio se rebeló en el laboratorio.

b) La científica al principio confió en el laboratorio.

c) La científica al principio enfermó en el laboratorio.

(32) a) El pintor durante años se comprometió con la escritora.

b) El pintor durante años se alegró con la escritora.

c) El pintor durante años envejeció con la escritora.

(33) a) La campesina un día se rebeló por las injusticias.

b) La campesina un día se preocupó por las injusticias.

c) La campesina un día desapareció por las injusticias.

(34) a) El bombero en diciembre se implicó durante la nevada.

b) El bombero en diciembre temió durante la nevada.

c) El bombero en diciembre se desorientó durante la nevada.

(35) a) La socorrista este verano se encargó del nuevo trampolín.

b) La socorrista este verano se sorprendió del nuevo trampolín.

c) La socorrista este verano se cayó del nuevo trampolín.

(36) a) El jefe durante meses se comprometió con los empleados.

b) El jefe durante meses se ilusionó con los empleados.

c) El jefe durante meses se sentó con los empleados.

(37) a) La inspectora en Madrid se involucró en la investigación.

b) La inspectora en Madrid creyó en la investigación.

c) La inspectora en Madrid apareció en la investigación.

(38) a) El administrativo esta mañana se responsabilizó de la obra.
b) El administrativo esta mañana desconfió de la obra.
c) El administrativo esta mañana vino de la obra.

(39) a) La luchadora en secreto se esforzó durante la temporada.
b) La luchadora en secreto enfureció durante la temporada.
c) La luchadora en secreto enfermó durante la temporada.

(40) a) El trapecista justo ayer se arriesgó durante la función.
b) El trapecista justo ayer se enfadó durante la función.
c) El trapecista justo ayer se desplomó durante la función.

(41) a) La enfermera hace años bailó en el hospital.
b) La enfermera hace años confió en el hospital.
c) La enfermera hace años nació en el hospital.

(42) a) El marinero hace meses buceó en el Ártico.
b) El marinero hace meses disfrutó en el Ártico.
c) El marinero hace meses falleció en el Ártico.

(43) a) La maestra hace años cantó en la escuela.
b) La maestra hace años se disgustó en la escuela.
c) La maestra hace años creció en la escuela.

(44) a) El empresario en Marbella navegó sin ninguna preocupación.
b) El empresario en Marbella se divirtió sin ninguna preocupación.
c) El empresario en Marbella envejeció sin ninguna preocupación.

(45) a) La directora en marzo dimitió durante la presentación.
b) La directora en marzo se aburrió durante la presentación.
c) La directora en marzo se tropezó durante la presentación.

(46) a) El monitor esta semana entrenó en la montaña.
b) El monitor esta semana se divirtió en la montaña.
c) El monitor esta semana se resbaló en la montaña.

(47) a) La peregrina durante semanas corrió sin ningún remordimiento.

b) La peregrina durante semanas amó sin ningún remordimiento.

c) La peregrina durante semanas se despertó sin ningún remordimiento.

(48) a) El paracaidista en Zaragoza saltó durante la celebración.

b) El paracaidista en Zaragoza se alegró durante la celebración.

c) El paracaidista en Zaragoza se desmayó durante la celebración.

(49) a) La dentista este lunes se involucró en la clínica.

b) La dentista este lunes se aburrió en la clínica.

c) La dentista este lunes apareció en la clínica.

(50) a) El astronauta hace tiempo se esforzó en la misión.

b) El astronauta hace tiempo confió en la misión.

c) El astronauta hace tiempo falleció en la misión.

(51) a) La fotógrafa el martes se arriesgó en la galería.

b) La fotógrafa el martes disfrutó en la galería.

c) La fotógrafa el martes se resbaló en la galería.

(52) a) El informático el viernes se encargó de la cena.

b) El informático el viernes gozó de la cena.

c) El informático el viernes desapareció de la cena.

(53) a) La traductora muy recientemente se comprometió con el equipo.

b) La traductora muy recientemente se enfadó con el equipo.

c) La traductora muy recientemente vino con el equipo.

(54) a) El arquitecto el miércoles se responsabilizó del nuevo puente.

b) El arquitecto el miércoles desconfió del nuevo puente.

c) El arquitecto el miércoles se cayó del nuevo puente.

(55) a) La atleta muchas veces se arriesgó en la competición.

b) La atleta muchas veces creyó en la competición.

c) La atleta muchas veces se desmayó en la competición.

(56) a) El agricultor en Jaén corrió durante la manifestación.

b) El agricultor en Jaén se disgustó durante la manifestación.

c) El agricultor en Jaén se sentó durante la manifestación.

