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Doctoral Dissertation

Processing Argument Structure: Eye-tracking Evidence from Spanish Native Speakers in the Visual World Paradigm

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Abstract

Psycholinguistic research on argument structure and thematic roles is essential to the understanding of language at the predicate level. Despite their centrality to linguistic theory, few studies have investigated thematic roles in processing directly (Bourguignon et al., 2012; Hafri, Papafragou and Trueswell, 2013; Kowalski and Huang, 2017; Sauppe et al., 2023; Ünal et al., 2024), resulting in little evidence regarding their processing patterns and underlying structure as cognitive categories. In this dissertation, I seek to fill this gap by investigating the processing of sentential subjects in different argument structures in Spanish. Specifically, I investigate two factors (thematic role and prototypicality) that affect the post-verbal activation of sentential subjects in the mental representation of speakers during sentence comprehension, and how these patterns can inform on the structure of thematic roles as cognitive categories. Using eye tracking and the Visual World Paradigm, I carried out three psycholinguistic experiments exploring (a) the impact of thematic role (Chapter 2) and prototypicality (Chapter 3) in subject processing patterns in unaccusative, unergative and transitive predicates, and (b) the processing of sentential subjects in psychological predicates to investigate the representation of thematic roles as cognitive categories (Chapter 4). Results show a general agent preference, modulated by prototypicality, in the processing of sentential subjects in unaccusative, unergative and transitive sentences. Additionally, I show evidence supporting a proto-role theory of thematic roles, finding that agent subjects and experiencer subjects share a common processing pattern, different from that of theme subjects.

To the snails, and how they come out when it rains.

Acknowledgements

Getting a PhD is the wildest ride I've ever been on. One good morning I stepped in and buckled up, young and naive, determined to achieve that kind of flawless, resounding success only the movies talk about. Needless to say, the PhD roller coaster had other plans for me. All of a sudden, it set in motion faster than the wind—heck, faster than a horse racing past the barn. And so, just like the horse, I too ended up falling. And let me tell you, I fell *hard*.

I thought about getting off this ride countless times. Somehow, I couldn't shake off that nauseous feeling, and at the back of my mind bitter questions began to harbor. *Is it worth the trouble, to become a language scientist? Am I even good enough to be here?* Intently, I listened to my seniors talk about the perks of the journey; but their words felt unreal, and I began to spiral. My imperfections piled up before me like a mountain so colossal that it felt impossible to move past it. For a while I sat at the bottom of that mountain, as tiny as a snail, waiting for it to crumble on its own. It only got bigger. Until one day I decided to go for a walk, just to see where it would get me. No promises of making it.

Just one step after another.

That's when the silver linings came into view. I caught myself taking pride in my own research when I shared it with others. There was relief, and excitement, whenever something which could have gone terribly wrong actually went right. I marveled at the sense of wonder I felt ploughing through my data, and when things started to make sense in my head. That magical click: the two puzzle pieces fitting together. The happiness that lives inside the shell of a small answer. *Probably insignificant*, I thought, *the answers I could give.*

But to me they felt precious.

And so, as the years went by, I climbed my mountain and found another voice of mine at the other side. A voice that now screams *You did it, you did it, you *bleep* *bleep* did it!* at the top of its lungs. There was maturation and growth, in every human way possible.

Thankfully, for my sanity, there was a finish line as well. And now as I am crossing it, I can't help but be taken back to the very beginning, to the reason why this journey had to begin at all.

Ever since I was a child, I have wondered deeply about the *whys* and *why nots* of things. I think the scientist in me awakened when I was a toddler, once I discovered what snails are and how they come out when it rains. The phenomenon completely fascinated me. At daycare, I took any chance I got to sneak out to the garden to look for those wondrous creatures. Meanwhile, I was learning to speak, and made a big fuss about that as well. I was one of those precocious little talkers, the ones who chatter on and on at the tender age of two and a half. Language became the most powerful of tools, which I used to convince people to let me out to the garden so I could sing the snails a little song. I'd also tell my mother things like 'Te quiero *mucha*,' and she'd try to correct me, offering the right word instead. But it was never in my nature to surrender. I actually argued my case most times, as a toddler, explaining what she seemed to be missing: that she, the fool, was undeniably a *girl*. It was so obvious back then: I loved language, and language seemed to love me back. Together, we were both in our prime. I wonder if it was fate, or a curse maybe, how many years later, I attended a Linguistics class at university, and couldn't help but fall in love with language all over again. From the moment I first read something of Chomsky's, I knew I was trapped: for better or for worse, I was bound to become a language scientist.

There are many people without whom I couldn't have gotten here, and I am ever grateful for their presence, support and guidance. First and foremost, I am grateful to my mother, a plant biologist who gave me life, language and, perhaps most importantly, a good guide to snail identification. She taught me all about nature, and how natural it is to ask it questions: to wonder about its intricate workings, its endless possibilities, its dazzling miracles. I believe this simple teaching, the legitimacy of asking questions, sits at the core of science. After all, a researcher is but a curious mind with a question, endurance, and (seldom) good-enough funding. I just hope that someday I'll be able to pass on this itch for knowledge to some little one too. I also hope I'll never stop wondering about the whys and why nots of language, or any other piece of nature, the way she taught me.

I am extremely grateful to my long-lasting academic mentors, Víctor Longa, Miren Arantzeta and Itziar Laka, who have always fueled and nurtured my love for language: thank you for believing I was good enough to get this far. Víctor, if it weren't for your kind and inspiring support, I never would have thought I had what it takes to become a linguist. Itziar, your fiery ideas and your fierce tenacity have never left me indifferent. Thank you for pushing me further than I thought I could go.

The Bilingual Mind research group in its entirety has been completely essential to my research. I am ever grateful to doctors Mikel Santesteban, Kepa Erdozia, Adam Zawiszewski and Irene de la Cruz, whose mentoring has meant a great deal to me—perhaps more than they know. My older colleagues, Sergio López-Sancio, Gillen Martínez de la Hidalga, Luis Pastor and Marta De Pedis, who finished their PhD before me and taught me just about *everything*. My younger colleagues, Noèlia Sanahuja, Victoria Cano, Patricia Fuente, and Marta Sánchez, who somehow managed to get work done with me around. Edurne Peritrena, our former lab administrator, who saved me from the claws of paperwork in numerous occasions. And finally, my endless gratitude to Yolanda Acedo, our lab technician; even when technology tried to sabotage my research, I had a great friend to help me out.

To all the people that have stuck by me during these difficult years: you make my thesis go around. Mar, Sergio, you are the best PhD buddies I could have ever asked for. I've learned that that to be loved is to be truly understood. I only hope that our understanding will grow even bigger and deeper as we age.

Lastly, I am forever grateful to Cata, the kindest, most caring person I have the pleasure of knowing. We met when we were two, and met again around twenty. As toddlers, I was the first person ever to show her what a snail was, but neither of us realized that until much later. She made the connection a few years ago, when I stopped dead in my tracks during a hike to crouch down next to a snail. She said she'd never seen someone spot one so easily, and then she remembered: many years ago, at daycare, a little kid showing her the snails, with enthusiasm bordering on devotion. She realized that kid had been me all along. And who knows why I loved snails so frigging much, but the thing was that I just did. The fact that I was so keen to grab her hand and show her what I loved, and the fact that she remembered, is probably what did it for us. Thank you for meeting me so many times throughout our lives. Thank you for listening carefully when I ramble on about language, and science, and research I'll never do—which is pretty much all the time. Thank you for being my greatest friend, my biggest support, and the sweetest home I'll ever know. Thank you for making beautiful art to go with this book. I can't wait to see what life has in store for us.

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List of Abbreviations

AFH Agent First Hypothesis

APH Agent Preference Hypothesis

APH*p Agent Preference Hypothesis modulated by prototypicality effects

EDCH Experiencers as a Distinct Category Hypothesis

GCA Growth Curve Analysis

NP Noun Phrase

NVN Noun Verb Noun

PPH Prototypicality Preference Hypothesis

PRH Proto-Role Hypothesis

ROI Region Of Interest

S Subject

UH Unaccusative Hypothesis

VP Verb Phrase

VWP Visual World Paradigm

Chapter 1.
General introduction

One of the most essential functions of language is to express *who did what to whom* in a given situation. For example, in transitive sentence (1), it is *the athlete* who hit *the ball*, and—thankfully for the athlete—not the other way around.

(1) The athlete hit the ball.

Argument structure research investigates precisely how language conveys this kind of information, i.e., that there is an event involving an athlete and a ball, and that the athlete is doing the hitting. Embedded within the larger field of the syntax-semantics interface, which studies how meaning and structure are related in language, argument structure explores the relationship between verb meaning and the number and type(s) of arguments it can take. In this manner, argument structure is understood as the general patterns of syntactic relationships between a verb and its argument(s) or, in other words, how a verb's argument(s) are mapped onto syntactic structures. For example, whereas *hit* is a transitive verb that requires two arguments (one hitter, and one being hit), the intransitive verb *die* can only take a single argument (2). It follows, then, that predicates (1) and (2) have different argument structures.

(2) The athlete died this morning.

The notion of *thematic role* is crucial to the understanding of argument structure, as it captures the relationship that event participants have both to the event itself and to one another (in the case of multiple arguments). Thematic roles are generally understood to be syntax-semantic categories that the verb assigns to the participants implicated in the event (Åfarli, 2007). In this manner, the most widely accepted view is that verb semantics determines the thematic role of the participant(s) involved, and thus dictates the predicate's argument structure. Since the 1960s, a number of thematic roles have been proposed to account for semantic and syntactic generalizations observed across predicates regarding the role that a given participant adopts in the event (Gruber, 1965; Jackendoff, 1972; Chomsky, 1981). For example, in (1), the sentential subject adopts an active role that affects the ball by hitting it. Likewise, in (3), the sentential subject also adopts an active role that affects another event participant, this time by killing it.

(3) The athlete killed a fly.

It is due to these similarities that the sentential subjects in (1) and (3) are considered to bear an *agent* thematic role. Other commonly accepted roles include patients, themes, goals, instruments and experiencers, although it is worth noting that the precise list of thematic role categories varies from author to author. In fact, there is a considerable amount of controversy surrounding the theoretical understanding of thematic roles at their very core, which has given way to a wide range of proposals regarding the nature and structure of these categories. From dozens-long lists of roles (Fillmore, 1971; Levin, 1993; Pesetsky, 1995; Levin and Rappaport-Hovav, 2005, *inter alia*) to proposals that center around a couple of proto-role categories (Dowty, 1991; Ackerman and Moore, 2001), the question of what thematic roles *are*, and *how many* there are, remains a topic of substantial disagreement within the field of both theoretical and experimental linguistics to this day. For this reason, thematic roles are still considered to be among the most central and yet nebulous constructs in any area of linguistic theory (Newmeyer, 2010).

Due to the diversity of optics through which argument structure types and thematic roles have been examined in linguistic research, there is no clear consensus yet as to how exactly these categories are assigned, processed and represented in the mental state of speakers. Other important questions surrounding this topic include whether there are key factors that determine thematic role processing patterns, as well as whether thematic roles constitute distinct and discrete categories, or rather, cluster categories with a proto-role structure. In this regard, there is not, to my knowledge, any thorough investigation of argument structure and thematic role processing that investigates the processing patterns of different predicate types and their arguments by tapping into their level of activation in the mental representation of listeners as they comprehend sentences, and which can address the questions outlined above. In this dissertation, I focus precisely on these issues by exploring the processing of arguments in different predicate types in Spanish, a nominative-accusative language with highly limited case-marking morphology.[1] Specifically, I investigate the processing patterns of agent and theme sentential subjects in intransitive predicates, as well as agent subjects in transitive predicates, by focusing on

[1] Note that, in Spanish, NPs operating as sentential subjects do not display any case-marking morphology; these arguments are the main objects of study in this dissertation.

the effect of thematic role on sentential subject processing. Additionally, I also investigate the interplay between thematic role and feature of animacy in argument structure processing by focusing on whether and how prototypicality of the argument significantly modulates its processing. Finally, I also explore the structure of thematic roles as categories in processing by focusing on whether traditional thematic roles that have been theoretically justified in the literature display distinct processing patterns or not, this time by examining the processing patterns of experiencer subjects.

1. Thematic roles

Thematic roles play a central role in both theoretical and experimental linguistics, as they describe the relationships that participants have in a given predicate, both among themselves (in the case of multiple arguments) and with respect to the event described by the verb. Although thematic roles have received some experimental attention in psycholinguistic and event perception research (Altmann, 1999; Manouilidou et al., 2009; Bourguignon et al., 2012; Kowalski and Huang, 2017; Sauppe et al., 2023), most of the psycholinguistic research that invokes the notion of thematic role do not study them directly (Trueswell, Tanenhaus and Garnsey, 1994; Boland et al., 1995; Frisch and Schlesewsky, 2001; Dahan and Tanenhaus, 2004; Kretzschmar et al., 2012; Buckle, Lieven and Theakston, 2017, *inter alia*). Due to their centrality in this Doctoral Dissertation, in this section I will provide a revision of the key aspects that surround the discussion of thematic roles and argument structure.

From the 1960s onwards, thematic role categories have received a great deal of attention in the theoretical study of syntax and lexical-semantics. The diversity of frameworks from which thematic roles have been entertained accounts for the variety of labels associated with them, including terms like *thematic relations* (Gruber, 1965), *deep semantic cases* (Fillmore, 1968), *thematic categories* (Jackendoff, 1972), and *theta roles* (Chomsky, 1981). Seminal works in generative linguistics (Jackendoff, 1972; Grimshaw, 1990; Pesetsky, 1995; Levin and Rappaport-Hovav, 1995, 2005) have appealed to this notion in order to establish mappings between the lexical-semantic properties of arguments and their syntactic realizations, thus becoming a central component of argument structure.

The works above, which are examples of list-based theories of thematic roles, have proposed a variety of categories (e.g., agent, patient, theme, goal, etc.) with the aim of capturing all the possible ways in which arguments relate to verbs in natural languages.

This is because, in these theories, thematic roles function as a finite set of abstract labels that are used to explain how verbs select their arguments and how these arguments are syntactically realized across languages. Crucially, there is considerable disagreement in the field over the exact list of roles that should be included in a comprehensive theory of lexical-semantics. For example, terms like *figure* and *ground* (Talmy, 1985), *neutral* (Rozwadowska, 1988), or *landmark* (Jackendoff, 1983) have been proposed as candidates for thematic roles, but not been accepted into others' theories (Grimshaw, 1990; Pesetsky, 1995; Levin and Rappaport-Hovav, 1995, 2005). There is also substantial debate surrounding the semantic properties associated with some roles, and differing views on how to categorize them. For instance, while some proposals distinguish between patients and themes as two different categories (Fillmore, 1968; Pesetsky, 1995; Levin and Rappaport-Hovav, 2005), others classify them as one single role (Jackendoff, 1972; Dowty, 1991).[2,3] In fact, the long-standing obscurity surrounding the notion of thematic role is such that, according to Dowty (1991), none of the aforementioned authors has attempted to provide an exhaustive list of roles. Because of this, consensus on which categories are needed to account for natural language semantics is yet to be reached within the field (Newmeyer, 2010). In the following section, I will further explore the differences across theories of thematic roles by discussing one of their most significant points of contention: the structure of thematic roles as categories.

1.1 The nature of thematic role categories

One of the most important characteristics of list-based proposals of thematic roles (Fillmore, 1971; Nishigauchi, 1984; Belletti and Rizzi, 1988; Levin, 1993; Levin and Rappaport-Hovav, 1995; Pesetsky, 1995, *inter alia*) is that they conceive thematic relations as discrete and distinct categories, putting forward a finite list of roles in order to encompass all the possible syntax-semantic relationships that event participants can bear. This particular conceptualization of thematic roles, i.e., one that relies on discreteness and distinctness, is not shared by proto-role theories (Dowty, 1991; Ackerman and Moore,

[2] The formal distinction between patients and themes in these approaches revolves around the features of *movement* and *change of state*. According to this, patients correspond to entities that undergo a change (e.g., The athlete broke *the window*), while themes correspond to entities that are moved but not necessarily changed by the action (e.g., The athlete hit *the ball*) (Fillmore, 1968; Pesetsky, 1990; Levin and Rappaport-Hovav, 2005).

[3] In this Doctoral Dissertation, I will use the term *theme* to refer to both patients and themes as a single category, unless specifically stated otherwise.

2001). Instead, Dowty's (1991) seminal work on the prototype structure of thematic roles is based upon the workings of *Prototype Theory*, a cognitive framework that claims that natural class concepts are not formed based on a well-defined set of features, but rather centered around *prototypes*, or typical examples, which serve as idealizes representatives of the category (Rosch et al., 1976; Rosch, 1973). His proposal claims that the best theory to account for thematic roles is not a traditional system of discrete roles (agent, theme, source, goal, etc.), but rather a theory of proto-roles (Dowty, 1991). This includes two cluster-concepts, *proto-agent* and *proto-patient*, each characterized by a set of verbal entailments; these determine the grammatical function that an argument is assigned in a given predicate. It is worth noting, however, that Dowty's (1991) theory of proto-roles does not subscribe to a Roschian view of thematic roles in which some members of the category are core exemplars, while other members are peripheral. Instead, it claims that thematic relations cannot be decomposed into discrete features, and therefore proposes two proto-role cluster concepts for thematic role assignment.

The most important difference between list-based and proto-role theories of thematic roles has to do with their assumptions regarding the *nature* of these categories. Whereas list-based proposals claim that they constitute discrete and distinct roles that do not overlap, proto-role accounts such as Dowty's (1991) claim that two maximally-different cluster categories (i.e., proto-agents and proto-patients) suffice to explain linguistic phenomena surrounding the topic of thematic role assignment. Despite the fact that thematic relations have been studied experimentally (Altmann, 1999; Manouilidou et al., 2009; Bourguignon et al., 2012; Hafri, Papafragou and Trueswell, 2013; Kowalski and Huang, 2017; Sauppe et al., 2023), research on these cognitive categories is scarce, and the question of whether the evidence supports the existence of distinct categories or proto-role categories in processing is unclear. This is because no psycholinguistic research to date has attempted to uncover the processing correlates of the most widely accepted roles proposed by list-based theories (e.g., agent, theme, source, goal, etc.). To my knowledge, the study that best aligns with this understudied research question is the eye-tracking study by Ünal et al. (2024), which explores the prominence of agents, themes, goals and instruments within the field of event perception. In their eye-tracking research, Ünal et al. (2024) use a series of tasks, including visual search and picture description, in order to gather measures informing on the saliency of four thematic role categories. Their results show significant differences across all four conditions, thus suggesting a prominence hierarchy of thematic roles in which agents are the most prominent role, followed by themes, then goals and, finally, instruments.

As advanced above, most of the available evidence of thematic roles in processing streams from studies which did not investigate them directly, but rather invoked this notion in order to explore the effect of important factors (e.g., word order, animacy, grammatical functions, etc.) in sentence processing (Kelly, Bock and Keil, 1986; Altmann, 1999; Trueswell, Tanenhaus and Garnsey, 1994; Boland et al., 1995; Frisch and Schlesewsky, 2001; Dahan and Tanenhaus, 2004; Kretzschmar et al., 2012; Buckle, Lieven and Theakston, 2017, *inter alia*). For example, Altmann (1999) investigated the time course of anomaly detection in embedded sentences by means of self-paced-reading methods. When interpreting results regarding how and when participants use contextual information to detect these anomalies, the author makes claims about the time course of thematic role assignment of preverbal subjects in sentence processing; however, this topic was not studied directly in his research (Altmann, 1999). Consequently, this heterogeneous body of research does not provide evidence to adjudicate between list-based and proto-role theories of thematic roles, as it is not concerned with the exploration the underlying mental representation as cognitive categories. In fact, only a handful of studies (Bourguignon et al., 2012; Hafri, Papafragou and Trueswell, 2013; Kowalski and Huang, 2017; Sauppe et al., 2023; Ünal et al., 2024) can be considered to have explored thematic roles directly.

Despite the scarcity of experimental evidence on this topic, a couple of annotation studies of semantic properties (Kako, 2006; Reisinger et al., 2015) find evidence compatible with the claims of proto-role theories of thematic roles, especially with those in Dowty's (1991) *Proto-Role Hypothesis* (henceforth PRH). In these studies, which investigated the representation and categorization of agent and theme categories, participants were asked to indicate which semantic properties they associated with each of the two event participants in a transitive sentence. Results show that sentential subjects and objects are consistently associated with the proto-agent and proto-patient properties laid out in Dowty (1991), respectively. For instance, they found that sentential subjects were more often associated with proto-agent properties, such as *volitional involvement in the event*, *sentience*, and *causing an event*; by contrast, sentential objects were more often associated with proto-patient properties, such as *undergoing a change of state*, or *being affected by another participant* (Kako, 2006; Reisinger et al., 2015).

Findings in Rissman and Majid (2019) are also especially relevant for the consideration of thematic role categories from a cognitive point of view. These authors carried out an extensive review of psycholinguistic, cognitive science, language acquisition and language typology research. Overall, they claim that there is robust evidence for the distinct representation of abstract agent and theme roles categories, which they purport to be "core knowledge" (Rissman and Majid, 2019). This finding partially aligns with Dowty's (1991) proposal containing only two primary proto-roles, proto-agent and proto-patient. However, Rissman and Majid (2019) also report finding robust evidence of abstraction for two other thematic role categories, i.e., goals and recipients; this particular aspect of their findings does not align with Dowty's (1991) claims. The results presented in Ünal et al. (2024) do not align with Dowty's (1991) PRH either, as these authors found evidence of prominence differences between four thematic role categories: agents, themes, goals and instruments. Finally, Manouilidou et al. (2009) report finding evidence of experiencers in processing, as they found that speakers with Alzheimer's disease showed greater difficulties in sentence-completion tasks with psychological verbs (which are assumed to assign one of the arguments the experiencer role) compared to verbs requiring agents and themes. It could be argued that these findings are not, in principle, compatible with PRH predictions.

In sum, the study of thematic roles as cognitive categories constitutes a mostly unexplored field within cognition and psycholinguistics, despite the centrality of thematic roles in any theory of language. More precisely, investigating whether thematic roles are distinct categories or proto-role types remains one of the main unexplained issues in psycholinguistic research investigating argument structure and thematic roles. To my knowledge, no other study to date has attempted to tackle this issue experimentally in order to discriminate between a proto-role and a list-based theory of thematic roles in processing.

1.2 The processing of intransitive predicates

Another topic of long-lasting discussion surrounding the notion of thematic roles has to do with the split of intransitive predicates into unergatives (4) and unaccusatives (5). On the one hand, unergative verbs take an agent as a single argument; on the other hand, unaccusatives take a theme (Perlmutter, 1978; Burzio, 1986; Dowty, 1991; Levin and Rappaport-Hovav, 1995).

(4) The athlete ran.

(5) The athlete fell.

This split of intransitive predicates, or *split intransitivity*, was proposed to systematically account for the heterogeneous properties of intransitive predicates at the syntax-semantics interface, especially with regards to case-marking, word order and auxiliary selection in a variety of languages (see Perlmutter, 1978, for a full discussion). The exploration of the syntactic and semantic differences between unergative and unaccusative predicates culminated in the formulation of the *Unaccusative Hypothesis* (henceforth UH), which claims that the syntax of unaccusative predicates (5) is more complex than that of unergatives (4) (Perlmutter, 1978).

Psycholinguistic research testing the UH has indeed found processing differences between unaccusative and unergative predicates. These studies report psychometric measures that reflect a higher processing cost for unaccusatives compared to unergatives; this, in turn, supports the claim of a higher syntactic complexity in the case of unaccusative predicates (Kegl, 1995; Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; M. Lee and Thompson, 2004; J. Lee and Thompson, 2011; Friedmann et al., 2008; McAllister et al., 2009; Koring, Mak and Reuland, 2012; Meltzer-Asscher et al., 2015; Momma, Slevc and Phillips, 2018).

However, other lines of research that also investigate the processing of predicate types involving agents and themes make no mention of the UH in their interpretation of results, despite finding important differences between conditions. For example, in sentence processing, a preference for agent-initial sentences in syntactically ambiguous contexts is found in a variety of languages (Ferreira, 2003; Bornkessel and Schlesewsky, 2006a; Laka and Erdocia, 2012; Lamers, 2012; Bisang, Wang and Bornkessel-Schlesewsky, 2013; Huang et al., 2013). This finding is interpreted as evidence in favor of the *Agent First Hypothesis* (henceforth AFH), which claims that the first ambiguous NP in a sentence is preferably processed as an agent. A similar finding is also described in language acquisition research, in which production studies report that children prefer agent-initial structures, both in oral and sign language modalities (Goldin-Meadow and Feldman, 1977; Angiolillo and Goldin-Meadow, 1982; Goldin-Meadow and Mylander, 1998). Finally, in event perception research, a preference for first fixations on agents as compared to themes is also found (Webb, Knott and MacAskill, 2010), with role recognition taking place faster and/or earlier for agents (Segalowitz, 1982), as well as an attentional preference towards agents (Robertson and Suci, 1980; Hamlin, Wynn and Bloom, 2007; Hamlin et al., 2011; Cohn and Paczynski, 2013).

Taken together, the evidence reported in these studies points towards a generalized processing distinction between agents and themes, as well as a general agent preference that causes a processing, attentional and/or perceptual bias to prefer agent arguments compared to theme arguments as event participants. Crucially, the UH-compatible results outlined above are also compatible with such an agent preference, but this interpretation was not originally considered in the studies. Disentangling between the two mainstream interpretations of this agents vs. themes body of research constitutes one of the pending assignments of current psycholinguistics. To my knowledge, no other study to date has been devoted to pitting both hypotheses against each other in the same experiment in order to discriminate between the UH and a general agent preference in the interpretation of sentence processing results.

2. Prototypicality as an interaction between thematic role and animacy

Experimental research investigating event perception, thematic roles and sentence processing has also given ample attention to the feature of animacy, as this factor has been found to constitute an important semantic cue that guides both event perception and language-related predictive processes (Heider and Simmel, 1944; Adams and Conklin, 1973; Mandler, 1992; Kanwisher, McDermott and Chun, 1997; Caramazza and Shelton, 1998; Chao, Martin and Haxby, 1999; Perani et al., 1999; Weckerly and Kutas, 1999; Frisch and Schlesewsky, 2001; Leube et al., 2001; Rakison and Poulin-Dubois, 2001; Traxler, Morris and Seely, 2002; Molina et al., 2004; Mahon and Caramazza, 2005; Traxler et al., 2005; Jäger, 2007; New, Cosmides and Tooby, 2007; Dahl, 2008; Demiral, Schlesewsky and Bornkessel-Schlesewsky, 2008; Philipp et al., 2008; Gao, McCarthy and Scholl, 2010; Muralikrishnan, Schlesewsky and Bornkessel-Schlesewsky, 2015). One of the most fundamental findings is that of a general preference for animate entities compared to inanimates in humans (Kriegeskorte et al., 2008; Poulin-Dubois, Crivello and Wright, 2015; Abdai et al., 2017) which, paired with a general preference for animate agents among hominids in general (New, Cosmides and Tooby, 2007; Brocard et al., 2024), reveals an important link between the feature of animacy and thematic role conceptualization in human cognition. The interaction between these two factors, animacy and thematic role, is best explored by means of the notion of *prototypicality*.

Prototypicality is a key concept in psychology, cognitive science, and linguistics, as it accounts for how the human mind categorizes information. In short, prototypicality makes reference to how typical or representative a member of a category is, with more prototypical members being central to the category, and less prototypical ones being peripheral. This idea is central to Prototype Theory, which argues that natural class concepts are organized around prototypes, or ideal examples, rather than a fixed set of features, thus allowing for graded category membership (Rosch, 1973; Rosch et al., 1976).

Prototypicality in argument structure and event perception is mainly determined by two factors: (a) thematic role, which encompasses the argument's relationship to the event; and (b) animacy, which reflects whether the argument is animate or inanimate (Dowty, 1991; Bornkessel and Schlesewsky, 2006a; Bornkessel-Schlesewsky and Schlesewsky, 2009; Paczynski and Kuperberg, 2011). In the case of agents and themes, these factors interact to create four combinations of prototypical or non-prototypical arguments. In this manner, prototypical arguments include animate agents and inanimate themes, i.e., the arguments of a canonical transitive sentence (Comrie, 1989; Dowty, 1991; Bornkessel and Schlesewsky, 2006b; Bornkessel-Schlesewsky and Schlesewsky, 2009). By contrast, non-prototypical arguments include inanimate agents and animate themes.

This interaction between thematic role and animacy deeply affects how events are perceived and how sentences are processed. In psycholinguistics and neurolinguistics, evidence suggests that the prototypicality of arguments has important effects in sentence processing. This, in turn, supports the claim that some arguments are more prototypical than others and, therefore, that they display a prototype structure (Angiolillo and Goldin-Meadow, 1982; Frisch and Schlesewsky, 2001; Traxler et al., 2005; Demiral, Schlesewsky and Bornkessel-Schlesewsky, 2008; Philipp et al., 2008; Betancort, Carreiras and Sturt, 2009; Bornkessel-Schlesewsky and Schlesewsky, 2009; Ibbotson and Tomasello, 2009; Bourguignon et al., 2012; Kretzschmar et al., 2012; Lowder and Gordon, 2012; Bickel et al., 2015; Muralikrishnan, Schlesewsky and Bornkessel-Schlesewsky, 2015; Foley, 2020; Sauppe et al., 2023). Importantly, experimental studies that explore argument structure processing do not always control for prototypicality of the arguments, even though introducing animacy as a controlled factor is more common (Lempert, 1989; Trueswell, Tanenhaus and Garnsey, 1994; Frisch and Schlesewsky, 2001; Buckle, Lieven and Theakston, 2017; Ünal, Wilson, Trueswell and Papafragou, 2024). It follows, therefore, that in comparisons among all-animate conditions (e.g., animate agents compared to animate themes) where results are interpreted as being consistent with a general agent preference, prototypicality might still constitute a confounding factor in the interpretation of results. Given that prototypicality has been found to deeply affect sentence processing, and that prototypical arguments are preferred over non-prototypical ones, it is possible that previous results which have been attributed to a general agent preference could also be accounted for by alluding to a general preference for prototypical arguments. To my knowledge, this gap in the literature has never been explored experimentally, as no other study has attempted to discriminate between an agent preference and a prototypicality effect in the interpretation of argument structure processing results.

3. Methodology

To conduct my research, I used eye tracking paired with the Visual World Paradigm (henceforth VWP).[4] In psycholinguistics, eye tracking allows for the implementation of a variety of methods that tap into the relationship between gaze fixations and linguistic processing, including both reading and spoken language studies. The VWP is used primarily to investigate spoken language processing, as it involves the simultaneous presentation of auditory and visual stimuli.

In the past decades, the VWP has become a commonly used methodology in psycholinguistics and other adjacent fields because it allows for a relatively natural and nonintrusive way of exploring spoken language processing (Tanenhaus, 2007). Unlike other methods, the VWP allows for the gathering of language processing data in a way that is fine-grained, overt, and time-locked to the auditory stimulus without necessarily stopping the flow of spoken word input. In VWP studies, gaze fixations on visual objects are viewed as a sensitive measure of ongoing cognitive processes that reveal the time course of changes in the mental state of participants, mostly related to representation, activation and attention (Tanenhaus, 2007). These measures are mostly gathered in the form of fixations to different positions in the visual display over time, where either static or dynamic images are projected. In the complex world of eye movements, fixations consist in maintaining the visual gaze on a visual object for a relatively long period of time, usually lasting 250 ms or more (Hooge, Vlaskamp and Over, 2007).

There are a number of eye-related phenomena that deeply affect how we design and

[4] Additionally, I also complemented this methodology with norming studies using both rating tasks and eye tracking tasks, which were carried out with the aim of improving my experimental designs before the in-lab sessions took place.

interpret VWP research; these phenomena have been discussed extensively in eye-tracking research specializing in methodological development (Cooper, 1974; Tanenhaus et al., 1995; Allopenna, Magnuson and Tanenhaus, 1998; Altmann and Kamide, 2004; Dahan and Tanenhaus, 2004; Huettig and Altmann, 2005; Yee and Sedivy, 2006; Henderson et al., 2007; Hooge, Vlaskamp and Over, 2007; Knoeferle, 2007; Tanenhaus, 2007; Webb, Knott and MacAskill, 2010; Altmann, 2011; Geisler and Cormack, 2011; Huettig, Olivers and Hartsuiker, 2011; Huettig, Rommers and Meyer, 2011; Godfroid and Hui, 2020; Do and Kaiser, 2022). First and foremost, eye-tracking methodologies are used in psycholinguistic and cognitive science research because the link between eye movements and linguistic processing is systematic and powerful. The basic assumption behind the use of the VWP is that eye movements constitute a measure of how linguistic processing interacts with the visual processing of the available environment. In this regard, eye gaze is interpreted as a function of the integration of visual representations with linguistic representations that are continuously activated as the speech input unfolds (Huettig, Olivers and Hartsuiker, 2011). This is why the VWP is considered to be a very useful methodology to explore a wide array of processing mechanisms, including ongoing syntactic analyses, predictions and event representations (Huettig, Olivers and Hartsuiker, 2011).

One such important link between overt eye movements and covert cognitive processes in VWP studies is that the processing of a lexical item promotes looks to a related visual object during sentence comprehension. The interpretation behind such a phenomenon generally appeals to a *cross-modal lexical priming effect*, by which exposure to the linguistic stimulus triggers the activation of the corresponding lexical representation in the listener's mind, which in turn causes the listener to direct their attention—and eye gaze—to an available visual object that is related to the lexical item (Huettig and Altmann, 2005; Yee and Sedivy, 2006; Altmann, 2011; Anjum and Hallowell, 2019). For this effect to occur, there need only exist a partial semantic overlap between the lexical item and the visual object, which explains why hearing *ratón* 'mouse' would prompt looks to a picture of a cheese (Huettig and Altmann, 2005). We say that this semantic priming effect is time-locked because there is a relatively stable delay between the presentation of the linguistic stimulus and the eye fixation to a related visual object, which, on average, takes place around 200 ms after the presentation of the auditory stimulus (Tanenhaus et al., 1995; Allopenna, Magnuson and Tanenhaus, 1998; Dahan and Tanenhaus, 2004). This delay is due to the time it takes the listener to process the given stimulus, as well as to plan and execute the eye movements that will result in a fixation on the related visual object.

I employed eye-tracking technology in conjunction with the VWP, which consists in the simultaneous presentation of auditory and visual stimuli. In the specific modality of the VWP that I used, participants listened to auditory linguistic stimuli while they viewed static visual displays consisting of four different visual objects. In critical trials, an element in the linguistic stimuli (e.g., *ratón* 'mouse') bore a strong semantic relationship with one of the visual objects presented on the screen (in this case, a depiction of a cheese).[5] Participants were told to listen carefully to the sentences so that they would be able to answer simple comprehension questions after some of the trials. Using this methodology, I conducted a series of experiments in which participants listened to auditory sentences in Spanish recorded by a female native speaker at a comfortable speech rate. Meanwhile, participants viewed static visual displays on a computer screen. Visual displays consisted of four black-and-white line-drawing pictures placed on each corner of the screen. In critical trials, one of the arguments in the sentence (e.g., *el ratón* 'the mouse') was strongly related to one of the drawings in the visual display (e.g., a drawing of a cheese). The lexical item that bore a strong semantic relationship with the visual target was always a preverbal sentential subject with no case-marking morphology to indicate its thematic role, as in (6). Relying on a semantic priming effect, I measured the magnitude and time course of the fixations towards the semantically-related visual target during the presentation of the auditory sentence. That is, I checked the ongoing proportion of participants' fixations on the related visual object during sentence comprehension as an indication of the activation levels of the sentential subject in the mental state of participants.

(6) El ratón gordo, peludo y grande corrió hacia la ventana.

'The big, fat, hairy mouse ran towards the window.'

This allowed me to measure the differences in argument processing after the verb was encountered, since this was the point during sentence processing in which participants could unequivocally assign a thematic role to the sentential subject. This processing phenomenon by which preverbal arguments become activated in the mental representation of a listener once the verb is processed is known as *argument reactivation*, and it is thought to be necessary for syntactic and semantic integration of the verb and its argument(s) into a single mental representation (Koring et al., 2012; Bever and Sanz, 1997; Friedmann et al., 2008; Burkhardt et al, 2003; Shetreet and Friedmann, 2012). Thus, my focus

[5] The strength of semantic relationships between linguistic and visual items was determined by previous norming studies.

lies on the difference in argument reactivation—as revealed by eye-tracking data—upon encountering the verb between conditions with different thematic roles and argument structures.

Regarding the population sample, the participants who participated in the experiments were native speakers of Spanish, most of which also reported knowledge of other language(s). Because my research focuses on the processing of argument structure by obtaining data from native speakers, bilingualism was not a relevant factor in recruitment. Participation criteria included the following: (a) being a native speaker of Spanish, which was corroborated by filling out a linguistic profile questionnaire; (b) having no history of language-related pathologies; (c) having normal or corrected-to-normal vision; and (d) being over 18 years of age. The vast majority of participants were young adults with a high educational level between the ages of 19 and 22, since most of them were students at the University of the Basque Country (UPV/EHU).

In sum, the use of eye tracking and the VWP allowed me to explore the real-time processing of argument structure by focusing on the time course and magnitude of activation of critical arguments (i.e., the lexical items) in the sentence. This is because eye movements provide a window into the operation of selective attention, which in turn can reveal the ongoing activation of lexical and visual representations. Research shows that fixation sites are selected based on the needs of the cognitive system in relation to the current task; in this case, participants were simply told to listen to the sentences carefully while looking at the pictures. Thus, the eye movements gathered in this dissertation are interpreted as being driven by real-time cognitive processes related to spoken language comprehension that reveal the attention devoted towards different elements in the linguistic stimuli (Henderson et al., 2007; Huettig, Olivers and Hartsuiker, 2011). This was of particular use to the goals of this dissertation, as it made it possible to test a number of hypotheses surrounding the notions of thematic role and argument structure processing that deal with preference, representation and activation. The specific ways in which these research questions were addressed is discussed in depth in the following section.

4. Aims and outline

In this section, I provide a brief outline of the main research questions addressed in each of the following chapters (Chapters 2 to 4). Overall, the main goal of this dissertation is to investigate the processing of predicates with different argument structures in Spanish, a nominative-accusative language, with a special focus on the sentential subjects of both intransitive and transitive predicates. More specifically, my research deals with (a) whether and how thematic role impacts the processing patterns of sentential subjects in transitive and intransitive predicates (Chapter 2), (b) whether and how key semantic features such as animacy interact with thematic role in the processing patterns of said sentential subjects (Chapter 3), and (c) how thematic roles are represented as categories in processing with respect to list-based or proto-role theories of thematic roles (Chapter 4).

- In **Chapter 2**, I focus on the effect of thematic role in the processing of sentential subjects in unaccusative, unergative and transitive predicates. In general, the experimental research on argument structure has reported mixed results regarding the processing of agent and theme sentential subjects in nominative-accusative languages. Moreover, the significant differences found between these two thematic roles have been interpreted as evidence supporting two different hypotheses in the experimental literature. On the one hand, the Unaccusative Hypothesis (UH), which claims that unaccusative subjects (i.e., themes) involve a more complex syntactic representation than unergative subjects (i.e., agents). On the other hand, the Agent First Hypothesis (AFH), which states that there exists an attentional preference to agents over themes and that agents are preferred as the first ambiguous NP in a sentence. Using eye tracking in the VWP, I investigate the processing patterns of agents (unergative and transitive conditions) and themes (unaccusative condition) by examining the visual attention that listeners spontaneously devote towards visual objects related to the sentential subject during sentence comprehension (Experiment 1). While the UH predicts a delayed reactivation of unaccusative subjects compared to unergatives after the presentation of the verb, the AFH predicts an overall larger reactivation of agent subjects than themes, with no delayed peak of reactivation in the unaccusative condition. Results show that the time course and magnitude of the gaze-fixation patterns are fully compatible with the predictions made by the AFH, but not with those of the UH, as agent subjects displayed a larger reactivation effect than theme subjects after verb offset, and no delayed peak of reactivation was found for theme subjects.

- In **Chapter 3**, I investigate the effect of prototypicality on thematic role processing by modulating the animacy and thematic role of sentential subjects in unaccusative, unergative and transitive predicates. Experiment 1 results constitute psycholinguistic evidence of a general agent preference in sentence processing; crucially, this experimental design does not take prototypicality of the arguments into consideration as a possible confounding variable. Generally, prototypical arguments include animate agents and inanimate themes, while inanimate agents and animate themes are considered non-prototypical. Using eye tracking in the VWP, I investigate the processing patterns of animate and inanimate agents (unergative and transitive conditions), as well as animate and inanimate themes (unaccusative conditions) by examining the visual attention that listeners spontaneously devote towards visual objects related to the sentential subject during sentence comprehension (Experiment 2). This resulted in six experimental conditions. The Agent Preference Hypothesis (APH), as modulated by prototypicality effects, predicts a larger magnitude of subject reactivation for agent conditions than theme conditions, as well as a larger magnitude of subject reactivation for prototypical compared to non-prototypical conditions. By contrast, the Prototypicality Preference Hypothesis (PPH) predicts a larger magnitude of subject reactivation for prototypical conditions than non-prototypical conditions after the verb, with no significant difference between prototypical agent and theme conditions. Results show that the time course and magnitude of the gaze-fixation patterns are compatible with the predictions made by the APH as modulated by prototypicality effects, but not with those of the PPH, as prototypical conditions elicited a larger reactivation effect than non-prototypical conditions, and prototypical agent conditions displayed a larger reactivation after the verb than the prototypical theme condition.

- In **Chapter 4**, I explore the processing of the assumed experiencer thematic role by investigating the processing of transitive and intransitive psychological predicates. List-based accounts of thematic roles generally claim that psychological verbs such as *love* assign the experiencer role to the participant who undergoes the mental state or emotion. According to the Experiencers as a Distinct Category Hypothesis (EDCH), the experiencer role is assumed to be categorically distinct from other roles, including agents and themes, and as such predict a distinct processing pattern for experiencer arguments of psych predicates. By contrast, according to the Proto-Role Hypothesis (PRH), these arguments are either assigned a proto-agent or proto-patient thematic role based on semantic characteristics met by the argument. Using eye tracking in the VWP, I investigate the processing patterns of sentential subjects in transitive and intransitive psychological predicates by examining the visual attention that listeners spontaneously devote towards visual objects related to the sentential subject during sentence comprehension (Experiment 3). Initially, I assumed that the transitive and intransitive conditions differed significantly in the semantic characteristics assigned to the sentential subjects, thus predicting different processing patterns according to PRH. By contrast, list-based accounts predict no significant differences across conditions according to the EDCH. After carrying out the analyses, which showed that the experimental conditions displayed largely the same processing pattern, I questioned my original assumptions regarding the semantic differences between experimental conditions, which critically affected the predictions of the hypotheses considered. I then conducted a post-hoc analysis in which I combined Experiment 3 data with a selection of Experiment 2 data in order to compare experiencer subjects with both agent and theme subjects. Crucially, these comparisons allowed me to discriminate between the considered hypotheses independently of the correctness of my original assumptions. Results from the post-hoc analysis showed that agent and experiencer subjects displayed the same processing pattern, which differed from the reactivation pattern of theme subjects. These results are consistent with PRH predictions, since a processing pattern common to agents and assumed experiencers was found, different from the processing pattern of themes.

- In **Chapter 5**, I summarize the main findings in this dissertation and sketch ideas for future research.

Chapter 2.
Eye-tracking the Agent Preference in Spanish[1]

Abstract

Experimental research on argument structure has reported mixed results regarding the processing of unaccusative and unergative predicates. Using eye tracking in the visual world paradigm, this study seeks to fill a gap in the literature by presenting new evidence of the processing distinction between agent and theme subjects. We considered two hypotheses. First, the Unaccusative Hypothesis states that unaccusative (theme) subjects involve a more complex syntactic representation than unergative (agent) subjects. It predicts a delayed reactivation of unaccusative subjects compared to unergatives after the presentation of the verb. Second, the Agent First Hypothesis states that the first ambiguous NP of a sentence will preferably be interpreted as an agent due to an attentional preference to agents over themes. It predicts a larger reactivation of agent subjects than themes. We monitored the time course of gaze fixations of 44 native speakers across a visual display while processing sentences with unaccusative, unergative and transitive verbs. One of the pictures in the visual display was semantically related to the sentential subject. We analyzed fixation patterns in three different timeframes: the verb frame, the post-verb frame, and the global post-verbal frame. Results indicate that sentential subjects across the three conditions were significantly activated when participants heard the verb; this is compatible with observing a post-verbal reactivation effect. Time course and magnitude of the gaze-fixation patterns are fully compatible with the predictions made by the Agent First Hypothesis. Thus, we report new evidence for (a) a processing distinction between unaccusative and unergative predicates in sentence comprehension, and (b) an attentional preference towards agents over themes, reflected by a larger reactivation effect in agent subjects.

[1] This chapter was originally published as an article. For inclusion in this Doctoral Dissertation, the following aspects were adapted to fit the general structure and style of this work: introduction, section labels, citation style, supplementary materials, formatting of tables and figures, and figure aesthetics. The original article can be found under the following reference: "Gómez-Vidal, B., Arantzeta, M., Laka, J. P., and Laka, I. (2022). Subjects are not all alike: Eye-tracking the agent preference in Spanish. *PloS One*, *17*(8), e0272211. https://doi.org/10.1371/journal.pone.0272211."

1. Introduction

The main research question that this chapter tackles has to do with whether and how thematic role of the sentential subject correlates with processing differences in unaccusative, unergative and transitive predicates. The methodology corresponds to eye tracking in the Visual World Paradigm, which is used to capture the visual attention that participants spontaneously devote to a visual object related to the sentential subject. The main aim of this chapter is to adjudicate between the two hypotheses that have been invoked in the previous literature investigating processing differences between unaccusative and unergative predicates, as well as between agents and themes in general. The structure of this chapter is as follows. First, I introduce a discussion of thematic roles, intransitive predicates and the considered hypotheses. Then, the design of Experiment 1 is presented, including methodology, materials, procedure and participants. Next, an account of the data processing and data analysis steps is provided. Subsequently, I lay out the results from the three analyzed timeframes, as well as the results from a resampling analysis. Finally, I discuss the results and lay out the conclusions at the end of this chapter.

1.1 Unaccusativity and thematic roles

The split of intransitive predicates into unaccusatives (1) and unergatives (2) is the object of a long-lasting discussion in theoretical linguistics (Perlmutter, 1978; Burzio, 1986; Dowty, 1991; Levin and Rappaport-Hovav, 1995). Theoretical approaches concur that unaccusative predicates take a *theme* as a single argument (1), whereas unergatives take an *agent* (2).

(1) $[_{S}$ $[_{NP}$ The girl$]_{i}$ $[_{VP}$ fell t_{i}.]]

(2) $[_{S}$ $[_{NP}$ The girl] $[_{VP}$ ran.]]

This difference has important implications for syntactic structure. Formal approaches (Perlmutter, 1978; Burzio, 1986; Dowty, 1991; Levin and Rappaport-Hovav, 1995) characterize the syntax of unaccusative predicates (1) as more complex than that of unergatives (2). More specifically, the *Unaccusative Hypothesis* (Perlmutter, 1978, henceforth UH) claims that unaccusative subjects start the derivation as objects, and then move to subject position. By contrast, unergative arguments are generated in subject position. This additional dependency in the structure of unaccusative predicates (1) compared to unergatives (2) is shown above in terms of syntactic movement within a Government and Binding framework (Chomsky, 1981; Burzio, 1986); note that the unaccusative argument leaves a trace at its base position.

Research in psycholinguistics testing the UH has found processing differences between unaccusative and unergative predicates. Studies conducted in a variety of methods and languages show evidence of a slower or less accurate processing of unaccusative sentences compared to unergatives (Kegl, 1995; Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; M. Lee and Thompson, 2004; Friedmann et al., 2008; McAllister et al., 2009; J. Lee and Thompson, 2011; Meltzer-Asscher et al., 2015; Momma, Slevc and Phillips, 2018). They report several phenomena associated with the processing of unaccusative sentences as compared to unergatives: (a) larger reaction times for unaccusatives in cross-modal lexical priming studies (Bever and Sanz, 1997; Friedmann et al., 2008); (b) higher error rates for unaccusatives in populations with and without aphasia (M. Lee and Thompson, 2004; McAllister et al., 2009; J. Lee and Thompson, 2011); and (c) increased brain cortical activation for unaccusatives in neuroimaging studies (Shetreet and Friedmann, 2012; Meltzer-Asscher et al., 2015). Studies using cross-modal lexical priming techniques (Bever and Sanz, 1997; Friedmann et al., 2008; Shetreet and Friedmann, 2012) specifically explored whether unaccusative and unergative subjects were reactivated after the verb. Results showed a late post-verbal reactivation of the subject (around 750 ms after verb offset) in unaccusative predicates, but not in unergatives. According to the *Trace Facilitation Hypothesis* (Bever and Sanz, 1997), speakers reactivate the mental representation of the referent at the point where its trace is encountered (Nicol and Swinney, 1989; Hickok et al., 1992; Love and Swinney, 1996). For this reason, their results (Bever and Sanz, 1997; Friedmann et al., 2008; Shetreet and Friedmann, 2012) were interpreted as evidence that the unaccusative argument had deposited a trace within the VP due to syntactic movement, whereas the unergative argument had not, as predicted by the UH.

However, more recent research using continuous measures of language processing indicates that post-verbal reactivation is not exclusive to unaccusative subjects, since the unergative subjects also undergo reactivation after the verb, with an earlier reactivation than for unaccusatives (Burkhardt, Piñango and Wong, 2003; Koring, Mak and Reuland, 2012). In a seminal study using eye tracking in the Visual World Paradigm (henceforth VWP), Koring, Mak and Reuland (2012) found two different patterns of subject reactivation in Dutch sentences with preverbal subjects: an early reactivation of the unergative subject (peaking around 300 ms after verb offset), and a late reactivation of the unaccusative subject (peaking around 950 ms after verb offset). As a consequence, these authors claim that post-verbal reactivation of a preverbal argument occurs independently of its thematic role, because argument reactivation is needed for the integration of an argument with its verb into a single semantic representation. Their results were interpreted as evidence for the UH, since a late peak in the reactivation of unaccusative subjects is compatible with added steps in the syntactic interpretation of unaccusative subjects compared to unergatives.