(57) a) La bibliotecaria el sábado bailó en la inauguración.

b) La bibliotecaria el sábado gozó en la inauguración.

c) La bibliotecaria el sábado se tropezó en la inauguración.

(58) a) El escalador hace mucho entrenó en los Alpes.

b) El escalador hace mucho amó en los Alpes.

c) El escalador hace mucho nació en los Alpes.

(59) a) La empleada en febrero se rebeló en la sede.

b) La empleada en febrero desconfió en la sede.

c) La empleada en febrero se desorientó en la sede.

(60) a) El boxeador de repente saltó en el ring.

b) El boxeador de repente enfureció en el ring.

c) El boxeador de repente se desplomó en el ring.

(61) a) La violinista muchas veces cantó en el conservatorio.

b) La violinista muchas veces se ilusionó en el conservatorio.

c) La violinista muchas veces enfermó en el conservatorio.

(62) a) El banquero un día dimitió por la ansiedad.

b) El banquero un día se preocupó por la ansiedad.

c) El banquero un día se despertó por la ansiedad.

(63) a) La surfista en Canarias buceó con el entrenador.

b) La surfista en Canarias se alegró con el entrenador.

c) La surfista en Canarias creció con el entrenador.

(64) a) El sargento en Cantabria navegó como de costumbre.

b) El sargento en Cantabria se preocupó como de costumbre.

c) El sargento en Cantabria apareció como de costumbre.

(65) a) La cirujana en noviembre se implicó por el paciente.

b) La cirujana en noviembre temió por el paciente.

c) La cirujana en noviembre se sentó por el paciente.

(66) a) El millonario al final entrenó en la mansión.
b) El millonario al final se aburrió en la mansión.
c) El millonario al final envejeció en la mansión.

(67) a) La dependienta hace poco se rebeló delante de todos.
b) La dependienta hace poco se enfadó delante de todos.
c) La dependienta hace poco se cayó delante de todos.

(68) a) El fontanero el lunes se encargó de la reparación.
b) El fontanero el lunes desconfió de la reparación.
c) El fontanero el lunes vino de la reparación.

(69) a) La camarera el sábado bailó toda la noche.
b) La camarera el sábado disfrutó toda la noche.
c) La camarera el sábado desapareció toda la noche.

(70) a) El técnico justo ayer se responsabilizó delante del jefe.
b) El técnico justo ayer enfureció delante del jefe.
c) El técnico justo ayer se resbaló delante del jefe.

(71) a) La buceadora hace tiempo saltó en la isla.
b) La buceadora hace tiempo se ilusionó en la isla.
c) La buceadora hace tiempo creció en la isla.

(72) a) El detective en primavera se involucró con gran entusiasmo.
b) El detective en primavera amó con gran entusiasmo.
c) El detective en primavera vino con gran entusiasmo.

(73) a) La conductora el jueves se esforzó durante el examen.
b) La conductora el jueves se sorprendió durante el examen.
c) La conductora el jueves se desorientó durante el examen.

(74) a) El jardinero en diciembre se arriesgó con la decoración.
b) El jardinero en diciembre se ilusionó con la decoración.
c) El jardinero en diciembre se tropezó con la decoración.

(75) a) La novelista hace años navegó cerca de Edimburgo.

b) La novelista hace años se divirtió cerca de Edimburgo.

c) La novelista hace años nació cerca de Edimburgo.

(76) a) El malabarista esta semana cantó en el circo.

b) El malabarista esta semana confió en el circo.

c) El malabarista esta semana se despertó en el circo.

(77) a) La dermatóloga rara vez corrió durante estos años.

b) La dermatóloga rara vez se disgustó durante estos años.

c) La dermatóloga rara vez enfermó durante estos años.

(78) a) El presentador al final buceó cerca de Cádiz.

b) El presentador al final gozó cerca de Cádiz.

c) El presentador al final envejeció cerca de Cádiz.

(79) a) La diputada en Bruselas dimitió durante la sesión.

b) La diputada en Bruselas temió durante la sesión.

c) La diputada en Bruselas se desmayó durante la sesión.

(80) a) El albañil en otoño se implicó en la reforma.

b) El albañil en otoño se alegró en la reforma.

c) El albañil en otoño falleció en la reforma.

(81) a) La coreógrafa en París se comprometió con otros artistas.

b) La coreógrafa en París disfrutó con otros artistas.

c) La coreógrafa en París creció con otros artistas.