Many studies (Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; Friedmann et al., 2008; Koring, Mak and Reuland, 2012; Shetreet and Friedmann, 2012) have interpreted the general finding of observing a processing distinction between unaccusative and unergative predicates as evidence for the UH. However, we claim that an alternative interpretation is possible attending to a generalized processing distinction between agents and themes. More specifically, the *Agent First Hypothesis* (Ferreira, 2003; Laka and Erdocia, 2012; Frenzel, Schlesewsky and Bornkessel-Schlesewsky, 2015) proposes a preference for agents over themes; this is compatible with finding processing differences between unaccusative and unergative predicates. In fact, there is a significant body of research in psycholinguistics and cognitive science to support such a distinction. Agent and theme roles correspond with two abstract and relatively salient categories that are accessed and processed rapidly and robustly in processing (Boland et al., 1995; Altmann, 1999; Kamide, Altmann and Haywood, 2003; Arunachalam and Waxman, 2010; Noble, Rowland and Pine, 2011; Chow and Phillips, 2013; Hafri, Papafragou and Trueswell, 2013; Chow et al., 2015; Kim, Oines and Sikos, 2016; Kowalski and Huang, 2017; Hafri, Trueswell and Strickland, 2018). This general finding has been reported in studies investigating adult and child populations, as well as during exposure to visual and/or linguistic events. More importantly, there is evidence that agents and themes follow distinct processing patterns. For example, agent subjects are preferred as the first argument in ambiguous syntactic contexts across a variety of languages (Ferreira, 2003; Bornkessel and Schlesewsky, 2006a; Laka and Erdocia, 2012; Lamers, 2012; Bisang, Wang and Bornkessel-Schlesewsky, 2013). Agents are also recognized faster than themes in visual events both by neurotypical populations (Robertson and Suci, 1980; Segalowitz, 1982; Webb, Knott and MacAskill, 2010; Rissman and Majid, 2019) and by people with agrammatic aphasia (Arantzeta et al., 2017). In acquisition literature, studies show that children learn to detect the agent in a given event before they learn to detect the theme (Naigles, 1990; Gertner, Fisher and Eisengart, 2006; Arunachalam and Waxman, 2010; Noble, Rowland

and Pine, 2011; Huang et al., 2013). Overall, this large body of evidence (Cohn and Paczynski, 2013; Rissman and Majid, 2019) points towards agents being more distinct and cognitively more salient than themes; this is one of the crucial claims of the AFH.

A recent study in English by Huang and Snedeker (2020) conducted a close replica of Koring et al. (2012) in three different experiments, failing to replicate any aspect of Koring et al.'s (2012) findings. These authors suggest that Koring et al.'s (2012) results are unreliable due to the method used for data analysis (i.e., Growth Curve Analysis), which they argue to be highly anti-conservative and ill-suited for psycholinguistic studies. Here, we aim to contribute to this debate on argument structure and thematic role processing by presenting our results from a Spanish close replica of Koring et al. (2012), which also bears close resemblance to the study recently conducted by Huang and Snedeker (2020). We consider two hypotheses, the UH and AFH, as possible accounts for findings reported in previous literature which observe a processing difference between unaccusative and unergative predicates. Our aim is to discriminate between the two, since they make different predictions for our data. We investigated the processing of agent and theme subjects in unaccusative, unergative and transitive sentences in Spanish using eye tracking in the VWP. This methodology (Cooper, 1974; Tanenhaus et al., 1995; Allopenna, Magnuson and Tanenhaus, 1998) consists in the simultaneous presentation of auditory and visual stimuli. The basic assumption behind the VWP is that eye fixations on visual targets are automatically guided by referentially-related linguistic stimuli. Hence, the likelihood of fixating on specific visual objects increases attending to the semantic and phonological relation between the visual object and the auditory linguistic message (Dahan and Tanenhaus, 2004; Huettig and Altmann, 2005; Yee and Sedivy, 2006). This methodology is a reliable measure of how different elements in the linguistic stimuli are activated (and reactivated) in participants' mental representation. As such, it is able to reveal how changes in attention to linguistic elements unfold during linguistic processing.

We presented 44 Spanish native speakers with spoken sentences while they viewed a display of pictures on a screen. In test trials, the visual target (e.g., a depiction of a cheese) was semantically related to the subject in the spoken sentence (e.g., *ratón* 'mouse'). We measured the proportion of fixations toward the visual target during the presentation of the spoken sentence to investigate argument reactivation after the verb. Argument reactivation is a processing phenomenon by which preverbal arguments become activated again in the mental representation of listeners once the sentential verb is encountered (Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; Friedmann et al., 2008;

Shetreet and Friedmann, 2012). It is argued that preverbal subjects must be reactivated after the presentation of the verb to integrate the argument and the verb into a single mental representation (Koring, Mak and Reuland, 2012). We measured the proportion of looks to a semantically-related visual target to detect the magnitude and time course of the reactivation of the sentential subject after the presentation of the verb.

1.2 Hypotheses

We consider two hypotheses in our experiment. First, the UH (Perlmutter, 1978) claims that unaccusative subjects have longer syntactic derivations than unergative subjects. According to this hypothesis, unaccusative subjects are born as objects of the verb and must be promoted to subject function; Burzio (1986) reinterprets this as syntactic movement, where the initial object moves to subject position leaving a trace in its original position. By contrast, unergative subjects are born in subject position and do not require additional interpretive steps like identifying the gap and assigning an argument to it. By extension of the UH (Perlmutter, 1978), and in line with previous research (Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; Friedmann et al., 2008; Shetreet and Friedmann, 2012), Koring et al. (2012) predict that unaccusative subjects will display a delayed reactivation compared to unergative subjects. Thus, two distinct reactivation patterns should be observed: an early reactivation for unergative subjects, and a late reactivation for unaccusative subjects. This predicts a difference in the time course of the reactivation effect between conditions, but no differences in the magnitude of the effect. Previous offline research (Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; Friedmann et al., 2008) have situated the unaccusative subject reactivation effect at around 750 ms after verb offset. Because the human eye needs approximately 200 ms to program and initiate movement in reaction to auditory stimuli (Matin, Shao and Boff, 1993), and based on the predictions of the UH, we should find a peak of gaze fixations signaling a reactivation of the unaccusative subject around 950 ms after verb offset, coinciding with Koring et al. (2012).

Second, we consider the Agent First Hypothesis (Ferreira, 2003; Laka and Erdocia, 2012; Frenzel, Schlesewsky and Bornkessel-Schlesewsky, 2015, henceforth AFH). This hypothesis is strongly related to similar proposals in psycholinguistics, such as the Subject First Hypothesis (Bever, 1970; Frazier and Fodor, 1978; Bates et al., 1988), the NVN strategy (Ferreira, 2003) and the Actor Strategy (Bornkessel and Schlesewsky, 2006b;

Bornkessel-Schlesewsky and Schlesewsky, 2016). The NVN strategy assumes a mapping of semantic roles to syntactic positions following an agent-action-patient order. The Actor Strategy claims that the language processing system prioritizes identifying the agent in the event. The Subject First Hypothesis claims that the first ambiguous NP in a given sentence is preferably processed as a subject, and has been supported by evidence from a number of studies (Matzke et al., 2002; Demiral, Schlesewsky and Bornkessel-Schlesewsky, 2008; Lamers, 2012; Bisang, Wang and Bornkessel-Schlesewsky, 2013). However, and because this hypothesis fails to take into account the thematic role of the subject, most of this body of evidence is also compatible with the AFH. The AFH claims that the first ambiguous NP in a given sentence is preferably processed as an agent, a claim that has been supported by some experimental research (Ferreira, 2003; Laka and Erdocia, 2012). In our study, and based on the array of evidence pointing toward the salience of agents compared to themes from a cognitive point of view, we assume the following formulation of the AFH: that the first ambiguous NP in a given sentence is preferably processed as an agent, because listeners display an attentional preference toward agents as compared to themes. In our data, the AFH predicts that agent subjects (unergative and transitive conditions) will display a larger reactivation effect than theme subjects (unaccusative condition) after the verb. This is so because, in the VWP, fixations on a visual object reveal how a related entity is being activated, processed, or otherwise being attended to in the participant's mental state. We argue that observing a difference in the magnitude of the reactivation effect (i.e., a significantly higher proportion of looks to the visual target in one condition compared to the other) can be interpreted as a difference in the attentional resources that listeners are devoting toward the reactivated element in their mental state.

2. Experiment 1

Using an experimental design closely following that of Koring et al. (2012), we explored the processing patterns of unaccusative, unergative and transitive subjects in Spanish to test the predictions of the UH (Perlmutter, 1978) and the AFH (Ferreira, 2003; Laka and Erdocia, 2012). To achieve this, we created SV(O) sentences where we measured the time course of subject reactivation upon encountering the verb by means of eye tracking in the VWP. The types of predicates explored differed slightly with respect to the original study: while Koring et al. (2012) investigated sentences with unaccusative, unergative and mixed verbs, we decided to incorporate sentences with unaccusative, unergative and transitive verbs into our study. The reason for this change has to do with the hypotheses that we contemplated. Because the AFH makes its predictions based on the thematic role of the argument (in this case, the sentential subject), it predicts no differences in the reactivation pattern of unergative and transitive subjects, which are both agents.

2.1 Methodology

We presented participants with auditory sentences and visual input simultaneously. To measure subject reactivation in our three predicate conditions, we created sentences with preverbal subjects in which we expected to find subject reactivation after the verb. We were interested in measuring subject reactivation, since it indicates how arguments are being processed regarding the argument structure that they participate in. We measured argument reactivation after verb onset by monitoring participants' eye fixations to a visual target that was semantically related to the sentential subject in the spoken sentence (e.g., sentential subject *mouse*, related to a depiction of a cheese).

2.2 Stimuli

The present study had a 3 x 2 design with two independent variables: (i) verb type (unaccusative, unergative, transitive), and (ii) trial type (test, control). In test trials, the sentential subject shared a strong semantic relation with the target drawing (e.g., subject *mouse*, related to a depiction of a cheese), thus allowing us to measure subject reactivation. By contrast, in control trials the sentential subject did not share a strong semantic relation with the target drawing (e.g., subject *chimpanzee*, unrelated to a depiction of a cheese), thus serving as a baseline for fixations to the target drawing. The dependent variable was the duration of eye fixations on the visual target. Stimuli comprised 170 trials, consisting of 170 unique spoken sentences paired with four black-and-white line pictures from the International Picture Naming Project website (Szekely et al., 2004). There were 120 experimental trials in total, including 60 test trials and 60 control trials. The other 50 were filler trials. Experimental trials were distributed evenly across 2 lists of stimuli. Each list of stimuli consisted of 30 test trials, 30 control trials and 50 filler trials. The same set of filler trials was used for both lists.

Linguistic stimuli consisted of spoken sentences recorded by a female native speaker of Spanish in a soundproof booth at a comfortable speaking rate. Experimental sentences had a mean length of 37 syllables (ranging from 31 to 46 syllables), a mean duration of

4244 ms and an average speech rate of 4.8 syllables per second (unaccusative condition: mean length 28 syllables, mean duration 5935 ms, average speech rate 4.6 syllables per second; unergative condition: mean length 29 syllables, mean duration 5829 ms, average speech rate 4.9 syllables per second; transitive condition: mean length 34 syllables, mean duration 6953 ms, average speech rate 4.9 syllables per second). Experimental sentences were structured into 4 (in unaccusative and unergative sentences) or 5 (in transitive sentences) regions of interest or ROIs (see Table 2.1). ROIs 3 and 4 were the relevant regions for the analysis, since they comprised the presentation of the verb and the post-verbal region. These correspond to the general point in time in which preverbal argument reactivation is to be expected. Following Koring et al. (2012), the number of syllables in ROIs 2 and 4 was thoroughly controlled to better align all experimental sentences at verb offset for the analysis. The average number of syllables in ROI 2 was 7.8, ranging from 7 to 9; the average number of syllables for ROI 4 was 13.8, ranging from 13 to 15. An example of an experimental transitive sentence is given in (3). Square brackets signal the different ROIs in which experimental sentences were structured (see Table 2.1 for a complete account).

(3) [La madre dijo que]$_1$ [la peluquera de grandes ojos verdes]$_2$ [contó]$_3$ [cuidadosamente y de manera muy pausada]$_4$ [el número de asistentes.]$_5$

‘[The mother said that]$_1$ [the hairdresser with big, green eyes]$_2$ [counted]$_3$ [carefully and in a very slow manner]$_4$ [the number of attendees.]$_5$’

ROI number	ROI name	Content
1	Introduction	A framing sentence including a variation of “[Someone] said that...”
2	Subject	The sentential subject NP, including a PP or AdjP that modified it.
3	Verb	The experimental verb (unaccusative, unergative or transitive).
4	Post-Verb	A post-verbal Adjunct (of manner, time, place...).
(5)	(Object)	The sentential object NP (only in the case of transitive sentences).

Table 2.1: **Structure of experimental sentences by ROIs.**

There were two types of experimental trials: test and control, which were created in pairs. Each pair consisted of one test and one control trial. Within each pair, the stimulus was kept identical in both trials, except for one word in the spoken sentence: the subject. In test trials (4), the subject was semantically related to the visual target in the visual display (e.g., subject *mouse*, related to a depiction of a cheese). In corresponding control trials (5), the stimulus was identical except for the subject, which was changed (e.g., subject *chimpanzee*, unrelated to a depiction of a cheese). This was done so that the sentential subject was semantically related to the visual target in test trials, but not in control trials, thus ensuring that control trials would serve as a baseline for fixations to the visual target. An example of a pair of test and control sentences is given in (4) and (5), respectively. Both sentences were paired with the same visual display (Figure 2.1), and only differ in their sentential subject. Square brackets signal the different ROIs in which experimental sentences were structured (see Table 2.1 for a complete account).

(4) [La señora dijo que][1] [el ratón negro, peludo y grande][2] [cayó][3] [ese día por las escaleras del edificio.][4]

'The lady said that the big, hairy, black mouse fell that day down the stairs of the building.'

(5) [La señora dijo que][1] [el chimpancé negro, peludo y grande][2] [cayó][3] [ese día por las escaleras del edificio.][4]

'The lady said that the big, hairy, black chimpanzee fell that day down the stairs of the building.'

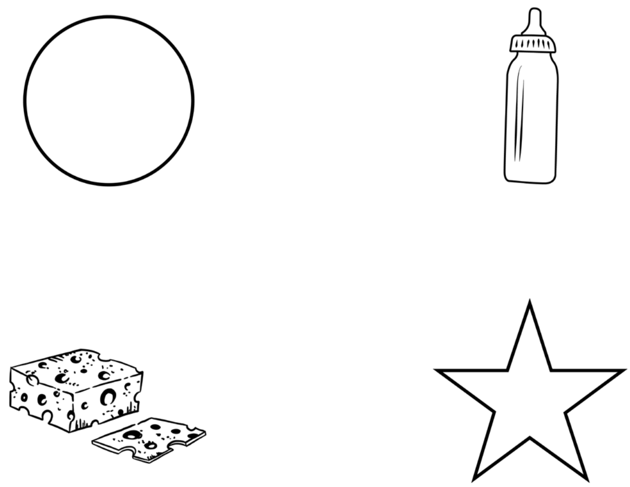

Figure 2.1: **Visual display paired with test sentence (4) and control sentence (5). The visual target is cheese, which is related to the sentential subject *ratón* 'mouse' in sentence (4), but unrelated to the sentential subject *chimpancé* 'chimpanzee' in sentence (5).**

The remaining trials were filler trials; in these, one of the words in the spoken sentence was directly matched by one of the drawings in the visual display. Filler trials were highly varied in their word order, syntactic structure and length of constituents. This was done in order to minimize the possibility of participants predicting the moment in which critical words would be presented in test and control trials.

The strength of the semantic relations between sentential subjects and visual targets (e.g., *mouse* – *cheese*) was determined by means of a norming study conducted online using the Ibex 0.3.8 platform (Drummond, 2007). Fifty-five voluntary Spanish native speakers rated the strength of the semantic relation between two nouns or a noun and a verb on a scale from 0 to 5. We selected strongly-related pairs of nouns (e.g., *mouse* – *cheese*) for the test sentences (i.e., pairs that received a mean rating of 4 or higher) and weakly-related pairs of nouns (e.g., *chimpanzee* – *cheese*) for the control sentences (i.e., pairs that received a mean rating of 2 or lower). This allowed us to distinguish eye fixations on the visual target in test trials, which were mediated by the semantic relation between the sentential subject and the visual target, from fixations on the visual target in control trials, which were not mediated by any semantic relationship and were therefore random. We also assessed the strength of the semantic association in pairs of a noun and a verb to ensure that the verbs were not especially related semantically to the sentential subject, which we believed could potentially affect argument reactivation. Thus, all noun and verb pairs selected received a mean rating of 2 or lower. Detailed results of the noun-noun ratings and noun-verb ratings from the online norming study are provided in Appendix B.

2.3 Participants and procedure

Forty-four students from the University of the Basque Country (UPV/EHU) participated in the experiment (33 female; mean age 22.6; *SD* 3.6). They were all native speakers of Spanish with normal or corrected to normal vision. This study was approved by the ethics board for human research of the University of the Basque Country (CEISH-UPV/EHU). Prior to their participation, subjects were properly informed of the procedure and indicated their written consent to participate by signing the informed consent paperwork. They were paid 6 € for their participation.

The experiment took place in a soundproof booth located at the Micaela Portilla Research Center. Participants were seated on a chair with their eyes about 60 cm from a 24” viewing monitor, set at a resolution of 1024 x 780 pixels. Participants wore binaural headphones to listen to the spoken sentences. The experiment was conducted using Tobii Studio 3.1.0 software (Tobii Technology, 2012), and eye movements were recorded by a Tobii X120 desktop eye tracker sampling at 120 Hz. Each session began with a calibration procedure with nine fixation points. Participants were told that they would hear some recorded sentences through the headphones while static visual displays showed on the screen. They were instructed to listen to the sentences very carefully while looking freely into the monitor. Participants were asked to fixate on a centrally-located cross that appeared between trials. This was done in order to reduce noise in the data, i.e., looks to a particular region of the screen before trial onset. Throughout the experiment, we did not check the status of the eye movements before sentence onset, but this did not pose a problem for our results due to (a) the randomization of the location of the visual target, (b) the use of control trials as a baseline for fixations in test trials. Participants did not have to perform any other task besides listening to the sentences and looking at the pictures. There was no cover story or recurring theme in the experiment. There was 1 second of silent previsualization of the visual stimuli in each trial before the onset of the sentence. Then, the spoken sentence played while the visual display remained on the screen. After the end of the sentence, there were another 2 seconds of silence before the visual display disappeared and the fixation cross appeared for 0.6 seconds on the center of the screen, after which another trial began. Stimuli presentation was randomized per participant. The entire experiment lasted 20 minutes.

3. Data

3.1 Data processing

We followed the procedure described by Koring et al. (2012). Only experimental (test and control) trials were selected for data analysis. Filler trials were discarded. Data classified as "saccades", "unclassified", and instances of track loss, which represented 22.9% of the data, were eliminated from the dataset. This value indicated that collection of relevant data for our analysis was successful around 80% of the time. Each experimental sentence was time-stamped at the onset of each ROI. Unaccusative and unergative sentences differed from transitive sentences in that their sentence offset took place earlier, given that transitive sentences included an additional ROI (5) for the sentential object NP. However, this difference did not interfere in the analysis because fixations to the visual target were analyzed in comparable time windows across all three conditions (see section 3.2). All trials were centered at verb offset, i.e., around the point in time when argument reactivation was expected to take place. As a result, verb offset corresponded with the 0 ms value in all trials.

To proceed with the data analysis, we first needed to verify that any increase in the fixations to the visual target in test trials was due to the activation of the sentential subject. We calculated the proportion of fixations to the target picture during the auditory presentation of the linguistic stimuli in each ROI. We created a linear mixed model containing three-way interactions for verb type (unaccusative, unergative, transitive), ROI (Introduction, Subject, Verb, Post-Verb, Object (only for the transitive condition)), and trial type (test, control) as fixed effects; stimuli and participant variables were included as random effects. Least-Squares Means (*lsmeans*) were calculated, and pairwise comparisons were carried out. Effects were considered significant at the $p < .05$ level. Results are shown in Table 2.2. The analysis was conducted using R Statistic 3.6.2 software (R Core Team, 2019) using the *lme4* package (Bates et al., 2015) and the *lsmeans* package (Lenth, 2016). Results showed that in all experimental conditions, participants fixated more on the visual target in test trials than in control trials since the presentation of the Subject ROI onward (i.e., during the presentation of Subject, Verb, Post-Verb, Object), and not before (Introduction) (see Table 2.2). These results confirmed that gaze fixations to the visual target in test trials were motivated by the semantic relation between the visual target and the sentential subject in the spoken sentence. These results also showed that control trials constituted a baseline for fixations into the visual target, which was relevant for the next step in data analysis.

	Unaccusative			Unergative			Transitive		
ROI name	**Est.**	**SE**	**p**	**Est.**	**SE**	**p**	**Est.**	**SE**	**p**
Introduction	-0.0265	2.94	0.9928	1.8943	2.94	0.5188	0.493	2.94	0.8666
Subject	-15.4	2.94	<.0001	-20.3	2.94	<.0001	-16.6	2.94	<.0001
Verb	-33.4	2.94	<.0001	-25.7	2.94	<.0001	-31.2	2.94	<.0001
Post-Verb	-17.4	2.94	<.0001	-25.5	2.94	<.0001	-27.6	2.94	<.0001
Object	-	-	-	-	-	-	-28.6588	2.94	<.0001

TABLE 2.2: **Pairwise comparisons of gaze fixations to the target by ROI and verb type.**

Proportions of gaze fixations towards the visual target were calculated as a function of ROI, trial type (test, control) and verb type (unaccusative, unergative, transitive).

Subsequent steps in data processing were carried out following Koring et al. (2012). The position of the eye fixation in the visual display was down-sampled every 20 ms. We computed the proportion of looks at the visual target in each time bin along with the presentation of the linguistic stimuli. We calculated the difference of proportion of looks to the target in the test and control conditions for each trial. This was done to obtain the proportion of looks to the visual target that reflected a reactivation effect.

3.2 Data analysis

Koring et al. (2012) examined gaze-fixation data within two time windows: (a) the verb frame, consisting of the time period occurring from -600 ms (mean verb onset) until 1000 ms after verb offset; and (b) the post-verb frame, consisting on the time period occurring from 200 ms until 1700 ms after verb offset. The authors shifted the timeline 200 ms down throughout the entire data frame to account for the time that the human eye needs to program and initiate movement in reaction to auditory stimuli (Matin, Shao and Boff, 1993; Altmann and Kamide, 2004).

In our case, we conducted an analysis of our data in three different time windows: (a) the verb frame, (b) the post-verb frame, and (c) the global post-verbal frame. First, we established the verb frame, ranging from -370 ms until 1230 ms after verb offset. The reason for this change with respect to the initial value for the verb frame in Koring et al. (2012) was that the average verb length in our experiment was 370 ms. Thus, we determined the initial value for our verb frame as -370 ms to maintain comparable regions of interest (in terms of duration) with those of the verb frame in Koring et al. (2012). Second, we established a post-verb frame, which was kept identical to the original study, ranging from 200 ms until 1700 ms after verb offset. Lastly, we established a global post-verbal frame, not included in Koring et al. (2012), ranging from 200 ms until 3968 ms after verb offset. This third time frame went from verb offset to the mean sentence offset in unaccusative and unergative sentences. This time window was included to conduct a post-hoc analysis of the gaze-fixation patterns in a broader time frame. It should be noted that sentences with unaccusative and unergative verbs had a mean duration of 3768 ms after verb offset, whereas sentences with transitive verbs had a mean duration of 4830 ms after verb offset (due to the additional sentential object). However, data analysis using the Growth Curve Analysis technique (henceforth GCA) requires all conditions to have comparable durations in order to fit unbiased orthogonal shapes. Because we analyzed gaze-fixation data from 200 until 3968 ms after verb offset across all conditions, the global post-verbal analysis did not include the processing of the second argument in transitive sentences (i.e., the sentential object).

We created three separate models using the GCA technique (Mirman, Dixon and Magnuson, 2008) following Koring et al. (2012). The first model was created to analyze the verb frame; the second, to examine the post-verb frame; and the third, to explore the global post-verbal frame. The first two models were identical in structure to those reported in Koring et al. (2012). The third model was identical to the one used to analyze the post-verb frame in Koring et al. (2012). The dependent variable was the difference of proportion of looks to the target in the test condition minus the proportion of looks to the target in the control condition for each pair of test and control trials. The independent variables were sentence condition (unaccusative, unergative, transitive) and orthogonal polynomials. The first model contained linear and quadratic polynomials, whereas the second and third models included linear, quadratic, cubic and quartic polynomials.

Random effects by subject and random slopes by subject per each condition were also included in the three models. The analysis was conducted using R Statistic 3.6.2 software (R Core Team, 2019) using the *lme4* package (Bates et al., 2015).

4. Results

4.1 Verb frame

The time course of the difference on the proportion of looks between target and control trials for each condition was modelled using the terms intercept, linear and quadratic. The models of the three conditions were compared, taking transitive verbs as the baseline. The goodness of fit of the models was analyzed using Akaike's Information Criterion (AIC) and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. Results are presented in Table 2.3. There was a significant effect of verb type on the intercept, but not on the linear and quadratic terms. This means that the difference between verb types was based on the average height of the curve but not on the progression of the curve. In Figure 2.2, we present the fit of the data in the most complex model (i.e., the quadratic model).

Model fit				
Model	**AIC**	**-2LL**	**Chisq**	***p* <**
Base	-9976.3	5004.20	-	-
Condition	-	-	-	-
x Intercept	-9982.9	5009.40	10.5573	.005 **
x Linear	-9981.9	5011.00	3.0246	.220
x Quadratic	-9982.1	5013.00	4.1764	.123

TABLE 2.3: **Analysis of the goodness of fit of the curves in the three conditions (unaccusative, unergative, transitive) across the verb frame (from -370 ms before verb offset until 1230 ms after verb offset). Transitive verbs are taken as a baseline. Asterisks signal levels of significance: $p < .05$ (*), $p < .01$ (**), and $p < .001$ (***).**

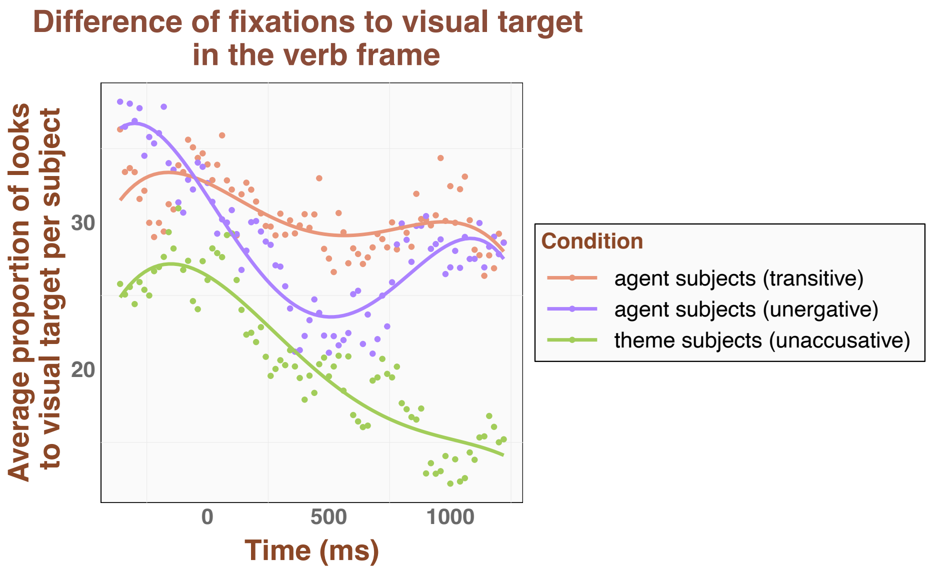

FIGURE 2.2: **Difference of mean percentage of fixations to the visual target between test and control trials across the verb frame (from -370 ms before verb offset until 1230 ms after verb offset). The timeline is centered in 0 ms, which corresponds to verb offset.**

Pairwise comparisons between the three conditions are shown in Table 2.4. The pattern of fixations towards the visual target was significantly lower in the unaccusative condition in comparison with the transitive and unergative conditions. By contrast, the average height of the curve did not differ between the transitive and unergative conditions. Pairwise comparisons across sentence conditions revealed no difference between the conditions in the linear term; there was an effect on the quadratic component limited to the comparison between unaccusative and unergative subjects. There was a significant interaction between unergative subjects and the quadratic orthogonal. Per condition analysis showed that unergative subjects had a significant positive quadratic component (ß = 0.273; t = 2.62; p = .012), signaling meaningful fall and rise in the proportion of looks towards the visual target. Critically, unaccusative subjects had a significant negative linear component (ß = -0.402; t = -2.943; p = .00517) by themselves. Transitive subjects did not show a significant linear (ß = -0.115; t = -0.967; p = .339) nor quadratic (ß = 0.039; t = 0.312; p = .757) component by themselves.

Parameter estimates									
	Transitive - Unaccusative			Transitive - Unergative			Unergative - Unaccusative		
Model	**Est.**	**t**	***p* <**	**Est.**	**t**	***p* <**	**Est.**	**t**	***p* <**
Condition	-	-	-	-	-	-	-	-	-
x Intercept	-0.099	-2.975	.00473**	-0.020	-0.620	.539	-0.078	-2.595	.01278*
x Linear	-0.286	-1.592	.114	-0.117	-0.68	.498	-0.168	-0.894	.373
x Quadratic	-0.039	-0.294	.770	0.233	1.58	.12	-0.272	-2.021	.046*

TABLE 2.4: **Pairwise comparisons of the models of the curves across the three conditions (unaccusative, unergative, transitive) across the verb frame.**

4.2 Post-verb frame

For the post-verb frame, we modelled the data as in the verb frame while also including a cubic and quartic term, following Koring et al. (2012). Transitive subjects were taken as a baseline to compare the models in the three conditions. Figure 2.3 shows the model fit of the experimental data. Again, the goodness of fit of the models was analyzed using Akaike's Information Criterion (AIC) and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models (see Table 2.5). There was an effect of condition only on the intercept. That is, the average height of the curve was different across verb conditions, but there was no interaction between any verb condition and a particular orthogonal component.

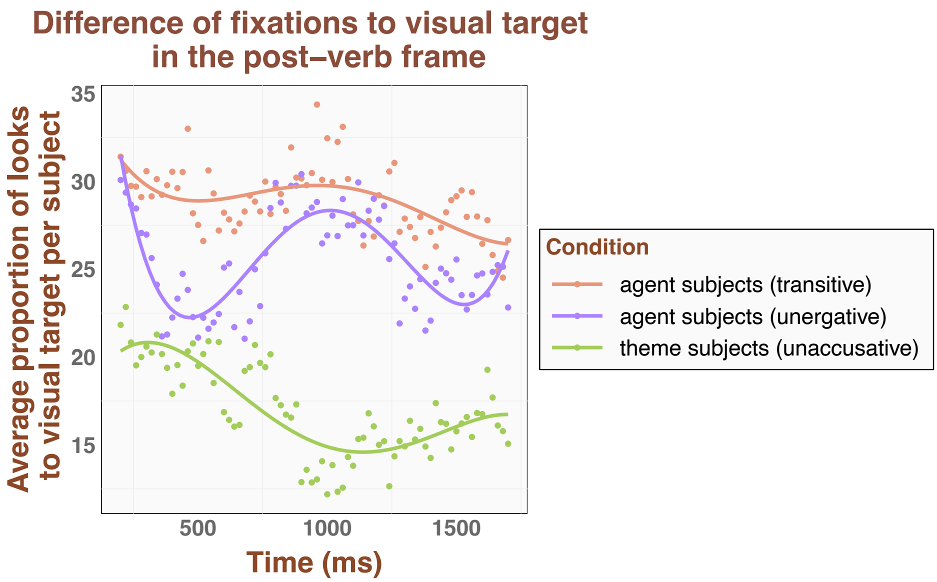

FIGURE 2.3: **Difference of mean percentage of fixations to the visual target between test and control trials across the post-verb frame (from 200 ms until 1700 ms after verb offset). The timeline is centered in 0 ms, which corresponds to verb offset.**

Model fit				
Model	**AIC**	**-2LL**	**Chisq**	***p*** **<**
Base	-13257	6664.6	-	-
Condition	-	-	-	-
x Intercept	-13267	6671.5	13.764	.001026*
x Linear	-13263	6671.6	0.224	.894028
x Quadratic	-13260	6672	0.823	.662344
x Cubic	-13258	6672.8	1.5985	.449674
x Quartic	-13259	6675.6	5.579	.061435

TABLE 2.5: **Analysis of the goodness of fit of the curves in the three conditions (unaccusative, unergative, transitive) across the post-verb frame (from 200 ms until 1700 ms after verb offset). Transitive subjects are taken as a baseline.**

The results of the pairwise comparisons across conditions are shown in Table 2.6. Unaccusative, unergative and transitive subjects did not differ from each other in the linear term. All three conditions had a negative slope. However, the parameter estimates for the different conditions showed that none of the falls was significant by itself (transitive subjects: *ß* = -0.071; *t* = -0.422; *p* = .675; unergative subjects: *ß* = -0.012; *t* = -0.1; *p* = .9209; unaccusative subjects: *ß* = -0.145; *t* = -1.342; *p* = .186).

Parameter estimates									
	Transitive - Unaccusative			**Transitive - Unergative**			**Unergative - Unaccusative**		
Model	**Est.**	**t**	***p* <**	**Est.**	**t**	***p* <**	**Est.**	**t**	***p* <**
Condition	-	-	-	-	-	-	-	-	-
x Intercept	-0.118	-3.821	.000381***	-0.034	-0.985	.329	-0.083	-2.82	.007**
x Linear	0.073	-0.417	.678	0.059	0.379	.707	-0.133	-0.834	.4086
x Quadratic	0.145	1.241	.218	-0.018	-0.164	.87	0.164	1.3	.1974
x Cubic	0.072	0.648	.520	-0.052	-0.481	.634	0.125	1.296	.2017
x Quartic	-0.066	-0.856	.394	0.128	1.53	.13	-0.195	-2.389	.0196*

TABLE 2.6: **Pairwise comparisons of the models of the curves across the different conditions (unaccusative, unergative, transitive) across the post-verb frame.**

There was no effect on the quadratic term. Transitive and unergative conditions had a negative estimate (i.e., a rise followed by a fall), whereas the unaccusative condition had a positive quadratic estimate (i.e., a fall followed by a rise). However, none of the parameter estimates for the different conditions was significant by itself (transitive subjects: *ß* = -0.0386; *t* = -0.519; *p* = .606; unergative subjects: *ß* = -0.0574; *t* = -0.634; *p* = .5295; unaccusative subjects: *ß* = 0.10701; *t* = 1.129; *p* = .265) and verb conditions did not differ in this component, as shown in Table 2.6.

There was no effect on the cubic term. Transitive and unergative conditions had a negative cubic estimate, whereas the unaccusative condition had a positive estimate. Still, the cubic component was not significant by itself across conditions (transitive subjects: *ß* = -0.03511; *t* = -0.385; *p* = .702; unergative subjects: *ß* = -0.087; *t* = -1.201; *p* = .2362; unaccusative subjects: *ß* = 0.037; *t* = 0.469; *p* = .641), and verb conditions did not differ from each other in this term.

There was an effect on the quartic term. Unergative subjects had a positive quartic component (*ß* = 0.158; *t* = 2.454; *p* = .0181), unlike transitive (*ß* = 0.0301; *t* = 0.539; *p* = .593) and unaccusative (*ß* = -0.03679; *t* = -0.628; *p* = .533) subjects. Unergative and unaccusative subjects were the only ones differing from each other in this term. Unergative subjects showed a clear three bend shape, i.e., a fall followed by a rise followed by a fall followed by a late rise.

4.3 Global post-verbal frame

Overall, our results showed different gaze-fixation patterns associated with processing different verb types. Thus, we replicated the general finding in Koring et al. (2012), since we also found a processing difference in subject reactivation between unaccusative and unergative predicates. We report finding evidence of subject reactivation at verb position in the three experimental conditions, as indicated by gaze-fixation differences between test and control trials. Still, the magnitude and trajectory of said reactivation were different across unergative, transitive and unaccusative conditions. Unlike Koring et al. (2012), we failed to find any peak (late or early) in the reactivation of the unaccusative subject. Overall, Koring et al. (2012) reported a negative quadratic effect for the unergative condition in the verb frame, signaling an early peak of reactivation around 300 ms after verb offset, as well as a significant positive quartic effect for the unaccusative condition in the post-verb frame, signaling a late peak of reactivation around 950 ms after verb offset. By contrast, our results showed a positive quadratic effect for the unergative condition and a negative linear effect for the unaccusative condition in the verb frame, as well as a positive quartic effect for the unergative condition in the post-verb frame. Hence, we found a peak of reactivation of unergative subjects around 1000 ms after verb offset, but no reactivation peak for unaccusative subjects.

It could be the case that the pattern of increased and decreased fixations towards the visual target, which signals the reactivation and deactivation of the argument, was affected by experimental confounds. One such confound could be the speed of auditory presentation of the linguistic stimuli. Although our stimuli were identical to that of Koring et al. (2012) in terms of syllabic length, the duration of the stimuli in milliseconds diverged between studies. Koring et al. (2012) did not facilitate average speech rate in their study, but their linguistic stimuli lasted on average more than 4000 ms from sentential subject NP onset until verb offset. In our study, the equivalent linguistic stimuli lasted around 2000 ms. Hence, we concluded that our linguistic stimuli were presented at a faster speech rate than in Koring et al. (2012), although our materials were recorded at a comfortable speaking rate. All other factors being equal, faster presentation of the preverbal linguistic stimuli could have affected argument reactivation in two ways. First, it could be the case that there was not enough time for listeners to deactivate the preverbal argument in their mental representation before the verbal information was presented. If that were the case, it could be possible that our measurements captured a continuous activation of the argument, rather than a reactivation, after verb offset. This would not account for differences in the pattern of subject reactivation between conditions, since it would affect all conditions equally. Second, faster speech rate could cause a delay in argument reactivation to a later time point than in Koring et al. (2012) due to deferral in language processing (Fernandez et al., 2020). Once again, this would not account for differences between conditions, since it would affect all conditions equally. To rule out the possibility that the peak in subject reactivation for the unaccusative condition was observed at a later point in our data, we conducted a post-hoc analysis including a wider time window, the global post-verbal frame, ranging from 200 ms to 3968 ms after verb offset (see section 3.2. for further details).

Transitive subjects were taken as a baseline to compare the models in the three conditions. The results of the model comparison are reported in Table 2.7. Adding new terms did not improve the explicative level of the model as measured by -2 times log-likelihood statistics and Akaike's Information Criterion (AIC). The model with the simplest linear interaction fitted the data better than the most complex quartic interaction. However, we report the quadratic model results, following Koring et al. (2012). Figure 2.4 shows the model fit of the experimental data.

Model fit				
Model	**AIC**	**-2LL**	**Chisq**	***p<***
Base	-22200	11136	-	-
Condition	-	-	-	-
x Intercept	-22210	11143	13.4607	.001194
x Linear	-22210	11145	4.6201	.099256
x Quadratic	-22212	11148	5.3715	.068172
x Cubic	-22208	11148	0.0401	.980147
x Quartic	-22205	11148	1.0300	.597493

TABLE 2.7: **Analysis of the goodness of fit of the curves in the three conditions (unaccusative, unergative, transitive) across the global post-verbal frame (from 200 ms until 3968 ms after verb offset). Transitive subjects are taken as a baseline.**

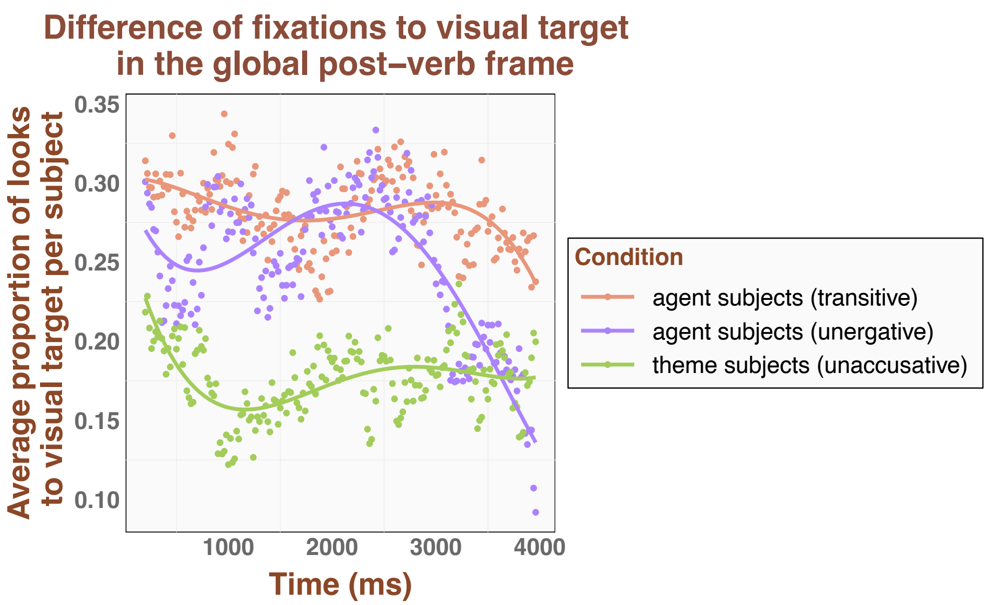

FIGURE 2.4: **Difference of mean percentage of fixations to the visual target between test and control trials across the global post-verbal frame (200 ms until 3968 ms after verb offset).**

Pairwise comparisons across conditions based on the full quadratic model are presented in Table 2.8. The magnitude of the fixations towards the visual target was greater in both transitive and unergative conditions than in the unaccusative condition. There was no difference between transitive and unergative conditions. Crucially, there was a significant interaction with the quadratic component in the comparison between unergative and unaccusative conditions. Per condition analyses aligned with these results. Unergative subjects had a negative quadratic component, which was significant by itself ($ß$ = -0.392; t = -2.764; p = .0083), whereas linear ($ß$ = -0.296; t = -1.81; p = .077), cubic ($ß$ = -0.160; t = -1.156; p = .254) and quartic ($ß$ = 0.088; t = 0.881; p = .383) components were not significant by themselves. In the transitive and unaccusative conditions, none of the falls nor the rises were significant by themselves, as we can see for the transitive linear component ($ß$ = -0.100; t = -0.507; p = .615), the transitive quadratic component ($ß$ = -0.009; t = -0.049; p = .961), the transitive cubic component ($ß$ = -0.107; t = -0.775; p = .443), the transitive quartic component ($ß$ = -0.050; t = -0.541; p = .591), the unaccusative linear component ($ß$ = 0.014; t = 0.074; p = .942), the unaccusative quadratic component ($ß$ = 0.077; t = 0.557; p = .58), the unaccusative cubic component ($ß$ = -0.144; t = -1.276; p = .209), and the unaccusative quartic component ($ß$ = 0.067; t = 0.538; p = .593).

Parameter estimates									
	Transitive - Unaccusative			**Transitive - Unergative**			**Unergative - Unaccusative**		
Model	**Est.**	**t**	***p* <**	**Est.**	**t**	***p* <**	**Est.**	**t**	***p* <**
Condition	-	-	-	-	-	-	-	-	-
x Intercept	-0.105	-4.59	3.64e-05***	-0.033	-1.214	.2312	-0.071	-3.056	.0038**
x Linear	0.115	0.524	.603	-0.195	-0.864	.3907	0.311	1.408	.1648
x Quadratic	0.086	0.384	.702	-0.383	-1.923	.0598	0.470	2.454	.0164*
x Cubic	-0.036	-0.224	.824	-0.052	-0.312	.7562	0.016	0.097	.9234
x Quartic	0.118	0.762	.448	0.139	1.072	.2872	-0.020	-0.136	.8926

TABLE 2.8: **Pairwise comparisons of the models of the curves across the different conditions (unaccusative, unergative, transitive) across the global post-verbal frame.**

4.4 Resampling analysis

In previous work also closely replicating Koring et al. (2012), Huang and Snedeker (2020) claimed that the GCA is inadequate to study argument reactivation within the VWP. Based on their resampling analysis results, these authors stated that growth curve models are highly anti-conservative and report many false positives, even more than expected due to chance. Considering the results reported by Huang and Snedeker (2020), and in order to check the validity of our analysis, we conducted a resampling analysis on the same data frame that we used for data modelling. We randomly switched the condition label of each subject's trials, always preserving the random assignation of the condition to the complete trial of each individual so that time-series dependencies would endure. Afterwards, we conducted the GCA described in section 3.2 on the resampled data frame and registered the results. This procedure was repeated 1000 times. We applied the resampling analysis in all three time windows: the verb frame, the post-verb frame and the global post-verbal frame (i.e., the time window selected for the post-hoc analysis). Results are shown in Table 2.9.

	Verb frame		Post-verb frame		Global post-verb frame	
Term	**False positives**	**p-value for true alpha level of 0.05**	**False positives**	**p-value for true alpha level of 0.05**	**False positives**	**p-value for true alpha level of 0.05**
UNERG	5.60%	0.0448	5.20%	0.0329	5.90%	0.0419
UNAC	5.20%	0.0457	5.10%	0.0489	6.20%	0.0408
Linear*UNERG	6.90%*	0.034	5.20%	0.0456	4.50%	0.0530
Linear*UNAC	6.50%*	0.0351	6.90%*	0.0479	6.80%*	0.0394
Quadratic*UNERG	4.30%	0.0502	7.10%*	0.0358	4.60%	0.0536
Quadratic*UNAC	4.90%	0.0570	6.90%*	0.0351	3.80%	0.0650
Cubic*UNERG	-	-	4.20%	0.0613	5.10%	0.0477
Cubic*UNAC	-	-	5.30%	0.0435	6.70%*	0.0382
Quartic*UNERG	-	-	7.20%*	0.0279	5.40%	0.0452
Quartic*UNAC	-	-	7.30%*	0.0303	7.00%*	0.0374

TABLE 2.9: **Resampling analysis across the three time windows. False positives and *p*-values for true alpha level of 0.05 were calculated from a sample of 1000 reshufflings. The instances in which the false positive rates were significantly greater than expected by Fisher's exact test are marked with an asterisk.**

Regarding the criteria for interpretation, we assume a 5% chance of false-positive result when alpha is set at 0.05. Attending to this, if our model were valid (i.e., conservative), the matrix should not produce significant results above 5% of the time. As shown in Table 2.9, the overall probability of obtaining a significant effect was found in 3.80% to 7.30% of the resampled data. This means that our models were slightly anti-conservative, but still adequate for analysis. Following Huang and Snedeker (2020), we also ordered the p-values obtained in our sample of 1000 reshufflings, selecting the 50th smallest value. If our model adequately captured the probability of false positive under the null hypothesis, this value should be around 0.05. As shown in Table 2.9, our data adequately captures this probability, as the provided p-values are around the estimated 0.05.

5. Discussion

In this study we investigated argument structure processing by exploring how thematic role (agent or theme) affects subject reactivation. We conducted a close replica of Koring et al. (2012) (and partially of Huang and Snedeker (2020)), investigating the reactivation of subjects after verb presentation in unaccusative, unergative and transitive sentences in Spanish. We measured the time course and magnitude of subject reactivation in three different time windows: (a) the verb frame, which was centered around the presentation of the verb; (b) the post-verb frame, which was centered around the presentation of the post-verbal Adjunct; and (c) the global post-verbal frame, which comprised a broader time frame going from verb offset until around 4000 ms after verb offset.

We entertained two hypotheses related to the time course and the magnitude of subject reactivation. On the one hand, the UH (Perlmutter, 1978) predicts a late peak in the reactivation of the unaccusative subject compared to unergative and transitive subjects, in line with previous eye-tracking research (Koring, Mak and Reuland, 2012). The late reactivation effect for unaccusative subjects is expected to occur around 950 ms after verb offset according to various previous findings (Bever and Sanz, 1997; Burkhardt, Piñango and Wong, 2003; Altmann and Kamide, 2004; Friedmann et al., 2008; Koring, Mak and Reuland, 2012). Koring et al. (2012) argue that the UH makes another prediction for eye-tracking data in the VWP: a larger reactivation of unaccusative subjects than unergatives, due to their greater processing cost of the former. Instead, we argue that the magnitude of argument reactivation is an indication of attention or preference, not of processing cost. On the other hand, we considered the AFH (Ferreira, 2003; Laka and Erdocia, 2012; Frenzel, Schlesewsky and Bornkessel-Schlesewsky, 2015). The AFH predicts a larger reactivation of agent subjects (unergative and transitive conditions) than theme subjects (unaccusative condition), due to a greater saliency of or preference for agents compared to themes.

To test our hypotheses, we monitored the gaze-fixation patterns of 44 Spanish native speakers while they were simultaneously presented with an auditory sentence and a visual display with four images; one of them was semantically related to the subject in test trials, but not in control trials. We found that specific linguistic stimuli (e.g., *mouse*) drove gaze fixations to semantically-related visual objects (e.g., a depiction of a cheese), in line with previous VWP studies (Huettig and Altmann, 2005; Yee and Sedivy, 2006). Crucially, not only did hearing *mouse* trigger gaze fixations towards a depiction of a cheese, but the auditory presentation of the verb (e.g., *fall*) also triggered gaze fixations towards the related visual object. This finding indicates that the reactivation of previously presented arguments follows the auditory presentation of the verb in order to integrate the verb and its arguments in a single mental representation, as found also in Koring et al. (2012).