(82) a) El piloto hace poco se arriesgó durante el campeonato.

b) El piloto hace poco temió durante el campeonato.

c) El piloto hace poco se desorientó durante el campeonato.

(83) a) La modelo en Milán se rebeló durante el desfile.

b) La modelo en Milán se disgustó durante el desfile.

c) La modelo en Milán se desplomó durante el desfile.

(84) a) El gerente en junio se encargó de la sucursal.

b) El gerente en junio desconfió de la sucursal.

c) El gerente en junio desapareció de la sucursal.

(85) a) La jueza en Salamanca se involucró durante la vista.

b) La jueza en Salamanca enfureció durante la vista.

c) La jueza en Salamanca enfermó durante la vista.

(86) a) El policía en Galicia saltó sin ninguna razón.

b) El policía en Galicia se preocupó sin ninguna razón.

c) El policía en Galicia se resbaló sin ninguna razón.

(87) a) La pediatra el jueves se esforzó en el ambulatorio.

b) La pediatra el jueves se aburrió en el ambulatorio.

c) La pediatra el jueves apareció en el ambulatorio.

(88) a) El arqueólogo en Egipto se comprometió con el historiador.

b) El arqueólogo en Egipto se enfadó con el historiador.

c) El arqueólogo en Egipto se cayó con el historiador.

(89) a) La manicurista esta mañana cantó en el negocio.

b) La manicurista esta mañana creyó en el negocio.

c) La manicurista esta mañana se sentó en el negocio.

(90) a) El meteorólogo justo ayer dimitió de manera inesperada.

b) El meteorólogo justo ayer se alegró de manera inesperada.

c) El meteorólogo justo ayer falleció de manera inesperada.

(91) a) La azafata durante meses se responsabilizó en el avión.

b) La azafata durante meses confió en el avión.

c) La azafata durante meses se despertó en el avión.

(92) a) El pastelero en Roma corrió con la tarta.

b) El pastelero en Roma se divirtió con la tarta.

c) El pastelero en Roma se tropezó con la tarta.

(93) a) La compositora hace tiempo bailó en la iglesia.

b) La compositora hace tiempo creyó en la iglesia.

c) La compositora hace tiempo se desmayó en la iglesia.

(94) a) El pastor hace décadas entrenó en el monte.
b) El pastor hace décadas gozó en el monte.
c) El pastor hace décadas nació en el monte.

(95) a) La vendedora hace días navegó con unos amigos.
b) La vendedora hace días se sorprendió con unos amigos.
c) La vendedora hace días se desplomó con unos amigos.

(96) a) El guionista en California buceó completamente en secreto.
b) El guionista en California amó completamente en secreto.
c) El guionista en California envejeció completamente en secreto.

3. Model comparison of Experiment 3

I used the same model comparison methodology as in Experiment 1.

(1) Example of model syntax:

Null model: Total Duration ~ 1

Model surprisal: Total Duration ~ Surprisal values

Model predictor: Total Duration ~ Event Role

Full model: Total Duration ~ Event Role + Surprisal values

Measure	Null model	Model surprisal	Model predictor	Full model
Gaze Duration				
Subject region	**0.940**	0.060	0.000	0.000
Pre-verb region	0.137	0.146	**0.717**	0.000
Verb region	0.060	0.000	0.000	**0.940**
Post-verb region	0.221	**0.608**	0.171	0.000
Regression Path Duration				
Subject region	**0.708**	0.287	0.005	0.000
Pre-verb region	0.429	**0.571**	0.000	0.000
Verb region	0.019	0.047	0.102	**0.833**
Post-verb region	0.000	0.411	**0.583**	0.007
Re-Reading Duration				
Pre-verb region	**0.698**	0.302	0.000	0.000
Verb region	0.000	0.362	**0.634**	0.004
Post-verb region	0.114	**0.786**	0.000	0.100
Regression Out Count				
Pre-verb region	**1.000**	0.000	0.000	0.000
Verb region	**0.926**	0.000	0.074	0.000
Post-verb region	0.299	0.000	**0.701**	0.000
Regression In Count				
Subject region	**0.566**	0.434	0.000	0.000
Pre-verb region	0.199	**0.665**	0.117	0.020
Verb region	0.350	0.001	**0.650**	0.000
Post-verb region	0.000	**1.000**	0.000	0.000
Total Duration				
Subject region	**0.680**	0.320	0.000	0.000
Pre-verb region	**0.598**	0.393	0.000	0.009
Verb region	0.000	0.031	0.155	**0.814**
Post-verb region	0.000	**0.601**	0.271	0.127