At the verb frame, we found several differences across verb conditions in both the magnitude and time course of subject reactivation. The verb frame was the earliest time frame in our analysis, as it was centered on the presentation of the verb. Regarding magnitude, agent subjects (unergative and transitive conditions) reactivated to a greater degree than theme subjects (unaccusative condition). That is, the overall height of the curve that indicates looks into the visual target was greater for agent subjects than for theme subjects throughout the entire verb frame. Koring et al. (2012) also found that the magnitude of reactivation was greater for unergative subjects than for unaccusatives in this time frame. Regarding time course, unergative subjects displayed a reactivation effect peaking around 1000 ms after verb offset, whereas unaccusative subjects showed a decay of activation throughout the entire verb frame. The trajectory of the curve displayed a fall of activation followed by a rise in the case of unergative subjects, but only a fall in the case of unaccusative subjects. This converges with Koring et al. (2012), since they also found only unergative subjects exhibiting an early peak in reactivation in the verb frame. We found no differences when comparing the unergative and transitive conditions in this time frame. Taken by themselves, the results in this time frame can be accounted for by both the AFH and the UH . For this reason, it is necessary to combine the results from the verb frame with the ones from the post-verb frame in order to adjudicate between the two hypotheses.

At the post-verb frame, we again found differences across conditions in both the magnitude and time course of subject reactivation. The post-verb frame was centered on the presentation of the post-verbal adjunct immediately following the verb. Agent subjects (unergative and transitive conditions) also showed a greater reactivation than theme subjects (unaccusative condition): the overall height of the curve was larger for agents than for themes throughout the entire post-verb frame. Regarding time course, unergative subjects displayed two peaks of reactivation: one around 1000 ms after verb offset, and another one around 1700 ms after verb offset. Note that we cannot state that the maximum peak of reactivation was located at 1700 ms after verb offset, since the analyzed time frame ends at 1700 ms. Still, a significant reactivation effect for the unergative condition was captured starting from around 1500 ms until the end of the post-verb frame. That means that the trajectory of the curve of unergative subjects displayed a rise after verb offset, a subsequent fall and a subsequent rise toward the end of this time frame. These rises indicate a peak in the reactivation of unergative subjects. We found no differences when comparing the unergative and transitive conditions in this time frame. Unlike Koring et al. (2012), we did not find a late peak in the reactivation of unaccusative subjects at the post-verb frame. During this time frame, the unaccusative condition showed a relatively low and constant pattern of post-verbal activation, without any rises in the trajectory of the curve to signal a peak in reactivation after the verb. Hence, we cannot state that the unaccusative pattern of gaze fixations constitutes a late reactivation effect.

At the global post-verbal timeframe, the post-hoc analysis showed that agent subjects (unergative and transitive conditions) displayed a greater magnitude of reactivation than theme subjects (unaccusative condition). Once again, we found no evidence of a late peak in the reactivation of the unaccusative subject during this time frame. This indicates that the absence of a late peak in the reactivation of unaccusative subjects in our results was not due to a faster speech rate of the spoken sentences in our experiment.

The combined results in the verb, post-verb and global post-verbal timeframes support the predictions of the AFH, but not those of the UH. We found a greater magnitude of reactivation in agent subjects than in themes, a result we interpret as evidence that listeners devoted more attentional resources towards agents than themes. However, contrary to UH predictions and Koring et al. (2012), we did not observe a late peak in the reactivation of unaccusative subjects in the post-verb frame. Unaccusative subjects did not undergo a late reactivation after the presentation of the verb, but rather showed a decay in activation at the verb frame and then continued to be slightly activated in a relatively low and constant manner throughout the post-verb timeframe. Lastly, we found no difference in the processing of unergative and transitive subjects in either timeframe. This further indicates that the pattern of subject reactivation is guided by the thematic role of the subject.

In line with this interpretation, we also suggest that previous findings adjudicated to the UH may also be accounted for by the AFH. For example, the late reactivation of the unaccusative subject reported by Koring et al. (2012), which they interpret as evidence of object-to-subject syntactic movement, was still lower in magnitude than the one observed for the unergative condition in their study. Moreover, Koring et al. (2012) also found a difference in the magnitude of reactivation across conditions in all time frames, which can be observed in the significant difference in intercept of the curves. That is, their overall finding that agent subjects reactivate to a greater degree than theme subjects can be accounted for by the AFH alone, without appeal to the UH.

Overall, we did not replicate the findings reported in Koring et al. (2012) regarding the time course of subject reactivation in the unaccusative and unergative conditions. Whereas Koring et al. (2012) found an early peak in the reactivation of unergative subjects and a late peak in the reactivation of unaccusative subjects, we found an early peak in the reactivation of unergative and transitive subjects (agents) after the verb, yet failed to find a late peak in the reactivation of unaccusative subjects (themes). This aspect of our results coincides with the findings reported in Huang and Snedeker (2020), also a close replica of Koring et al.'s (2012) study, who also failed to replicate the patterns of subject reactivation reported in Koring et al. (2012). Given the concerns about the method's validity expressed in Huang and Snedeker (2020), we performed a resampling analysis of our data. Results validated our methods and the methods employed by Koring et al. (2012) for testing processing differences of subject reactivation in different argument structures. We thus conclude that GCA of VWP data constitutes a valid method to investigate the processing of argument structure.

Our results provide new evidence concerning the processing of argument structure and thematic roles in sentence comprehension, since we found different reactivation patterns depending on the thematic role of the subject (agent or theme). Our main finding is the difference in the magnitude of subject reactivation across conditions. Subjects with an agent role (unergative and transitive conditions) displayed a post-verbal reactivation of greater magnitude than subjects with a theme role (unaccusative condition) in all timeframes. These results are fully compatible with the predictions generated by the AFH, which claims that the first ambiguous NP in a sentence will preferably be interpreted as an agent. This hypothesis can also account for the differences between unaccusative and unergative predicates without necessarily involving distinct syntactic structures, as the UH crucially claims. Our results are not compatible with the UH, since we failed to observe a late peak in the reactivation of the unaccusative subject after the verb. Because fixation data in the VWP reveals cognitive attention and activation of elements within the participant's mental state, we take our results to constitute solid evidence of a greater attentional preference towards agents, shown by the larger reactivation effect we report.

6. Conclusion

In this study we report new evidence of processing differences between agent and theme subjects in Spanish by means of eye tracking in the VWP. We presented participants with SV(O) spoken sentences with transitive, unergative and unaccusative verbs, while monitoring the time course of gaze fixations into the visual display. Subjects of transitive and unergative verbs are agents while subjects of unaccusative verbs are themes. In test trials, the visual target (e.g., a depiction of a cheese) was semantically related to the sentential subject (e.g., *mouse*). We measured the time course and magnitude of the activation of the sentential subject across the presentation of the spoken sentence. We found that agent subjects (transitive and unergative conditions) underwent a post-verbal reactivation of greater magnitude than theme subjects (unaccusative condition).

Our main finding lies in a difference in the magnitude of the reactivation effect, not in the time course of the effect. We found differences across verb conditions in all time frames. Unergative and transitive subjects, both agents, displayed a larger reactivation effect than unaccusative subjects (themes). We did not find any significant difference in subject reactivation between the unergative and the transitive conditions, suggesting that agent subjects share a common pattern of reactivation regardless of transitivity. We interpret this difference in the magnitude of reactivation as an indication of the amount of attentional resources or cognitive preference directed towards sentential subjects during sentence comprehension. In other words, as soon as thematic roles could be determined (i.e., when participants heard the verb), we observed an attentional preference towards agents over themes.

Our findings thus fully meet the predictions made by the AFH. We found an early reactivation of the unergative subject after the verb, but crucially, not a late one for the unaccusative subject. This is contrary to Koring et al. (2012), who reported a late reactivation of unaccusative subjects at the post-verb frame, which they interpret as evidence for syntactic movement as predicted by the UH. Our findings can be accounted for by the AFH without resorting to the UH, and we argue that previous experimental findings interpreted as evidence for the UH can also be accounted for by the AFH, following an attentional preference for agents compared to themes rooted in human cognition.

Chapter 3. The impact of prototypicality on argument structure processing

Abstract

In Experiment 1, I found that agent subjects received greater visual attention than theme subjects in SV(O) Spanish sentences. This result suggests that the thematic role of the subject determines its processing pattern in both transitive and intransitive sentences, with a preference for agents over themes. However, the sentential subjects in Experiment 1 were all animate, which leaves room for a possible experimental confound: the factor of prototypicality. Given that animate agents are prototypical, but animate themes are not (Comrie, 1989; Dowty, 1991; Bornkessel-Schlesewsky and Schlesewsky, 2009), Experiment 1 results comparing prototypical agent subjects to non-prototypical theme subjects could also be accounted for by alluding to a preference for prototypical subjects instead of an agent preference. In order to explore whether prototypicality plays a role in the processing pattern of sentential subjects, I conducted a 2 x 3 experiment with animacy (animate, inanimate) and verb type (unaccusative, unergative, transitive) as independent variables, thus yielding both prototypical and non-prototypical agent and theme sentential subjects. I contemplated two hypotheses: (i) the Agent Preference Hypothesis in conjunction with prototypicality effects (henceforth APH*p), and (ii) the Prototypicality Preference Hypothesis (henceforth PPH). The APH*p predicts finding a modulation of the general agent preference proposed by the APH based on the prototypicality of the sentential subjects. Three specific prototypicality effects were considered in the form of predictions: (i) that animate agents (prototypical) will display a larger reactivation effect than inanimate agents (non-prototypical); (ii) that inanimate themes (prototypical) will display a larger reactivation effect than animate themes (non-prototypical); and (iii) that animate agents (prototypical) will display a larger reactivation effect than inanimate themes (prototypical). Secondly, I considered the PPH, which proposes a general preference for prototypical subjects compared to non-prototypical ones. Importantly, this hypothesis makes the same predictions as the APH*p except for one: whereas the APH*p predicts finding an overall agent preference, the PPH predicts that all prototypical subjects (animate agents and inanimate themes) will display a reactivation effect equivalent in magnitude. Sixty-four participants listened

to SV(O) sentences while looking at visual displays; in the critical trials, the sentential subject was related to one of the pictures. Results showed that visual objects related to animate agents and inanimate themes (prototypical arguments) received a greater proportion of fixations than those related to inanimate agents and animate themes (non-prototypical arguments). Among the prototypical conditions, agents displayed a larger magnitude of reactivation than themes. These results are consistent with APH*p predictions, since I found a modulation of the agent preference based on the prototypicality of the sentential subjects, and prototypical agent subjects showed a larger reactivation than prototypical theme subjects. These findings replicate previous results obtained in Experiment 1 that support a general agent preference in argument structure processing, while also providing new evidence of the specific ways in which prototypicality effects modulate the agent preference.

1. Introduction

The *Agent Preference Hypothesis* (henceforth APH) claims (i) that the first ambiguous NP of a sentence is preferably processed as an agent, and (ii) that listeners display an attentional preference towards agents as compared to themes. A large and heterogeneous body of evidence is compatible with the claims of the APH, including the results in Experiment 1 (Slobin, 1966; Goldin-Meadow and Feldman, 1977; Angiolillo and Goldin-Meadow, 1982; Burkhardt, Piñango and Wong, 2003; Goldin-Meadow, 2003; M. Lee and Thompson, 2004; Dryer, 2005; Friedmann et al., 2008; Goldin-Meadow et al., 2008; McAllister et al., 2009; Arunachalam and Waxman, 2010; J. Lee and Thompson, 2011; Kemmerer, 2012; Cohn and Paczynski, 2013; Dryer and Haspelmath, 2013; Meltzer-Asscher et al., 2015; Momma, Slevc and Phillips, 2018; Gómez-Vidal et al., 2022).[1]

The main finding in Experiment 1 was that agent subjects received greater visual attention than theme subjects. I interpreted these results as evidence that agent subjects are preferred over theme subjects, in accordance with the APH. However, research in psycholinguistics and cognitive science suggests that other factors, such as animacy, also play an important role in the processing of arguments in a sentence by acting as cues that guide predictive processes (Heider and Simmel, 1944; Adams and Conklin, 1973; Mandler, 1992; Kanwisher, McDermott and Chun, 1997; Caramazza and Shelton, 1998;

[1] Some of these studies claim to lend support to the UH and/or other related hypotheses, with no mention to the APH. As discussed in Chapter 2, it should be noted that UH-compatible results are also compatible with the APH in the cited studies, since these hypotheses make convergent predictions for the gathered data.

Chao, Martin and Haxby, 1999; Perani et al., 1999; Weckerly and Kutas, 1999; Frisch and Schlesewsky, 2001; Leube et al., 2001; Rakison and Poulin-Dubois, 2001; Traxler, Morris and Seely, 2002; Molina et al., 2004; Mahon and Caramazza, 2005; Traxler et al., 2005; Jäger, 2007; New, Cosmides and Tooby, 2007; Dahl, 2008; Demiral, Schlesewsky and Bornkessel-Schlesewsky, 2008; Philipp et al., 2008; Gao, McCarthy and Scholl, 2010; Muralikrishnan, Schlesewsky and Bornkessel-Schlesewsky, 2015). Crucially, these factors were not considered in Experiment 1. Thus, the current chapter seeks to fill this gap by exploring the relevance of animacy and prototypicality in the processing of subjects in Spanish. This allows for the collection of relevant new data for the investigation of argument structure processing, as well as for a more nuanced discussion of Experiment 1 results.

The structure of this chapter is as follows. First, I will review the relevant findings in the literature investigating argument structure and event processing, which have been attributed to three factors: (i) the thematic role of the argument, (ii) the animacy of the argument, and (iii) the prototypicality of the argument. Then, I will present the experimental design of Experiment 2 and the hypotheses considered, as well as other information regarding methodology, preparation and validation of materials, procedure and participants. Next, I will provide an account of the data processing steps and statistical analyses that were carried out with the collected data. Finally, I will lay out the results, discussion and conclusions at the end of this chapter.

1.1 Thematic role: agents vs. themes

Research in a wide array of fields investigating language and cognition have found consistent differences between agents and themes. This includes studies in event perception (Slobin, 1966; Leslie and Keeble, 1987; Saxe, Tenenbaum and Carey, 2005; Hamlin, Wynn and Bloom, 2007; Spelke and Kinzler, 2007; Hamlin et al., 2011; Noble, Rowland and Pine, 2011; Hafri, Papafragou and Trueswell, 2013), language production (Angiolillo and Goldin-Meadow, 1982; Momma, Slevc and Phillips, 2018), language comprehension (Bever and Sanz, 1997; Friedmann et al., 2008; Shetreet and Friedmann, 2012; Meltzer-Asscher et al., 2015; Gómez-Vidal et al., 2022), aphasiology (Bates et al., 1988; Burkhardt et al., 2003; M. Lee and Thompson, 2004; McAllister et al., 2009; J. Lee and Thompson, 2011), language acquisition and development (Angiolillo and Goldin-Meadow, 1982; Arunachalam and Waxman, 2010; Goldin-Meadow, 2003; Goldin-Meadow and Mylander, 1998; Naigles, 1990; Noble et al., 2011; Rissman and Goldin-Meadow, 2017; Saxe et al., 2005), and language typology (Dryer and Haspelmath, 2013). Due to the heterogeneity of the methods in the works cited above, there is not a single pattern of results common to this body of evidence, but rather a constellation of related findings, which are elaborated on below.

Language production and comprehension research reveals that the ordering of agent and theme arguments has a great impact on sentence processing. For instance, production studies in children report a preference for agent-initial structures, both in oral and sign language modalities (Goldin-Meadow and Feldman, 1977; Angiolillo and Goldin-Meadow, 1982; Goldin-Meadow, 2003). This tendency also emerges when adult speakers of mutually unintelligible spoken languages are prompted to communicate via spontaneous gestures (Goldin-Meadow et al., 2008). In ambiguous syntactic contexts, agent subjects are preferred over theme subjects as the first argument of a transitive sentence in a variety of languages, including Mandarin, German, English, Basque and Dutch (Ferreira, 2003; Bornkessel-Schlesewsky and Schlesewsky, 2006a; Laka and Erdocia, 2012; Lamers, 2012; Bisang, Wang and Bornkessel-Schlesewsky, 2013; Huang et al., 2013). This agent-initial preference in processing is related to findings in linguistic typology investigating frequency of structures and constituent order: around 86% of the world's languages have a predominant agent-initial word order in canonical transitive sentences (Comrie, 1989; Dryer, 2005).[2] Processing differences are also found between intransitive sentences with agent subjects (i.e., unergative sentences) and intransitive sentences with theme subjects (i.e., unaccusative sentences), both in healthy speaker populations (Shetreet and Friedmann, 2012; Meltzer-Asscher et al., 2015; Momma, Slevc and Phillips, 2018) and speakers with aphasia (Burkhardt et al., 2003; Friedmann et al., 2008; McAllister et al., 2009; J. Lee and Thompson, 2011). In these studies, the processing of unergative sentences elicits neurological and psychometric measures associated with less neural activation, less processing cost, higher accuracy and/or earlier integration compared to the processing of unaccusative sentences.[3, 4]

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[2] Canonical transitive sentences involve two participants, an agent subject and a theme object, and display the default (or unmarked) linear ordering of said arguments in the language.

[3] Some of the works cited here (Burkhardt et al., 2003; Friedmann et al., 2008; J. Lee and Thompson, 2011) do not interpret the deficits observed in unaccusative sentence processing as an indication of an agent preference. Alongside their original interpretations, I argue here that their results are also compatible with finding a preference for agents compared to themes in sentence processing.

[4] Note that this finding has been obtained in languages in which both agent and theme subjects receive the same morphological markings. However, this general finding has not been replicated in processing studies of ergative languages like Basque (Martinez de la Hidalga, Zawiszewski and Laka, 2019).

Findings in language acquisition suggest that children possess abstract knowledge of agent and theme categories. For example, when given novel verbs such as *moop* using a transitive template, 2-year-old toddlers correctly identify agent and theme participants in the event, and match their interpretation to a visual scene showing a causative action (Naigles, 1990; Gertner, Fisher and Eisengart, 2006; Arunachalam and Waxman, 2010; Noble, Rowland and Pine, 2011). Although scarce, some evidence suggests that this syntactic bootstrapping might stem from the universal properties of syntax-semantics mappings, rather than from categorization and generalization derived of linguistic input (Lidz, Gleitman and Gleitman, 2003). Regarding this matter, the linguistic behavior of Deaf children raised in non-signing families seems to lend further support to the claim that mechanisms in agent and theme categorization are guided by innate knowledge, since they have been found to display sensitivity to the agent-theme distinction in their homesign languages (Goldin-Meadow and Mylander, 1998; Rissman and Goldin-Meadow, 2017).[5]

Evidence from visual event perception research also reveals important processing distinctions between agents and themes. Preverbal infants and toddlers differentiate the roles of participants in a visual event, displaying an attentional preference towards pro-social agents (Hamlin, Wynn and Bloom, 2007; Hamlin et al., 2011). When viewing a dynamic event, children attend more to agent participants than to theme participants as the action unfolds (Robertson and Suci, 1980), and also verify scenes linked to active sentences more quickly and accurately than those linked to passive ones (Slobin, 1966). In adults, both visual search and linguistic description tasks reveal that agents are more salient than theme event participants (Ünal et al., 2024). Additionally, the extraction of agent and theme categories in visual scenes can occur successfully in under 100 ms, suggesting the high availability and/or priority of detecting such information (Hafri, Papafragou and Trueswell, 2013; Hafri, Trueswell and Strickland, 2018). Event perception research also reports a preference for first fixations on agents as compared to themes (Webb, Knott and MacAskill, 2010), with role recognition taking place faster and/or earlier for agents (Segalowitz, 1982). More broadly, visual processing studies also reveal a stable link between the agent role and relevant semantic traits, such as intentionality and/or causality. For example, preverbal infants seem to assign the agent role to objects that affect others in a visual scene (e.g., object A causes object B to move) (Leslie and Keeble,

[5] Homesigns are linguistic systems based on gestures created by Deaf children with little or no accessible exposure to another existing language, either signed or spoken (Hill, Lillo-Martin and Wood, 2018).

1987), and seem to interpret the actions of causal agents as intentional (Saxe, Tenenbaum and Carey, 2005).

All in all, ample evidence from a wide range of fields investigating processing, acquisition and development suggests that the distinction between agents and themes is a high-priority task in language, and that the processing of agents is faster, earlier and/or less costly than the processing of themes. The heterogeneity of methods, languages and populations tested in this body of evidence has led to the proposition of a number of general claims (Wierzbicka, 1996; Spelke and Kinzler, 2007; Carey, 2009; Strickland, 2017; Rissman and Majid, 2019): one, that agents and themes constitute core universal knowledge; two, that the distinction between agents and themes in language streams from a general cognitive bias rooted in human cognition; and three, that agents conform a more robust, better-defined abstract category than themes. However, a comprehensive review of the legitimacy of such claims is beyond the scope of this chapter, which revolves around the discussion of evidence in favor of the APH instead. Regarding this, the majority of results within the body of evidence discussed above are compatible with APH claims; those findings which are not ascribable to preference (and, therefore, not necessarily concerned with APH claims) are nevertheless compatible with finding a robust agent-theme distinction in processing. In any case, the common thread between the works presented above is that thematic role is understood as the key factor that produces the widespread effects reported in the literature. However, it is possible that other factors besides the thematic role of the arguments may account for such processing differences. Among these, animacy is a key factor in argument structure processing, since it acts as a cue that guides predictive processes in thematic role assignment and event recognition (Swart and Van Bergen, 2019). This factor is discussed in depth in the following section.

1.2 Animacy: animates vs. inanimates

In general terms, humans perceive natural world entities as either animate or inanimate, depending on whether these are capable of biological motion (Lowder and Gordon, 2015).[6] It has been found that humans and other mammalian animals display certain behaviors regarding animacy: first, we show a cognitive bias towards distinguishing animates from inanimates; second, we show an attentional preference towards animate en-

[6] Biological motion refers to the movement patterns exhibited by living organisms, with a particular focus on those of humans and other animals.

tities compared to inanimates (Kriegeskorte et al., 2008; Poulin-Dubois, Crivello and Wright, 2015; Abdai et al., 2017). Evidence from comparative cognition suggests that all hominids display a universal preference towards animate agents, thus revealing significant cognitive associations between animacy and agency among primates (Brocard et al., 2024). A similar trend had been previously reported in humans, as we have been found to consistently link animate entities to active or agentive behavior (New, Cosmides and Tooby, 2007). By contrast, humans typically associate inanimates with passive behavior, although natural forces such as hurricanes and earthquakes might constitute an exception (Lowder and Gordon, 2015).

Animacy-related cognitive biases are regarded as fundamental traits of human cognition (Szewczyk and Schriefers, 2011; Nairne, VanArsdall and Cogdill, 2017).[7] Evidence from cognitive development research reveals that both the animate-inanimate distinction and the attentional bias towards animates arise early in development, with some of these mechanisms readily available at birth (Mandler, 1992; Rakison and Poulin-Dubois, 2001; Molina et al., 2004; Bidet-Ildei et al., 2014). During infancy, animate-inanimate categorization strategies are refined through the exposure to new relevant input (Gelman, Durgin and Kaufman, 1996; Poulin-Dubois, Crivello and Wright, 2015). Infants use this information to make predictions about the behavior of animate and inanimate entities (Mandler, 1992; Rakison and Poulin-Dubois, 2001; Molina et al., 2004). More specifically, it has been found that babies expect animates to act rationally, as well as to possess mental states like goals, desires and beliefs (Gergely and Csibra, 2003; Hamlin, Wynn and Bloom, 2007; Newman et al., 2010; Luo, 2011).

Visual attention and event perception studies show that the animate-inanimate distinction is an integral aspect of event processing as well (Heider and Simmel, 1944; New, Cosmides and Tooby, 2007; Gao, McCarthy and Scholl, 2010). By default, the visual system attends more to animate entities compared to visually-similar inanimate objects (New, Cosmides and Tooby, 2007; Pratt et al., 2010), and also involuntarily picks out shapes that give the illusion of possessing agency and/or intentions (Heider and Simmel, 1944; Gao, McCarthy and Scholl, 2010).[8] Humans are also faster and/or more accurate at detecting change when dealing with animates than with inanimates (New, Cosmides and

[7] The question of how these biases relate to similar cognitive biases in other animal species remains, to my knowledge, unclear.

[8] This is referred to as *perceptual animacy*, a phenomenon in which observers tend to recognize inanimate entities as animate objects based on simple motion cues (Tremoulet and Feldman, 2000).

Tooby, 2007); this effect is attributed to the different monitoring strategies that humans direct toward each class.

The relevance of the animate-inanimate distinction has also permeated every field of linguistic research, including theoretical and experimental linguistics. In fact, animacy is regarded by many as one of the most fundamental semantic features that shape language. Some theoretical linguists hold that mapping animate entities to the subject function is a basic feature of language, and that it governs syntactic computations (Bock, Loebell and Morey, 1992). Albeit indirectly, animacy also plays a crucial role in the conceptualization of thematic roles. In fact, properties such as *sentience* and *volition*, which necessarily require the entity to be animate, are conceived as a defining characteristic of agents and recipients (Dowty, 1991; Rissman and Majid, 2019). Some sentence processing models also incorporate animacy into their workings as an important cue in the assignment of syntactic functions and thematic roles. For example, the Argument Dependency Model holds that animacy is one of the few universal cues that the processing system uses to parse the arguments of a sentence (Bornkessel-Schlesewsky and Schlesewsky, 2016). It should be noted here that several theoretical accounts dealing with syntax and semantics claim that the class of animates is heterogeneous, and hierarchies have been proposed to account for this diversity (Silverstein, 1976). In these animacy hierarchies, humans rank higher than non-human animals within the class of animates; that is, humans are considered to be the quintessential animate entity by other humans (Silverstein, 1976). For our current purposes, the animate and inanimate classes will be treated categorically throughout this chapter, without expanding into the hierarchies that have been proposed within each class.

Within linguistic typology, it is widely accepted that animacy is one of the most pervasive features to shape the syntax and semantics of the world's languages, since most languages incorporate this distinction into their grammatical systems in some way or other (Silverstein, 1976; Vihman and Nelson, 2019). Common grammatical phenomena shaped by animacy include verb agreement, case marking, and gender, pronoun and classifier systems (Adams and Conklin, 1973; Comrie, 1989; Bayanati and Toivonen, 2019; Vihman and Nelson, 2019). The way in which world languages encode the animate-inanimate distinction varies greatly, although some patterns appear to be considerably stable. For example, sentences describing an animate entity acting upon an inanimate one comprise the most frequent predicate type, and they tend to be morphosyntactically unmarked (Jäger, 2007; Dahl, 2008).[9] By contrast, events which do not describe animate-upon-inanimate interactions tend to be marked regarding the morphosyntax of the language in question (Comrie, 1989).

Substantial psycholinguistic and neurolinguistic research indicates that animacy shapes language processing. This is especially true of language comprehension, a field of study where animacy has been proposed as a particularly relevant cue for guiding the predictive processes involved in sentence processing (Szewczyk and Schriefers, 2011; Wang et al., 2020).[10] Electrophysiological evidence suggests that predicting the animacy of participants in a given event constitutes a high-priority task during sentence processing (Frisch and Schlesewsky, 2001), due to the fact that this plays a central role in the assignment of thematic role and identification of syntactic function. For instance, an ERP study in English shows evidence that clause-initial inanimate nouns elicit a larger N400 effect compared to clause-initial animate ones (Weckerly and Kutas, 1999). The opposite pattern has been reported for animate nouns as sentential objects, which elicited a larger N400 effect compared to inanimate nouns (Paczynski and Kuperberg, 2011). Eye-tracking evidence shows that animacy has immediate effects in ambiguity resolution of temporally-ambiguous sentences in English. These sentences, which contained an initial NP followed by a past participle, were associated with greater processing cost when the initial noun was animate (e.g., *the cat stolen by...*), compared to the inanimate condition (e.g., *the evidence stolen by...*) (Trueswell, Tanenhaus and Garnsey, 1994). These results suggest that animacy is used as a cue to predict the thematic role and/or syntactic function of clause constituents, with animate nouns being preferred as subjects and unpreferred as objects, and inanimate nouns being preferred as objects and unpreferred as subjects.

Moreover, an additional body of evidence supports the claim that animacy represents a unique semantic feature from a neurocognitive standpoint. For instance, animacy violations produce larger P600 effects than other semantic violations, such as those involving world knowledge (Szewczyk and Schriefers, 2011). This suggests that mechanis-

[9] In morphosyntax, markedness refers to the opposing manner in which linguistic features are conceived to relate to others within the system. This renders unmarked (or default) forms, in contrast with marked forms. Marked forms display greater morphological complexity than unmarked ones or, in the case of word order, involve linear orderings that differ from canonical word orders (Comrie, 1989).

[10] Probabilistic prediction is regarded as one of the most fundamental principles that support language comprehension, since it allows comprehenders to facilitate processing by anticipating upcoming linguistic stimuli (Kuperberg and Jaeger, 2016). Prediction can be achieved by a wide range of linguistic cues, including those pertaining to discourse, lexical-semantics, grammar and prosody (Wang et al., 2020).

ms involved in the processing of animacy differ (at least partially) from those involved in the processing of other semantic features. When it comes to the animate-inanimate distinction in itself, neurolinguistic research shows that animate and inanimate entities elicit distinct neural activation patterns (Kanwisher, McDermott and Chun, 1997; Chao, Martin and Haxby, 1999; Leube et al., 2001; Mahon and Caramazza, 2005; Bourguignon et al., 2012). The animate-inanimate distinction has also been linked to category-specific deficits in individuals with brain damage (Caramazza and Shelton, 1998). Lastly, semantic categorization based on animacy seems to be quite robust, since it is one of the last distinctions to suffer deterioration in individuals with neurodegenerative diseases such as Alzheimer's (Saffran and Schwartz, 1994).

Sentence processing studies also show that certain well-known effects are strongly modulated by animacy. One such classical effect is the subject-relative clause preference, whereby the processing of subject relative clauses tends to involve less processing cost than that of object relatives (King and Kutas, 1995; Gibson, 2000; Grodner and Gibson, 2005; Mak, Vonk and Schriefers, 2006).[11] Furthermore, it has been found that the added processing cost of object relatives decreases whenever the subject of the main clause is inanimate and the subject of the relative clause is animate (1), compared to the reversed condition (2) (Traxler, Morris and Seely, 2002; Traxler et al., 2005).[12]

(1) The movie$_i$ that the director$_a$ watched received a prize.

(2) The director$_a$ that the movie$_i$ represented received a prize.

Taken together, ample evidence from electrophysiological, neuroimaging and sentence processing studies in language support the idea that animacy plays an important role in language processing, especially when it comes to language comprehension. Because of this, it is worth considering whether animacy could have played a role in Experiment 1 results. The fact that all sentential subjects in Experiment 1 were animate, and yet distinct

[11] Evidence from sentence processing research in Basque suggests that object relative clauses are associated with less processing cost than subject relatives in this language (Carreiras et al., 2010). These authors argue that processing cost of subject and object relative clauses may be dependent on the processing strategies determined by language-specific features.

[12] Animacy of the nouns is marked in the examples by means of subscript letters: *a* for animate, and *i* for inanimate.

patterns of reactivation were observed, indicates that the factor of animacy alone could not have explained the obtained pattern of results. However, the question of whether this factor could have interacted with that of thematic role in Experiment 1 still stands. In order to consider this issue further, the interaction of these two factors, thematic role and animacy, will be considered in depth in the following section by means of the discussion of *prototypicality*.

1.3 Prototypicality: prototypical vs. non-prototypical arguments

Prototypicality is a prominent concept in the fields of psychology, cognitive science and linguistics, and it is essential to the understanding of how information is represented by the human mind. It refers to how much a specific member of a category is seen as a typical example of that category or, in other words, the degree to which a particular member of a category is considered a representative of it. This notion is of particular relevance to Prototype Theory, a cognitive framework that claims that categories are not formed based on a well-defined set of features, but rather centered around prototypes, or typical examples, which serve as idealizes representatives of the category (Rosch, 1973; Rosch et al., 1976). Unlike other proposals, this view allows for graded membership: while some members are prototypical within the category, other members are peripheral.

The first experimental evidence to become associated with *Prototype Theory* involved the representation of categories such as color, form and everyday common objects or beings (e.g., birds, fruits, or furniture). Results suggest that these categories have a prototypical structure, since participants recall and name prototypical members of each category earlier, faster and more accurately than other peripheral members of the category, as well as give higher ratings of representativity for prototypical members than peripheral members of the category (Rosch, 1973; Rosch and Mervis, 1975; Rosch et al., 1976). Since then, research in theoretical and experimental linguistics has also produced findings that point towards prototypical structure of other types of categories, including that of thematic roles (Kelly, Bock and Keil, 1986; Lempert, 1989; Onishi, Murphy and Bock, 2008; Panther and Köpcke, 2008; Hafri, Papafragou and Trueswell, 2013; Buckle, Lieven and Theakston, 2017). Dowty's (1991) seminal work on the prototype structure of thematic roles has been particularly influential in the study of verb semantics and the understanding of how language represents and categorizes event participants. His *Thematic Proto-Roles* proposal claims that the best theory to account for thematic roles is not a traditional system of discrete roles (agent, patient, source, goal, etc.), but rather a theory of proto-roles (Dowty, 1991).[13] This includes two cluster-concepts, proto-agent and proto-patient, each characterized by a set of verbal entailments (Dowty, 1991). According to this proposal, an event participant is assigned either of the two proto-roles based on the number of verbal entailments that this argument meets (Dowty, 1991).

Findings in psycholinguistics and neurolinguistics support the claim that event participants display a prototype structure, thus allowing for prototypical and non-prototypical category members; these results will be considered in the following paragraphs. In order to tackle this research and their findings, it is first necessary to establish how prototypicality is applied to the notion of thematic roles within the fields of psycholinguistics and neurolinguistics, a task which is often left unaddressed (at least, explictly) by researchers who investigate the effect of prototypicality in sentence processing. The most widely-accepted view is that prototypicality affects event participants mainly through the interaction of two factors: (i) thematic role, conceived as the type of relationship that the argument has to the event and other event participant(s); and (ii) animacy, understood as an important and cognitively-salient semantic feature which has been demonstrated to deeply affect event perception and sentence processing (see section 1.2 for a full review of the relevant literature). Assuming that thematic roles have a proto-type structure, pairings of core thematic roles with the feature of animacy result in four unique combinations of either prototypical or non-prototypical arguments; these are shown in Table 3.1. In essence, animate agents are viewed as prototypical, while inanimate agents are not; the opposite is true for themes (Dowty, 1991; Bornkessel and Schlesewsky, 2006b; Bornkessel-Schlesewsky and Schlesewsky, 2009; Paczynski and Kuperberg, 2011).

		Thematic role	
		Agent	**Theme**
Animacy	**Animate**	Prototypical	Non-prototypical
	Inanimate	Non-prototypical	Prototypical

TABLE 3.1: **Prototypicality of arguments regarding two factors: thematic role and animacy.**

[13] Note that Dowty's (1991) theory of proto-roles does not subscribe to a Roschian view of thematic roles in which some members of the category are core exemplars, while other members are peripheral. Instead, it claims that thematic relations cannot be decomposed into discrete features, and therefore proposes two proto-role cluster concepts for thematic role assignment.

It is worth noting that frequency of occurrence correlates with considerations of prototypicality: animate agents are in fact the most frequent type of sentential subject, while inanimate themes are the most frequent type of sentential object (Comrie, 1989; Dowty, 1991; Bornkessel and Schlesewsky, 2006b; Bornkessel-Schlesewsky and Schlesewsky, 2009). In other words, prototypical arguments occur more frequently than non-prototypical ones. One could argue, therefore, that it is frequency of occurrence what truly determines the prototypicality of an argument. This is particularly significant given that, within Prototype Theory, prototypes are conceived as exhibiting a maximal number of features common to the category, which are often “averaged” across exemplars; this notion implicitly includes frequency (Ibbotson and Tomasello, 2009).

However, it is equally possible that preexisting cognitive biases at play are what determines the differences in frequency of occurrence between prototypical and non-prototypical arguments in the first place. Although essential to the understanding of how prototypes support linguistic meaning, it is beyond the scope of this chapter to determine exactly where frequency sits in this equation, that is, as an originator or as an effect of the bias. After all, the goal of this chapter is to examine whether prototypicality, understood as the interaction between thematic role and animacy, has an impact on argument structure processing. For my current purposes, it suffices to state that frequency of occurrence and prototypicality of arguments are indeed strongly correlated across languages.

In order to consider the topic of prototypicality fully, it is essential to offer a review of related psycholinguistic and neurolinguistic findings, which in turn are connected to the evidence already discussed regarding thematic role and animacy as independent factors. In linguistic development, infants show an early tendency to produce transitive sentences with prototypical arguments, thus mapping animate participants to agents and inanimates to themes (Angiolillo and Goldin-Meadow, 1982). In this vein, cross-linguistic evidence shows that young children acquire transitive sentences with prototypical arguments earlier than they do other transitive constructions; the evidence includes child learners of English, German, Polish and Cantonese (Ibbotson and Tomasello, 2009).

Sentence processing studies using electrophysiological and neuroimaging techniques present evidence that it is the prototypicality of an argument, and not its thematic role or animacy taken as independent factors, what elicits distinct neural activation and processing patterns. For instance, sentences with non-prototypical arguments generate greater processing costs than those with prototypical ones (Bornkessel-Schlesewsky and Schlesewsky, 2009; Foley, 2020). In transitive sentences, inanimate arguments are processed more easily as sentential objects than animate arguments (Traxler et al., 2005; Demiral, Schlesewsky and Bornkessel-Schlesewsky, 2008; Betancort, Carreiras and Sturt, 2009; Kretzschmar et al., 2012; Bickel et al., 2015; Sauppe et al., 2023).[14] The opposite pattern is true for animates, since animate arguments are predicted as sentential subjects more frequently than inanimate arguments (Bourguignon et al., 2012). Similarly, prototypical agents seem to be preferred over non-prototypical ones (Choudhary, 2011; Lowder and Gordon, 2012). It should be noted that this last finding, i.e., that non-prototypical agents are unpreferred to prototypical ones, is in direct conflict with the predictions made by the APH, since this hypothesis claims a general preference for agents across the board (see section 2.1 for a complete account).

Findings from EEG studies suggest that the processing of non-prototypical arguments in transitive templates elicits N400 effects compared to the processing of prototypical arguments; this electrophysiological measure is associated with finding unexpected or incongruent semantic information (Toffolo, Freedman and Foxe, 2022). In these experiments, participants were presented with a theme argument and a subsequent inanimate agent, which is a non-prototypical agent. The processing of these arguments elicited a significant N400 effect compared to the baseline condition, where the agent was prototypical (Frisch and Schlesewsky, 2001; Philipp et al., 2008; Muralikrishnan, Schlesewsky and Bornkessel-Schlesewsky, 2015). These results are compatible with the claim that animate entities are predicted to be agents (i.e., sentential subjects) in transitive sentences, while inanimate entities are not predicted to be agents. In other words, results suggest that argument structure processing favors prototypical mappings over non-prototypical ones, a finding which has been replicated using eye-tracking methods (Clifton, 1992, 1993; Traxler et al., 2005; Betancort, Carreiras and Sturt, 2009).

Depending on the questions asked and methods used, the results outlined above have been interpreted as resulting from (a) a difference in preference, and (b) a mismatch in prediction. Both children and adults prefer to map animate entities as agents and inanimate entities as themes (Angiolillo and Goldin-Meadow, 1982; Bornkessel-Schlesewsky and Schlesewsky, 2009; Choudhary, 2011; Lowder and Gordon, 2012; Foley, 2020). Pro-

[14] Demiral et al.'s (2008) results were interpreted as evidence for a subject-first strategy in Turkish. However, I argue that their results are compatible with other hypotheses that involve the notion of prototypicality, i.e., the interaction of thematic role and animacy, rather than alluding to syntactic function.

totypical configurations entail less processing cost than non-prototypical ones, which can also be attributed to preference (Traxler et al., 2005; Demiral, Schlesewsky and Bornkessel-Schlesewsky, 2008; Betancort, Carreiras and Sturt, 2009; Kretzschmar et al., 2012; Bickel et al., 2015). Parallel to this, speakers predict the thematic role and/or syntactic function of arguments primarily based on animacy, thus exhibiting a preference for implementing prototypical mappings at the first parsing of a sentence. More specifically, structures involving non-prototypical arguments are associated with measures indicating semantic unexpectedness; these are absent in the integration of prototypical arguments (Frisch and Schlesewsky, 2001; Philipp et al., 2008; Bourguignon et al., 2012; Muralikrishnan, Schlesewsky and Bornkessel-Schlesewsky, 2015). Given my research questions, assumptions and methods, this chapter seeks to further explore the line of research that investigates a processing preference for prototypical mappings in sentence comprehension, while still noting the importance of those results that attribute differences between prototypical and non-prototypical arguments to predictive processes.

Although previous works in psycholinguistics and neurolinguistics have explored the impact of prototypicality in processing, no hypothesis in the cited works fitted my research needs. For this reason, I combined previous ideas mentioned in the cited works with my own in order to formulate the *Prototypicality Preference Hypothesis* as it appears in this dissertation. The Prototypicality Preference Hypothesis (henceforth PPH) claims that prototypical arguments are preferred over non-prototypical arguments. This hypothesis is not only compatible with the evidence presented in this section regarding prototypicality, but crucially, it is also compatible with a significant amount of the previously-discussed evidence regarding a preference for agents and animate entities. In light of this overlap, it is possible that the processing differences found in Experiment 1 were due to the prototypicality of the arguments, and not solely to their thematic role. This is because the conditions in Experiment 1 (i.e., animate agents and animate themes) differed in their prototypicality, which resulted in the comparison of prototypical agents with non-prototypical themes. To disentangle this issue, I decided to conduct Experiment 2, a follow-up of Experiment 1 with a similar design, but this time including both prototypical and non-prototypical agents and themes in order to explore the impact of prototypicality on argument structure processing.

2. Experiment 2

Using an experimental design similar to that of Experiment 1, I explored the processing patterns of prototypical and non-prototypical sentential subjects in Spanish in order to test the predictions of the APH*p and PPH (see section 2.1 for a full discussion). To achieve this, I created SV(O) sentences where I measured the magnitude and time course of subject reactivation upon encountering the verb by means of eye tracking in the VWP. Just like in Experiment 1, spoken sentences were paired with visual displays containing four simple pictures. In the critical trials, one of the pictures in the visual display was semantically related to the sentential subject (e.g., sentential subject *eagle*, related to a depiction of a feather).

Experiment 2 had a 2 x 3 design with two independent variables: (i) animacy of the subject (animate, inanimate), and (ii) verb type (unaccusative, unergative, transitive), resulting in six experimental conditions. This design is illustrated in Table 3.2, where prototypicality of the subject is also indicated in the rightmost column by means of a tick or a cross.

Independent variables			
Animacy of the subject	**Verb type**	**Experimental condition**	**Prototypicality**
animate	unaccusative	animate theme (unaccusative)	x
animate	unergative	animate agent (unergative)	✓
animate	transitive	animate agent (transitive)	✓
inanimate	unaccusative	inanimate theme (unaccusative)	✓
inanimate	unergative	inanimate agent (unergative)	x
inanimate	transitive	inanimate agent (transitive)	x

Table 3.2: **Experimental conditions by independent variables. Prototypicality of the subject is indicated with a tick or a cross.**

2.1 Hypotheses

For Experiment 2, I contemplated two hypotheses: (i) the APH in conjunction with *prototypicality effects* (henceforth APH*p), and (ii) the Prototypicality Preference Hypothesis (henceforth PPH). In this section, I will illustrate the two hypotheses by listing the specific predictions that they make for Experiment 2 data. Predictions will be numbered (e.g., Prediction 0) and referred to throughout the text by means of its abbreviation (e.g., P0). It should be noted here that although previous works have explored prototypicality effects in sentence processing, there was not, to my knowledge, any particular theoretical account that fitted my research needs. For this reason, I decided to combine previous ideas about processing effects mentioned in the cited works together with my own in order to propose the specific prototypicality effects discussed in this chapter.

As with Experiment 1, all predictions revolve around the differences in magnitude of subject reactivation between conditions, which I contend can be interpreted as showing *preference*. The underlying assumption for such an interpretation is that fixations on a visual object (e.g., a feather) reveal the degree to which a related item (e.g., sentential subject *eagle*) is being activated in the participant's mental state. I argue that observing a difference in the magnitude of the reactivation effect between conditions can be interpreted as a difference in the attentional resources that listeners devote toward the sentential subject. If preference is understood in terms of attention to a stimulus, with greater attention denoting greater preference, then a larger reactivation effect indicates a greater preference for that stimulus compared to others with a lesser reactivation effect.

Let us first go over the APH plainly, without further considerations. By itself, the APH claims that the first ambiguous NP of a sentence is preferably processed as an agent, and that listeners display an attentional preference towards agents as compared to themes. Thus, the APH makes the following general prediction: that agent subjects will display a larger reactivation effect than theme subjects after the verb.

However, thematic role of the argument is not the only factor at play, since Experiment 2 also includes animacy as an independent variable. This brings about differences in the prototypicality of the sentential subjects (see Table 3.2). Such differences might, in turn, give rise to modulations of the general agent preference put forth by the APH depending on the prototypicality of the subjects. In other words, prototypicality effects could alter the way in which APH predictions are materialized for Experiment 2 data. For this reason, I introduced a slightly different nomenclature for the hypothesis described here: the APH*p, which combines the APH label with an asterisk followed by the letter *p*, expressing the modulation of the APH according to prototypicality. I considered three specific ways in which prototypicality effects might arise with respect to Experiment 2 data. These are listed below in the form of predictions (Predictions 1-3, henceforth P1-3):

(P1) Animate agents (prototypical unergative and transitive conditions) will display a larger reactivation effect than inanimate agents (non-prototypical unergative and transitive conditions) after the verb.

(P2) Inanimate themes (prototypical unaccusative condition) will display a larger reactivation effect than animate themes (non-prototypical unaccusative condition) after the verb.

(P3) Animate agents (prototypical unergative and transitive conditions) will display a larger reactivation effect than inanimate themes (prototypical unaccusative condition) after the verb.

Figures 3.1-3.3 illustrate the predictions of the prototypicality effects considered above (P1-3).[15] These graphs contain a modeled representation of the difference in subject reactivation between conditions, and they are based on a simplified visual representation of Experiment 1 data (Gómez-Vidal et al., 2022). The difference in magnitude of subject reactivation is expressed in proportions (*y* axis), and set within a generalized post-verb timeframe expressed in milliseconds (*x* axis), where 0 represents verb offset.

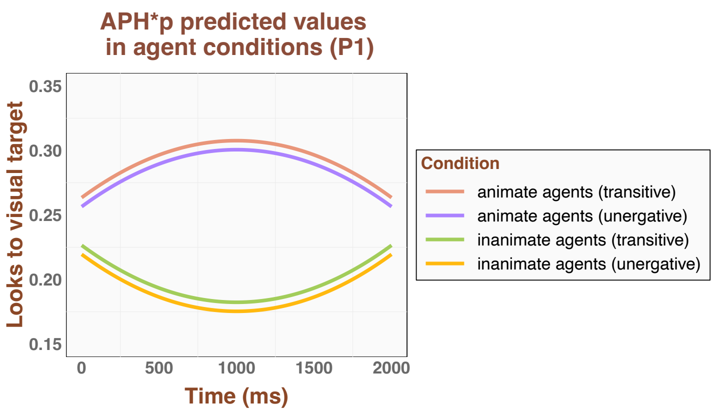

FIGURE 3.1: **Predicted difference in magnitude of subject reactivation between agent conditions in accordance with the APH*p (P1).**

[15] All graphs were generated using the *ggplot2* package (Wickham, 2016).

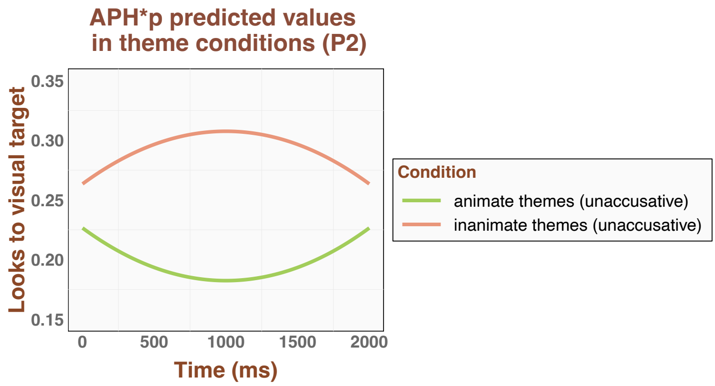

FIGURE 3.2: **Predicted difference in magnitude of subject reactivation between theme conditions in accordance with the APH*p (P2).**

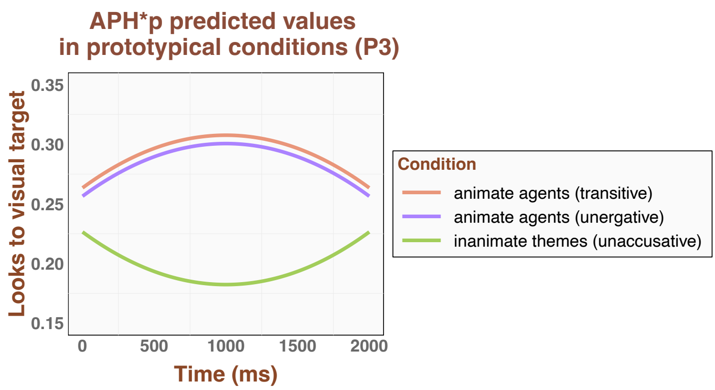

FIGURE 3.3: **Predicted difference in magnitude of subject reactivation between prototypical conditions in accordance with the APH*p (P3).**

Secondly, I also considered the PPH, which claims that listeners display an attentional preference towards prototypical arguments as compared to non-prototypical ones. Thus, the PPH makes the following general prediction for Experiment 2 data: that prototypical subjects (animate agents and inanimate themes) will display a larger reactivation effect than non-prototypical subjects (inanimate agents and animate themes) after the verb. Importantly, the PPH makes convergent predictions with those of the APH*p in two out of three instances, since the PPH also predicts finding that animate agents will display a larger reactivation effect than inanimate agents (P1), and that inanimate themes will display a larger reactivation effect than animate themes (P2). However, the PPH predicts the following with regards to the comparison of prototypical conditions (Prediction 4, henceforth P4) as illustrated in Figure 3.4:

(P4) Animate agents (prototypical unergative and transitive conditions) will display an equivalent reactivation effect as inanimate themes (prototypical unaccusative condition) after the verb.