4. Raw data of Experiment 3

Eye-tracking measures	Subject Region	Pre-verb Region	Verb Region	Post-verb Region
	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Gaze Duration				
Agent	512 (226)	369 (167)	364 (211)	329 (193)
Experiencer	507 (198)	381 (174)	340 (166)	348 (208)
Patient	510 (217)	373 (177)	343 (169)	328 (197)
Regression Path Duration				
Agent	512 (226)	441 (258)	408 (254)	497 (475)
Experiencer	508 (202)	442 (234)	387 (210)	532 (573)
Patient	510 (217)	451 (262)	378 (207)	450 (409)
Re-reading Duration				
Agent		585 (365)	551 (349)	719 (606)
Experiencer		549 (299)	504 (221)	748 (828)
Patient		608 (331)	495 (315)	662 (479)
Regression Out Count				
Agent		0.13 (0.36)	0.08 (0.28)	0.16 (0.43)
Experiencer		0.12 (0.34)	0.09 (0.30)	0.18 (0.47)
Patient		0.13 (0.36)	0.07 (0.27)	0.12 (0.37)
Regression In Count				
Agent	0.54 (0.78)	0.25 (0.49)	0.35 (0.57)	0.34 (0.51)
Experiencer	0.51 (0.72)	0.30 (0.56)	0.36 (0.58)	0.40 (0.55)
Patient	0.54 (0.78)	0.26 (0.54)	0.29 (0.54)	0.39 (0.57)
Total Duration				
Agent	673 (382)	514 (278)	522 (317)	493 (282)
Experiencer	651 (315)	530 (300)	496 (278)	533 (330)
Patient	674 (380)	514 (289)	467 (269)	492 (296)

5. Time-course analysis of Experiment 4

In addition to the main ERP analyses restricted to two predefined time windows, an additional time course analysis spanning the interval from –100 to 896 ms relative to the onset of the critical verb was conducted. This analysis focused on a central-posterior region of interest, including electrodes Cz, CP1, CP2, C3, C4, Pz, P4, P8, and CP6. The model that included experimental condition as a predictor provided a significantly better fit than the null model ($F(2.84) = 1360.6$, $p < .001$).

Pairwise comparisons between conditions (Agent vs. Experiencer, Agent vs. Patient, and Experiencer vs. Patient) revealed consistent differences between 300-500 ms and 600-800 ms following the verb onset. This time course analysis supports the selection of time windows used in the main analyses (centered on the N400 and P600 components). Some earlier effects were also detected though the interpretation of very early ERP responses remains controversial (Isasi-Isasmendi, Sauppe, et al., 2023). It is more plausible that such early differences arise from visual or lexical characteristics of the verb stimuli, since the verb sets differ across conditions.

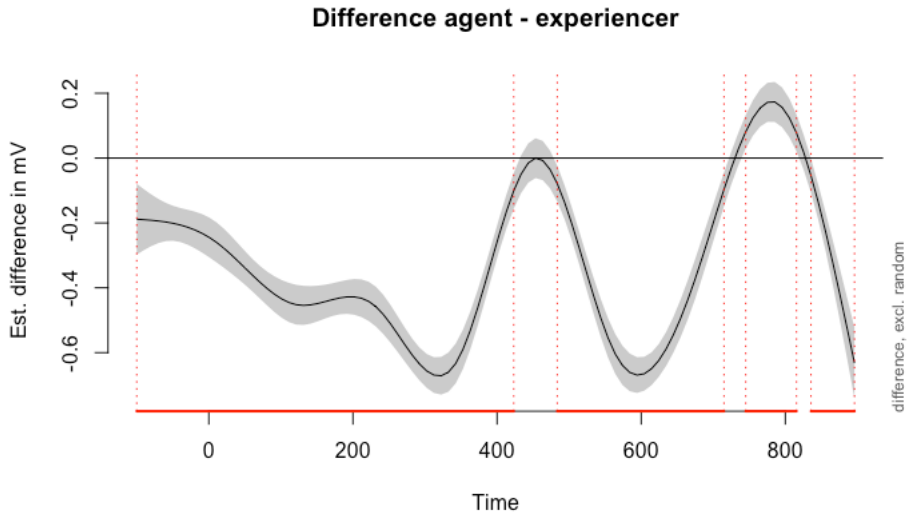

Figure D.01: Temporal distribution of amplitude differences between Agent and Experiencer conditions, extracted from the GAMM model. Red areas indicate where the difference between conditions is significant (confidence interval does not include zero).