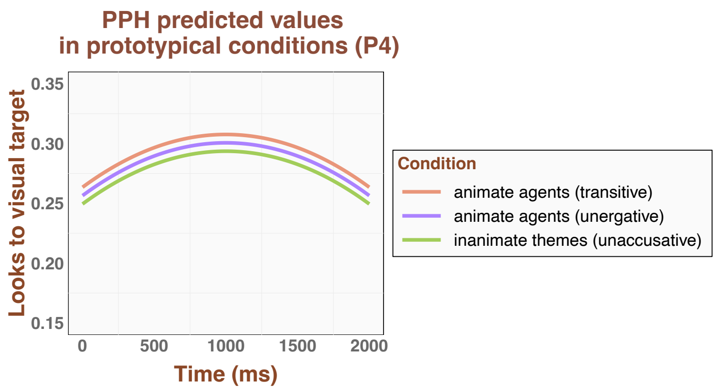

FIGURE 3.4: **Predicted difference in magnitude of subject reactivation between prototypical conditions in accordance with the PPH (P4).**

In summary, the APH*p makes three different predictions for Experiment 2 data (P1-3), positing a modulation of a general agent preference based on the prototypicality of the sentential subject. The PPH, which proposes a general preference for prototypical subjects compared to non-prototypical ones, also makes three predictions for Experiment 2 data. Two of these (P1-2) are identical to those made by the APH*p, while the remaining one (P4) is exclusive to the PPH. Given this overlap in predictions between the two competing hypotheses, only the comparison of prototypical conditions included in predictions P3 and P4 will allow us to differentiate between APH*p and PPH-compatible results, since each hypothesis makes a distinctive prediction for this contrast. The goal of this chapter is to gather new processing data that will allow me to differentiate between these competing hypotheses, in order to provide a more in-depth discussion on whether and how prototypicality plays a role in argument structure processing.

2.2 Methodology

For Experiment 2, I used the same methodology as in Experiment 1, presenting participants with auditory sentences and visual stimuli simultaneously. Sentences had preverbal subjects in order to measure the reactivation of the preverbal subjects upon verb presentation, i.e., during the post-verb timeframe. This was the selected time window for the analysis because it is at this point that an effect of thematic role in conjunction with feature of animacy could arise, since listeners can only unequivocally assign a thematic role to a preverbal argument once the verb is processed. During the experiment, I monitored the eye fixations of participants to a visual target that was semantically related to the sentential subject in the spoken sentence (e.g., sentential subject *eagle*, related to a depiction of a feather). This was done in order to obtain information on the attentional processes of native speakers upon processing the argument(s) of the spoken sentences, following the assumption that a higher number of fixations correlates with greater preference for the related argument.

2.3 Stimuli

Experiment 2 had a 2 x 3 design with two independent variables: (i) animacy of the subject (animate, inanimate), and (ii) verb type (unaccusative, unergative, transitive). This created a total of six experimental conditions (see Table 3.2). The dependent variable was the proportion of gaze fixations on the visual target. Stimuli comprised 240 trials in total, consisting of 240 unique spoken sentences paired with 120 visual displays containing four simple gray-scale pictures from the Multilingual Picture (MultiPic) databank (Duñabeitia et al., 2018). Out of 240 trials, 180 were experimental trials, and the other 60 were filler trials. Experimental trials were distributed evenly across six lists of stimuli following a Latin square design. Each list of stimuli consisted of 30 test trials and 60 filler trials, with a total of 90 trials per list. The same set of filler trials was used for all lists, and each participant was shown one list of stimuli. A complete list of the linguistic stimuli in Experiment 2 is provided in Appendix C.

2.3.1 Sentences

Linguistic stimuli consisted of spoken sentences recorded by a female native speaker of Spanish in a soundproof booth at a comfortable speaking rate. Linguistic stimuli comprised both experimental and filler sentences. Experimental sentences were structured into five ROIs, as shown in Table 3.3. Like in Experiment 1, the number of syllables in ROIs 2 and 4 was controlled to better align all experimental sentences at verb offset for the analysis (ROI 2: mean = 12.4, range = 10-15; ROI 4: mean = 13.9, range = 13-15).

ROI number	ROI name	Content
1	Introduction	A framing sentence including a variation of "[Someone] said that..."
2	Subject	The sentential subject NP, including a PP or AdjP that modified it.
3	Verb	The experimental verb (unaccusative, unergative or transitive).
4	Post-verb	The post-verbal Adjunct (of manner, time, place...).
5	Object/Additional Adjunct	The sentential (inanimate) object NP (only in the case of transitive sentences) or an additional Adjunct (in the case of unaccusative and unergative sentences).

TABLE 3.3: **Structure of experimental sentences by ROIs.**

Experimental and filler sentences were paired with visual displays to create experimental and filler trials. In experimental trials, one of the pictures in the visual display was strongly related to the sentential subject in the experimental sentence (e.g., sentential subject *águila* 'eagle', related to a depiction of a feather). An example of an experimental trial is given in sentence (3) and Figure 3.5. Note that the square brackets and numbers in sentence (3) mark the different ROIs in which experimental sentences were structured (see Table 3.3).

(3) [La bióloga dijo que][1] [el águila de color negro y marrón][2] [desapareció][3] [en aquella cueva pequeña, fría y oscura][4] [entre las piedras.][5]

'The biologist said that the black-and-brown-colored eagle disappeared in that small, dark and cold cave among the rocks.'

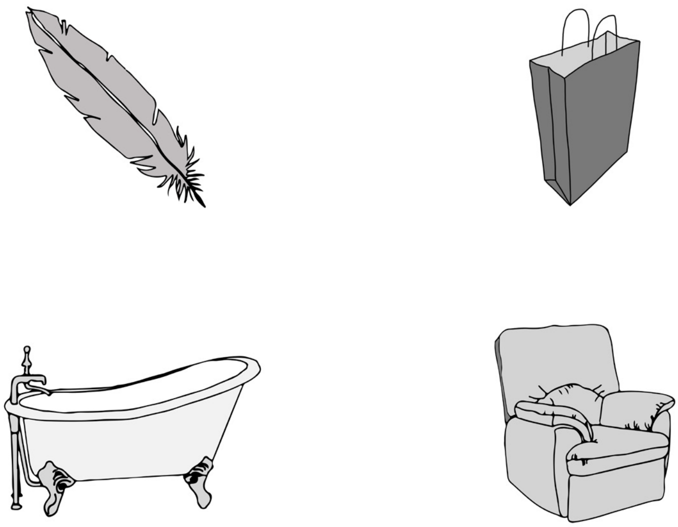

FIGURE 3.5: **Visual display paired with experimental sentence (3), where the visual target is a feather, related to the sentential subject *águila* 'eagle'.**

Experimental sentences had a mean length of 44 syllables, a range of 39 to 55 syllables, a mean duration of 8159 ms, and an average speech rate of 5.4 syllables per second, with the following values by experimental condition: animate unaccusative condition (mean length = 44 syllables, mean duration = 8179 ms, mean speech rate = 5.4 syllables per second), animate unergative condition (mean length = 45 syllables, mean duration = 8359 ms, mean speech rate = 5.3 syllables per second), animate transitive condition (mean length = 44 syllables, mean duration = 8339 ms, mean speech rate = 5.2 syllables per second), inanimate unaccusative condition (mean length = 43 syllables, mean duration = 7982 ms, mean speech rate = 5.4 syllables per second), inanimate unergative condition (mean length = 44 syllables, mean duration = 8106 ms, mean speech rate = 5.4 syllables per second), and inanimate transitive condition (mean length = 43 syllables, mean duration = 7991 ms, mean speech rate = 5.4 syllables per second). Previous research investigating the impact of speech rate in anticipatory eye movements while processing filler-gap dependencies suggests that native speakers benefit most from speech rates between 4.5 and 5.5 syllables per second (Fernandez et al., 2020). The speech rate of experimental sentences fitted within this range for all experimental conditions.

In order to check that there were no significant differences in total syllables, total duration and speech rate between conditions, I conducted a series of pairwise comparisons using linear models. In these models, the relevant factor (i.e., total syllables, total duration or speech rate) was modeled as a function of *animacy* or *verb*, depending on the specific subset of data. For example, when comparing the speech rate of animate unaccusative sentences and animate unergative sentences, *speech rate* was modeled as a function of *verb*, and not *animacy*, because both conditions are animate. By contrast, when comparing the speech rate of animate unaccusative sentences and inanimate unaccusative sentences, *speech rate* was modeled as a function of *animacy*, and not *verb*, because both conditions are unaccusative. All *p*-values were calculated using the *R Stats* package included in the R programming environment (R Core Team, 2019). These pairwise comparisons revealed no significant differences in total syllables, total duration or speech rate between conditions; the summaries of the coefficients are provided in Table 3.4.

Total syllables				
Conditions	**Animate unaccusative-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.867	0.500	87.821	<0.001
x Unergative	0.800	0.706	1.132	0.262
Conditions	**Animate transitive-animate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.767	0.445	98.314	<0.001
x Unaccusative	0.100	0.630	0.159	0.874
Conditions	**Animate transitive-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.767	0.507	86.251	<0.001
x Unergative	0.900	0.718	1.254	0.215

Conditions	Inanimate unaccusative-inanimate unergative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.233	0.456	94.776	<0.001
x Unergative	0.867	0.645	1.343	0.184
Conditions	**Inanimate transitive-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.233	0.403	107.252	<0.001
x Unaccusative	0.000	0.570	0.000	1
Conditions	**Inanimate transitive-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.233	0.476	90.847	<0.001
x Unergative	0.867	0.673	1.288	0.203
Conditions	**Animate unaccusative-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	43.867	0.409	107.297	<0.001
x Inanimate	-0.633	0.578	-1.095	0.278
Conditions	**Animate unergative-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	44.667	0.539	82.881	<0.001
x Inanimate	-0.567	0.762	-0.744	0.46
Conditions	**Animate transitive-inanimate transitive**			
	Estimate	**SE**	*t*-**value**	*p*-**value**
(Intercept)	43.767	0.440	99.489	<0.001
x Inanimate	-0.533	0.622	-0.857	0.395

Total duration

Conditions	Animate unaccusative-animate unergative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8131.6	84.966	95.704	<0.001
x Unergative	-65.1	120.160	-0.542	0.59
Conditions	**Animate transitive-animate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8210.467	84.193	97.520	<0.001
x Unaccusative	-78.867	119.066	-0.662	0.51

Conditions	Animate transitive-animate unergative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8210.467	86.612	94.796	<0.001
x Unergative	-143.967	122.488	-1.175	0.245
Conditions	**Inanimate unaccusative-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8148.267	80.325	101.441	<0.001
x Unergative	22.733	113.597	0.200	0.842
Conditions	**Inanimate transitive-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8228.367	84.681	97.170	<0.001
x Unaccusative	-80.100	119.756	-0.669	0.506
Conditions	**Inanimate transitive-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8228.367	86.719	94.885	<0.001
x Unergative	-57.367	122.639	-0.468	0.642
Conditions	**Animate unaccusative-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8131.600	80.339	101.216	<0.001
x Inanimate	16.667	113.616	0.147	0.884
Conditions	**Animate unergative-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8066.5	84.953	94.953	<0.001
x Inanimate	104.5	120.141	0.870	0.388
Conditions	**Animate transitive-inanimate transitive**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	8210.467	88.345	92.936	<0.001
x Inanimate	17.900	124.939	0.143	0.887

Speech rate

Conditions	Animate unaccusative-animate unergative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.408	0.080	67.724	<0.001
x Unergative	0.147	0.113	1.301	0.198

Conditions	Animate transitive-animate unaccusative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.346	0.072	74.644	<0.001
x Unaccusative	0.062	0.101	0.612	0.543
Conditions	**Animate transitive-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.346	0.082	65.033	<0.001
x Unergative	0.209	0.116	1.797	0.078
Conditions	**Inanimate unaccusative-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.315	0.063	84.547	<0.001
x Unergative	0.093	0.089	1.049	0.299
Conditions	**Inanimate transitive-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.267	0.058	91.301	<0.001
x Unaccusative	0.048	0.082	0.587	0.559
Conditions	**Inanimate transitive-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.267	0.067	78.367	<0.001
x Unergative	0.141	0.095	1.485	0.143
Conditions	**Animate unaccusative-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.408	0.061	88.246	<0.001
x Inanimate	-0.093	0.087	-1.072	0.288
Conditions	**Animate unergative-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.555	0.081	68.518	<0.001
x Inanimate	-0.147	0.115	-1.279	0.206
Conditions	**Animate transitive-inanimate transitive**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	5.346	0.069	77.963	<0.001
x Inanimate	-0.079	0.097	-0.813	0.419

TABLE 3.4: **Summary of pairwise comparisons of the six conditions (animate unaccusative, animate unergative, animate transitive, inanimate unaccusative, inanimate unergative, inanimate transitive) regarding total syllables, total duration and speech rate.**

It should be noted that the average speech rate of the experimental sentences in Experiment 2, averaging at 5.4 syllables per second, was higher than the average speech rate in Experiment 2, which corresponded to 4.8 syllables per second. Previous research shows that speech rates above 4.5 can be associated with a delay in the related eye movements of participants (Fernandez et al., 2020). For this reason, and given that ROI 3 (mean duration = 540 ms) was the shortest of all regions of interest in the experiment, I discarded ROI 3 for the analysis and selected ROI 4 as the only relevant region for analysis in Experiment 2 (see Table 3.3). ROI 4 immediately follows the presentation of the verb, and comprises the presentation of the post-verbal Adjunct. This ROI corresponds to the general point in time in which thematic role assignment of a preverbal argument can occur, and therefore processing patterns due to differences in thematic role can arise. Given the characteristics of the linguistic stimuli in Experiment 2, I estimated that it is also at ROI 4 that we can expect to measure such differences by means of related eye movements.

Experimental sentences were created in groups of items following a Latin square design. Because Experiment 2 had six experimental conditions, each group of items contained six sentences, which were identical except for the modulation of experimental condition.[16] This meant that the same group of verbs was paired with both animate and inanimate subjects across the three predicate types (unaccusative, unergative and transitive). Verbs were matched in Log Count values across conditions in the EsPal database (Duchon et al., 2013), with the following values by experimental condition: unaccusative condition (mean = 3; maximum = 3.9; minimum = 2.4; *SD* = 0.5), unergative condition (mean = 3.2; maximum = 4; minimum = 2.1; *SD* = 0.7), and transitive condition (mean = 3.1; maximum = 4.1; minimum = 2.2; *SD* = 0.6).[17] Nouns in the subject NPs were also matched in frequency across conditions by checking log count values in the EsPal database (Duchon et al., 2013), with the following values by experimental condition: animate nouns (mean = 3.6; maximum = 4.7; minimum = 2.5; *SD* = 0.7), and inanimate nouns (mean = 3.5; maximum = 4.2; minimum = 2.7; *SD* = 0.4).

[16] Sentences belonging to the same group of items also differed in ROI 5, since I gave each condition a unique ending in order to make the sentences more natural. However, this did not affect data analysis, because the data was gathered at an earlier timeframe than that of the presentation of ROI 5. In other words, sentences belonging to the same group of items were identical (save for the modulation of experimental condition) at all times in which data for the analysis was gathered.

[17] Log count values (current minimum value = 0.301030, current maximum value = 7.340494, current average value = 1.332151) are the best value to match words based on word frequency in the EsPal database (Duchon et al., 2013).

The task of creating natural sentences in Spanish adhering to this design proved rather difficult, on account of the fact that the verbs that were easily paired with animate beings did not seem as natural with inanimate subjects, and vice versa. I believe that this is an intrinsic issue in the comparison of animate and inanimate entities, given the fact that animates and inanimates simply relate to others in different ways, and thus participate in different events (see section 1.2 for a complete discussion). Admittedly, an alternative solution to this problem would have been to discard a Latin square design to create the linguistic stimuli, thus using one group of verbs for animates and another one for inanimates. However, this would have reduced the experimental control in the design, eliminating the possibility of comparing trials in which the only difference was the modulation of experimental condition. For this reason, I chose to maintain a Latin square design, thus sacrificing the degree of naturalness of the sentences across conditions.

Filler sentences were specifically created to improve the naturalness of experimental sentences by providing some form of previous context for the action described in the experimental sentences (see section 2.5 for a complete account on procedure). There were two types of filler trials regarding the relationship between the visual display and the spoken sentence. In half of the filler trials, one of the words in the spoken sentence was directly matched by one of the pictures in the visual display. In the other half of filler trials, none of the pictures matched any of the words in the spoken sentence. This was done in order to minimize the possibility that participants would predict the relationship between the spoken sentence and the visual stimuli given the structure of the spoken sentence. Importantly, filler trials were highly varied in their word order, syntactic structure and length of constituents. This was done in order to minimize the possibility that participants would predict the structure and length of constituents in the upcoming spoken stimuli.

2.3.2 Visual displays

Spoken sentences were paired with visual displays (e.g., Figure 3.5) containing four gray-scale pictures from the MultiPic databank (Duñabeitia et al., 2018). Pictures were resized to fill a similar proportion of the screen across visual displays, in order to prevent some objects from appearing larger or smaller than others. Pictures were positioned at the four corners of the screen, and the location of the visual target was counterbalanced across trials.

As mentioned above, experimental sentences were created in groups of six nearly-identical items, which only differed in the modulation of experimental condition. Initially, I sought out to create experimental sentences in which both the animate and inanimate subjects belonging to the same group of items shared the same visual target (e.g., having a picture of the sea as the visual target for both *sailor* and *ship*, with *sailor* as the subject NP for the animate conditions, and *ship* as the subject NP for the inanimate conditions within the same group of items). However, I found it impossible to create materials in this manner for all groups of items, due to the fact that most animate and inanimate subjects within the same group of items belonged to different semantic fields (e.g., having *eagle* as the subject NP for the animate conditions, and *leaf* as the subject NP for the inanimate conditions within the same group of items). As a consequence, I decided to assign a unique visual target to each subject NP, thus splitting the assignment of visual targets by animacy within each group of items (e.g., having a picture of a feather as the visual target for *eagle*, and a picture of a plant as the visual target for *leaf* within the same group of items). This meant that, for each group of items, two visual displays were created; one was paired with the animate conditions, while the other was paired with the inanimate conditions. The only difference between them was the visual target. In this manner, a total of 60 visual displays were paired with 180 unique experimental sentences to create 180 experimental trials. For the filler trials, each filler sentence was paired with a unique visual display for a total of 60 filler trials.

Given these design choices, it was necessary to make sure that the strength of the semantic relationships between animate subject NPs and their visual targets was the same as that of the inanimate subject NPs and their visual targets. For this reason, I conducted two separate norming studies, which are detailed in the following section.

2.4 Norming studies

The strength of semantic relationships between sentential subjects and visual targets was assessed by means of two separate norming studies using different methods for data collection. The first one was an online norming study in which participants rated the strength of the semantic relationship between NPs and pictures on a scale. In this study, the rating score was taken as the relevant measure to indicate the strength of the semantic relationship between the NPs and the pictures. The second one was a visual norming study in which participants heard NPs in isolation while the visual target was showing on a screen, within a visual display containing four pictures (e.g., Figure 3.5). In this study, eye fixations on the visual target were monitored by an eye tracker; and the proportion of fixations on the visual target was taken as the relevant measure to indicate the strength of the semantic relationship between the NPs and the pictures. Below, I detail the reasons for conducting each norming study, as well as their procedures and results.

2.4.1 Online norming study

Initially, I sought out to assess the relationship between subjects NPs and visual targets by means of a norming study conducted online using the Ibex Farm platform (Drummond, 2007). Fifty-five voluntary Spanish native speakers rated the strength of the semantic relationship between a noun and a visual target on a scale from 1 to 7. This norming study included 40 test trials of nouns paired with visual targets, which were estimated to be strongly related prior to the study, as well as 80 filler trials. Out of the 80 filler trials, 40 were estimated to be moderately related prior to the study, while the other 40 were estimated to be weakly related. This was done in order to prevent participants from consciously adapting their ratings (Cowart, 1997; Keller, 2000; Schütze and Sprouse, 2014). In total, the online norming study included 120 trials. The presentation of pairs was randomized by the Ibex Farm platform, and the rating task took around ten minutes to complete. A complete list of the online norming study stimuli is provided in Appendix C.

Raw ratings from the norming study were transformed into z-scores, taking each participant's mean and standard deviation into account. Two linear mixed models were run on z-score ratings including animacy as the predictor using the *lme4* package (Bates et al., 2015) in the R (version 3.6.2) programming environment (R Core Team, 2019). Sum contrasts were defined for the predictor: *animate* was coded as 1, and *inanimate* as -1. Model comparisons were carried out by means of likelihood ratio tests using the chi-square goodness of fit test in the *car* package (Fox and Weisberg, 2019), after which the most parsimonious model was fitted. In the final model, z-scores were modeled as a function of animacy, including varying intercepts by participant and by item: *z.score.rating ~ animacy + (1 | participant) + (1 | item)*. All *p*-values were calculated using the *lmerTest* package (Kuznetsova, Brockhoff and Christensen, 2017).

Results are summarized in Figures 3.6 and 3.7, showing mean raw ratings and mean z-score ratings, respectively.[18] The summary of the coefficients of the model is provided

[18] Note that no analysis was run on raw ratings; still, I provide a graphic representation of raw ratings in Figure 3.6 because these are interpreted more intuitively than z-score ratings.

in Table 3.5. Results from the linear mixed model showed a significant main effect of *animacy*, with animate nouns receiving higher ratings than inanimate nouns.

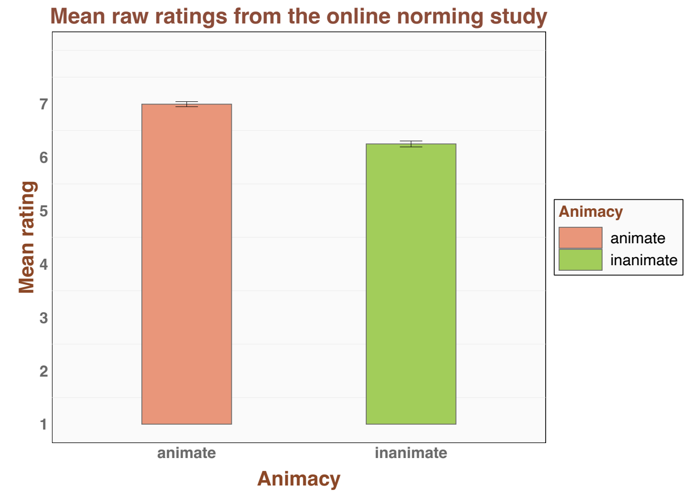

FIGURE 3.6: **Mean raw ratings showing the strength of the relationship between nouns and pictures obtained in the online norming study. Error bars show standard error.**

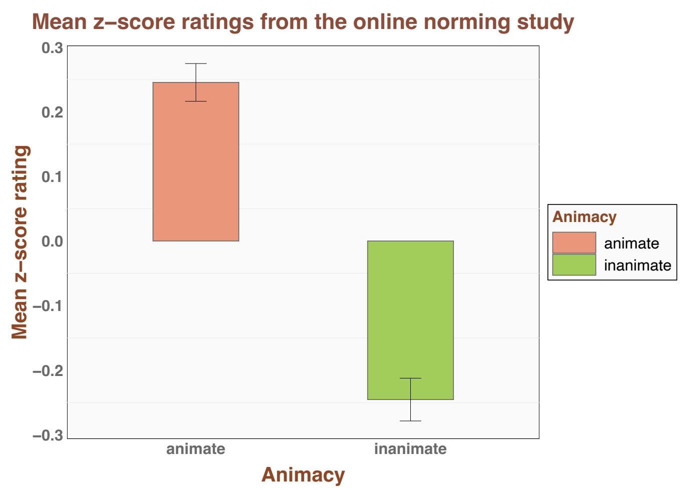

FIGURE 3.7: **Mean z-score ratings showing the strength of the relationship between nouns and pictures obtained in the online norming study. Error bars show standard error.**

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.000	0.114	0.000	1.000
Animate	0.245	0.114	2.158	0.039

TABLE 3.5: **Summary of the coefficients from the linear mixed model in the online norming study.**

Results from the online norming study revealed that participants consistently rated animate nouns as having a stronger relationship with the pictures than inanimate nouns. This result could indicate a fundamental flaw in the design of materials in Experiment 2: if the animate nouns were related to their paired pictures more strongly than the inanimate nouns, this would result in an impossibility for comparison between the experimental conditions due to a preexisting confounding variable in the materials.

However, I suspected that this result might be influenced by the requirements of the rating task itself, since participants were asked to evaluate the strength of the relationship between two items on a scale. Because a certain degree of conscious judgment is necessary in any rating task (Allwood and Selart, 2001), it could be possible that animate nouns were linked more intuitively to the pictures than inanimate nouns, due to a general preference for animate entities observed in humans (see section 1.2 for a complete account). Because of this, I contemplated the possibility that the effect reported in Table 3.5 would not arise if the measurement to indicate the strength of relationship between items were automatic, rather than guided by conscious or semi-conscious judgment processes. Importantly, Experiment 2 was designed to be carried out using eye-tracking methodology in order to monitor spontaneous fixations on visual objects upon presentation of related linguistic stimuli. As a consequence, I decided to conduct a similar norming study using eye-tracking methodology, in order to check whether the difference between conditions observed in rating scores would also be observed in spontaneous fixations on a visual object upon exposure to a related spoken noun.