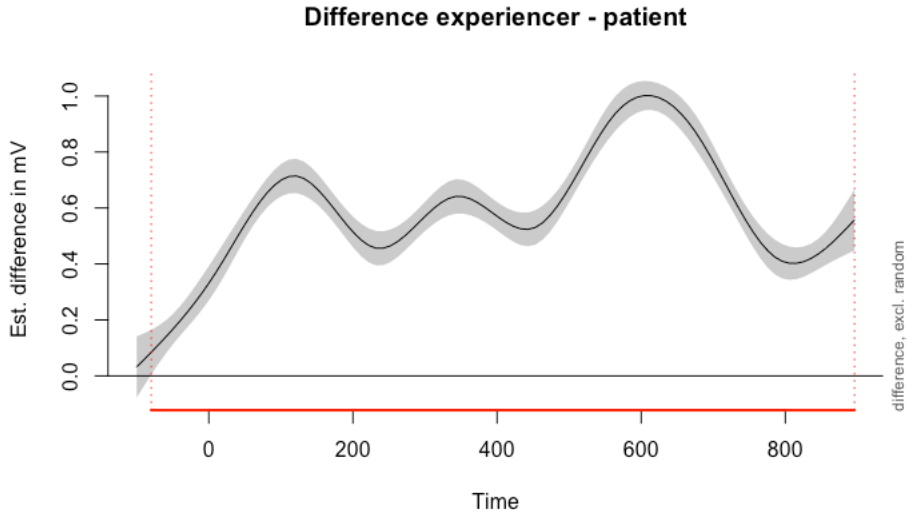

Figure D.02: Temporal distribution of amplitude differences between Experiencer and Patient conditions, extracted from the GAMM model. Red areas indicate where the difference between conditions is significant (confidence interval does not include zero).

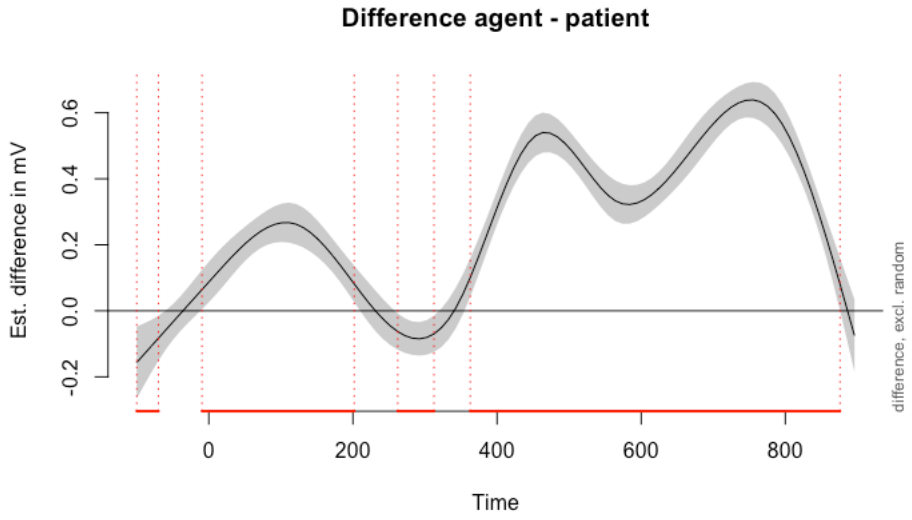

Figure D.03: Temporal distribution of amplitude differences between Agent and Patient conditions, extracted from the GAMM model. Red areas indicate where the difference between conditions is significant (confidence interval does not include zero)

6. Model comparison of Experiment 4

For ERPs models, I used the same methodology as in Experiment 3 for model comparison, and the same model syntax.

ERP models

Time-window	Null model	Model surprisal	Model predictor	Full model
300-500 ms	0.020	0.000	**0.975**	0.005
600-800 ms	0.001	0.300	**0.676**	0.023

For TFA models, I used the Akaike information criterion (AIC) for model comparison, since they are Frequentist models. The AIC values are reported here, with lower values indicating better model fit.

TFA models

Theta band

Time-window	Null model	Model surprisal	Model predictor	Full model
300-500 ms	7985389	7985388	**7984991**	7984994
600-800 ms	6878178	6878165	**6877111**	**6877111**

Alpha band

Time-window	Null model	Model surprisal	Model predictor	Full model
300-500 ms	24072792	24072776	24069765	**24069741**
600-800 ms	24039177	24039112	24037364	**24037279**

Low-beta band

Time-window	Null model	Model surprisal	Model predictor	Full model
300-500 ms	29379683	29379645	29376655	**29376607**
600-800 ms	29352290	29352216	29348592	**29348505**

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