2.4.2 Visual norming study

In this visual norming study, I assessed the relationship between nouns and visual targets in order to explore whether the animacy of the nouns would elicit differences in the visual attention that participants devoted to the related pictures. Sixty-four students from the University of the Basque Country (UPV/EHU) participated in this study. The task was conducted during the same session as the experimental task. Subjects were native speakers of Spanish with normal or corrected-to-normal vision, and no history of language-related pathologies (see section 2.5 for a complete account of participants and procedure).

The visual norming study included 20 of the test pairs of nouns and visual targets that were used previously in the online norming study; I selected the most strongly related pairs according to the online norming study data. Each of the 20 test pairs appeared twice throughout the procedure, although the visual target appeared in a different screen position and with different surrounding drawings in the visual display; this produced a total of 40 test trials. For the filler trials, I selected 20 nouns; each was paired with two visual displays, thus producing a total of 40 filler trials. In total, the visual norming study included 80 trials. A complete list of the visual norming study is provided in Appendix C.

Each noun was paired with a visual display containing four gray-scale pictures; in the case of test trials, one of the pictures was the visual target. The position of the visual target in the visual display was counterbalanced across trials. During the presentation of each trial, there was a silent previsualization of the visual display that lasted 1 second, after which participants heard an NP in isolation. When the spoken stimuli had ended, there was a silent visualization of the visual display that lasted 2 seconds, after which the trial ended. Trials were randomized by E-Prime 2.0 software for experiment presentation (Psychology Software Tools, 2012), and separated by a fixation cross that required participants to fixate on the center of the screen during 250 ms (continuously). The visual norming task took around seven minutes to complete, and Figure 3.8 illustrates its procedure.

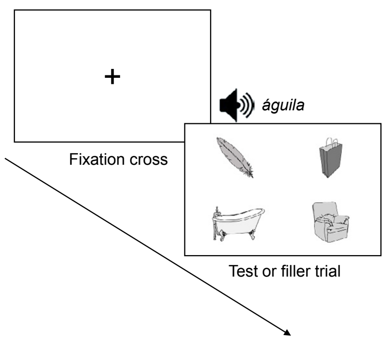

FIGURE 3.8: **Scheme of the visual norming study procedure, comprising the presentation of one trial. The visual target is a feather, related to the noun *águila* 'eagle.'**

During the task, participants' eye fixations on the visual target were monitored using a Tobii X120 desktop eye tracker sampling at 120 Hz. Only test trials were selected for the analysis; filler trials were discarded. The proportion of fixations on the visual target was calculated for each 20 ms time bin of eye data for each trial (see section 3.1 for a complete account of data processing). Two timeframes were created for the analysis: (i) the noun timeframe, starting from the onset of the spoken noun until the offset of the spoken noun; and (ii) the post-noun timeframe, starting from the offset of the spoken noun until the end of the trial.

For the noun timeframe, three models were created using the *Growth Curve Analysis* technique (Mirman et al., 2008; henceforth GCA) using the *lme4* package (Bates et al., 2015) in the R programming environment. The dependent variable was the proportion of fixations to the visual target, including *animacy* as the predictor as well as orthogonal polynomials. The number of models was determined by the shape of the curves observed during the visual exploration of the data. The first model included linear and quadratic polynomials, without interactions; the second model included linear and quadratic polynomials, with a linear interaction; and the third model included linear and quadratic polynomials, with a quadratic interaction. Model comparisons were carried out by means of likelihood ratio tests using Akaike's Information Criterion (AIC) (Akaike, 1974; Cavanaugh and Neath, 2019), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. After this, the most parsimonious model was fitted. The final model was an intercept model, where proportion of fixations were modeled as a function of *animacy*, including linear and quadratic polynomials as well as varying intercepts and slopes by participant per each condition: *proportion ~ animacy + ot1 + ot2 + (ot1 + ot2 | participant) + (ot1 + ot2 | participant:animacy)*. All *p*-values were calculated using the *lmerTest* package (Kuznetsova, Brockhoff and Christensen, 2017). Treatment contrasts were defined for the predictor: *animate* was coded as 0, and *inanimate* as 1.

Results are summarized in Figure 3.9, showing the proportion of fixations to the visual target in the noun timeframe. The summary of the coefficients of the model is provided in Table 3.6. Results from the quadratic model showed a significant positive intercept, a significant positive linear term and a significant negative quadratic term, but no significant effect of *animacy*. This means that the proportion of fixations on the related visual target was significantly larger than 0; fixations displayed a significant linear growth, as well as a significant negative quadratic term during the timeframe, but no significant difference was found between the animate and inanimate conditions.

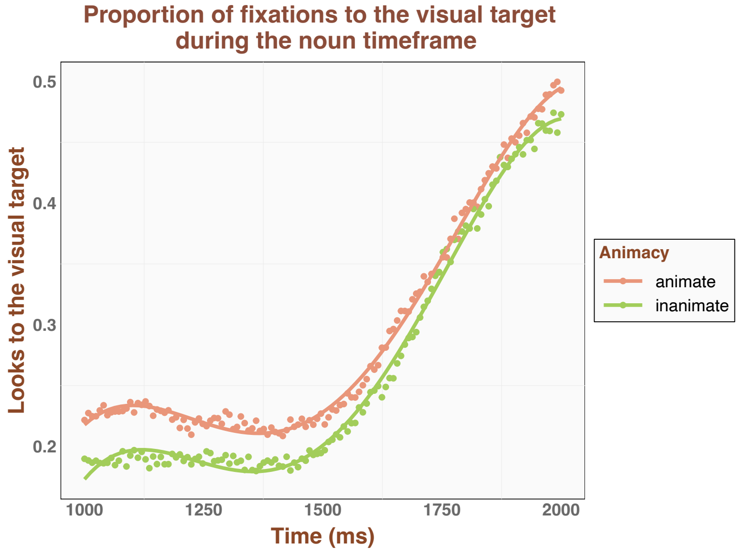

FIGURE 3.9: **Proportion of fixations to the visual target during the noun timeframe. On the *x* axis, 1000 corresponds to noun onset.**

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.442	0.017	26.338	<0.001
x Linear	1.112	0.089	12.467	<0.001
x Quadratic	-0.432	0.054	-7.992	<0.001
x Inanimate	-0.015	0.011	-1.333	0.187

TABLE 3.6: **Summary of the coefficients from the quartic model in the noun timeframe in the visual norming study.**

I interpreted these results as showing an increase of fixations towards the visual target during this timeframe, i.e., upon presentation of the spoken stimuli. This result is expected in the VWP due to the strength of the semantic relationship between the auditory and visual stimuli. However, there was no effect of animacy regarding the increase of fixations to the visual target, which means that animate and inanimate nouns elicited the same increase of fixations towards their related pictures.

For the noun timeframe, two GCA models (Mirman, Dixon and Magnuson, 2008) were created using the *lme4* package (Bates et al., 2015) in the R programming environment. The dependent variable was the proportion of fixations to the visual target, including *animacy* as the predictor as well as orthogonal polynomials. The number of models was determined by the shape of the curves observed during the visual exploration of the data. The first model included a linear polynomial, without interactions; the second model included a linear polynomial with a linear interaction. Model comparisons were carried out by means of likelihood ratio tests using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. After this, the most parsimonious model was fitted. The final model was a linear model, where proportion of fixations for each time bin were modeled as a function of *animacy*, including a linear polynomial as well as varying intercepts and slopes by participant per each condition: *proportion ~ animacy + ot1 + animacy:ot1 + (ot1 | participant) + (ot1 | participant:animacy)*. All *p*-values were calculated using the *lmerTest* package (Kuznetsova, Brockhoff and Christensen, 2017). Treatment contrasts were defined for the predictor: *animate* was coded as 0, and *inanimate* as 1.

Results are summarized in Figure 3.10, showing the proportion of fixations to the visual target in the post-noun timeframe. The summary of the coefficients of the model is provided in Table 3.7. Results from the linear model showed a significant positive intercept, but no significant linear term, and no significant effect of *animacy*. This means that the proportion of fixations was significantly larger than 0; fixations did not display any significant linear increase or decrease during the timeframe, and no significant difference was found between the animate and inanimate conditions.

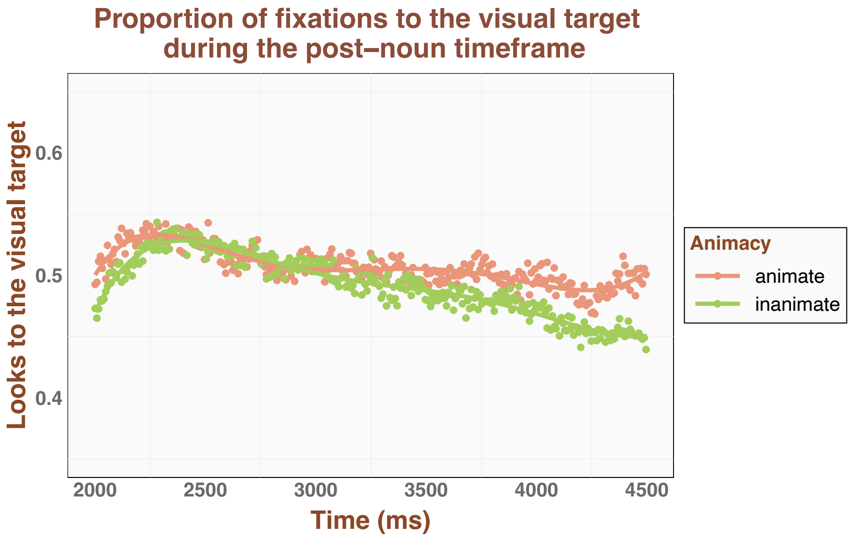

FIGURE 3.10: **Proportion of fixations to the visual target during the post-noun timeframe. On the *x* axis, 0 corresponds to trial onset.**

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.502	0.028	18.010	<0.001
x Linear	-0.120	0.131	-0.917	0.361
x Inanimate	-0.016	0.039	-0.409	0.683

TABLE 3.7: **Summary of the coefficients from the linear model in the post-noun timeframe in the visual norming study.**

I interpreted these results as showing an increase and subsequent continuity of fixations towards the visual target during this timeframe, i.e., after presentation of the spoken stimuli. This result is expected in the VWP due to the strength of the semantic relationship between the auditory and visual stimuli. However, there was no effect of animacy regarding the increase or continuity of fixations to the visual target, which means that animate and inanimate nouns elicited the same pattern of fixations towards their related pictures.

Results from the visual norming study revealed that participants spontaneously fixated on the visual target upon presentation of the related spoken noun. There was no difference in the time course or proportion of fixations between the animate and inanimate conditions. Contrary to the online norming study results, the visual norming study results indicated that the strength of the relationship between nouns and target pictures was equivalent for the animate and inanimate conditions when measured by spontaneous fixations on a visual object upon presentation of a spoken noun. These results verified that Experiment 2 materials were correctly designed, thus validating the comparison between animate and inanimate conditions within the same group of items using eye-tracking and VWP methodology.

2.5 Participants and procedure

Sixty-four students from the University of the Basque Country (UPV/EHU) participated in the experiment (51 = female, mean age = 19.2, *SD* = 2.5). Participants were native speakers of Spanish with normal or corrected-to-normal vision, and no history of language-related pathologies. This study was approved by the ethics board for human research of the University of the Basque Country (CEISH-UPV/EHU). Prior to their participation, participants were properly informed of the procedure and indicated their written consent to participate by signing the document of informed consent. Each session lasted around 45 minutes in total, and they were paid 10 euros for their participation.

The experiment took place in the same facility as Experiment 1. Participants were seated on a chair with their eyes about 60 cm from a 24" viewing monitor, set at a resolution of 1920 x 1080 pixels. A chinrest was used to properly position the participants' head with respect to the screen and the eye tracker. Auditory stimuli were played through two speakers placed at either side of the viewing monitor. The experiment was conducted using E-Prime 2 software for experiment presentation (Psychology Software Tools, 2012), and eye movements were recorded by a Tobii X120 desktop eye tracker sampling at 120 Hz.

Each session began with a calibration procedure with nine fixation points. Participants were told that they would hear some recorded linguistic stimuli while static visual displays appeared on the screen. First, participants completed the visual norming task, in which they listened to spoken NPs in isolation while they viewed visual displays (see section 2.4.2 for more information on the visual norming study procedure). Afterwards, participants completed the experimental task, in which they listened to spoken sentences while they viewed visual displays. In the experimental task, the presentation of trials was pseudo-randomized using the randomization features available in E-Prime 2.0 software for experiment presentation (Psychology Software Tools, 2012). In this manner, the order of sets was randomized, but the order of trials within each set was fixed. Each set of trials contained one or two filler trials, a subsequent experimental trial, and a simple comprehension question about the experimental sentence.[19] Sets of trials were separated by a fixation cross that required participants to fixate on the center of the screen during 250 ms (continuously). Within each set, trials were separated by a 500 ms centrally-located cross. The experimental task took around 25 minutes to complete, and Figure 3.11 illustrates the scheme of Experiment 2 procedure.

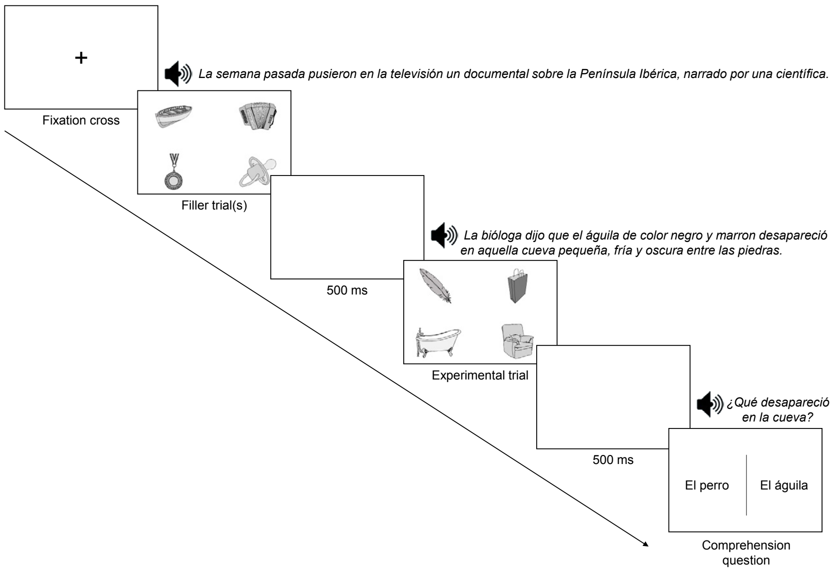

FIGURE 3.11: **Scheme of Experiment 2 procedure, comprising the presentation of one set of trials. In the experimental trial, the visual target is a feather, related to the subject NP *el águila* 'the eagle.'**

During the experimental task, participants were asked to answer some comprehension questions about the sentences by pressing a joystick button. Comprehension questions always followed experimental trials, and they were simple questions about who or what had performed the action in the experimental sentence (see Appendix C for a complete list of the comprehension questions). During comprehension question trials, a spoken comprehension question was heard, after which two possible answers appeared at the

[19] A total of six sets of trials did not include a comprehension question, due to the fact that all the trials within the sets were filler trials.

right and left side of the screen separated by a vertical line in the center. To respond, participants had to choose the correct answer, and then press the joystick button that corresponded to the side of the screen where the correct answer was located (i.e., left or right). During the session, participants were instructed to look at the visual displays while listening to the spoken stimuli very carefully. In between trials, participants were asked to fixate on a centrally-located cross in order to reduce noise in the data. In this manner, I ensured that participants were fixating to a neutral point before the onset of each trial (in the visual norming study) and before the onset of each set of trials (in the experimental task).

3. Data

3.1 Data processing

After data collection, two participants were excluded from the analysis for not meeting the criteria for the study. I followed the procedure described in Experiment 1 for data processing and analysis. Filler trials were discarded, and only test trials were included in the analysis. Experimental sentences were time-stamped at the onset of each ROI; these values were used to categorize the time course of eye data into regions that corresponded with the ROIs in the linguistic stimuli. The timeline of eye data was shifted 200 ms down throughout the entire data frame resulting from these steps, in order to account for the estimated time that the human eye needs to program and initiate movement in reaction to auditory stimuli (Matin, Shao and Boff, 1993; Altmann and Kamide, 2004). Trials were centered at verb offset (i.e., the offset of ROI 3 and the onset of ROI 4, which correspond with the 0 ms value in all trials). The position of the eye fixation in the visual display was down-sampled every 20 ms for the analysis. The proportion of fixations to the visual target was calculated in each time bin that corresponded with the presentation of linguistic stimuli (i.e., the ROIs in Table 3.3). This proportion of fixations was taken as an indication of the attention that participants were devoting to the processing of the related spoken stimuli.

3.2 Data analysis

I analyzed the gaze fixation data in two different time windows that corresponded to the presentation of ROI 4: (i) the early post-verb frame, from 200 ms until 1700 ms after verb offset, and (ii) the late post-verb frame, from 1700 ms to 3200 ms after verb offset. The early post-verb frame time values were selected to match the post-verb frame in Experiment 1. The late post-verb frame time values were selected to account for the remaining time of ROI 4 presentation in a time window of comparable duration to that of the early post-verb frame.

For each timeframe, five GCA models (Mirman, Dixon and Magnuson, 2008) were created using the *lme4* package (Bates et al., 2015) in the R programming environment. The dependent variable was the proportion of fixations to the visual target, including *animacy*, *verb* and their interaction as the predictors, as well as orthogonal polynomials. Treatment contrasts were defined for the predictors: for the *animacy* predictor, *animate* was coded as 0, and *inanimate* as 1; for the *verb* predictor, *transitive* was coded as the reference level. The number of models was determined by the shape of the curves observed during the visual exploration of the data. The first model included linear, quadratic, cubic and quartic polynomials, without interactions; the second model included linear, quadratic, cubic and quartic polynomials, with a linear interaction; the third model included linear, quadratic, cubic and quartic polynomials, with a quadratic interaction; the fourth model included linear, quadratic, cubic and quartic polynomials, with a cubic interaction; and the fifth model included linear, quadratic, cubic and quartic polynomials, with a quartic interaction. Model comparisons were carried out by means of likelihood ratio tests using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. After this, the most parsimonious model was fitted. In the early post-verb frame, the final model was a cubic model, where proportion of fixations were modeled as a function of *animacy* and its interaction with *verb*, including linear, quadratic and cubic polynomials as well as varying intercepts and slopes by participant per each condition: *proportion ~ animacy*verb + ot1 + ot2 + ot3 + animacy*verb:ot1 + animacy*verb:ot2 + animacy*verb:ot3 +* (*ot1 + ot2 + ot3 | participant*). In the late post-verb frame, the final model was a quartic model, where proportion of fixations were modeled as a function of *animacy* and its interaction with *verb*, including linear, quadratic, cubic and quartic polynomials as well as varying intercepts and slopes by participant per each condition: *proportion ~ animacy*verb + ot1 + ot2 + ot3 + ot4 + animacy*verb:ot1 + animacy*verb:ot2 + animacy*verb:ot3 + animacy*verb:ot4* (*ot1 + ot2 + ot3 + ot4 | participant*). All *p*-values were calculated using the *lmerTest* package (Kuznetsova, Brockhoff and Christensen, 2017).

4. Results

4.1 Early post-verb frame

Results from the analysis of goodness of fit of the models in this timeframe are presented in Table 3.8. The goodness of fit of the models was analyzed using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models.

	AIC	-2LL	Chisq	*p*-value
x Base	-8223.5	4132.8	-	-
x Intercept	-8340.1	4194.0	122.5671	<0.001
x Linear	-8405.2	4233.6	79.1355	<0.001
x Quadratic	-8413.0	4242.5	17.7580	0.003
x Cubic	-8418.8	4250.4	15.7994	0.007
x Quartic	-8414.0	4253.0	5.2608	0.384

TABLE 3.8: **Analysis of goodness of fit of the models in the early post-verb frame.**

Results from the cubic model are summarized in Figures 3.12 and 3.13, showing the proportion of fixations to the visual target in the early post-verb timeframe for the agent (unergative and transitive) and theme (unaccusative) conditions, respectively. The summary of the coefficients of the model is provided in Table 3.9. Results from the model showed a significant positive intercept; this means that the fixations to the visual target were significantly larger than 0. There was a significant negative effect of animacy in the inanimate condition; this means that the average proportion of fixations was significantly lower for the inanimate condition compared to the animate condition. There was a significant positive effect of verb in the unaccusative and unergative conditions; this means that the average proportion of fixations was significantly higher for the unaccusative and unergative conditions compared to the transitive condition. Overall, there was a significant positive interaction between animacy and verb on the animate transitive condition.

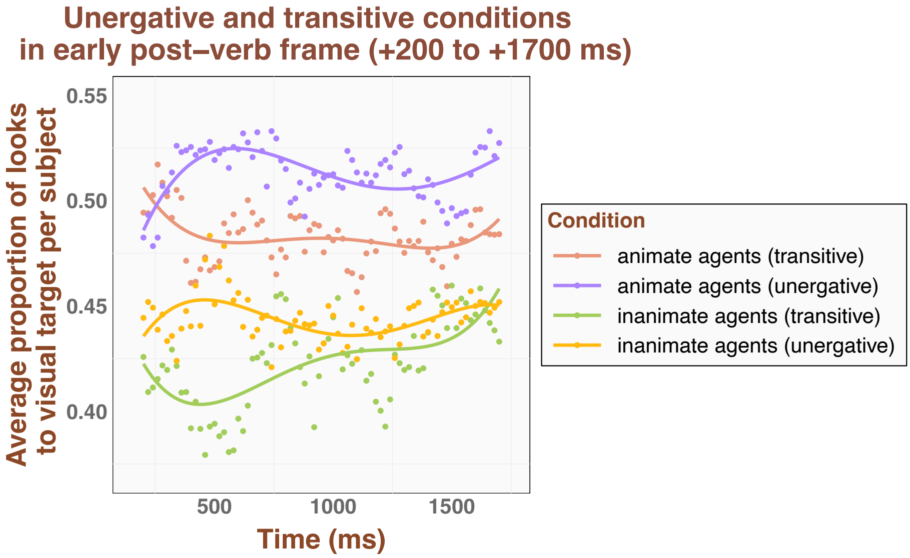

FIGURE 3.12: **Proportion of fixations to the visual target during the early post-verb frame for the unergative and transitive conditions, comparing animate and inanimate agents. On the *x* axis, 0 corresponds to verb offset.**

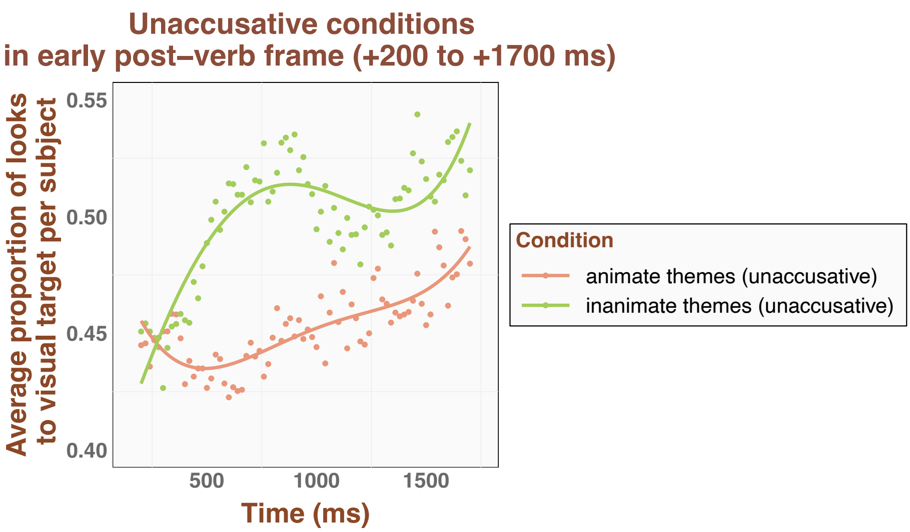

FIGURE 3.13: **Proportion of fixations to the visual target during the early post-verb frame for the unaccusative conditions, comparing animate and inanimate themes. On the *x* axis, 0 corresponds to verb offset.**

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.443	0.03	14.812	<0.001
x Linear	-0.024	0.043	-0.563	0.574
x Quadratic	0.032	0.039	0.817	0.415
x Cubic	-0.010	0.034	-0.293	0.770
x Inanimate	-0.020	0.004	-4.706	<0.001
x Unaccusative	0.010	0.004	2.352	0.019
x Unergative	0.030	0.004	7.154	<0.001
x Inanimate*Unaccusative	0.026	0.006	4.427	<0.001
x Inanimate*Unergative	-0.009	0.006	-1.478	0.139
x Linear*Unaccusative	0.130	0.037	3.537	<0.001
x Linear*Unergative	0.018	0.037	0.476	0.634
x Quadratic*Unaccusative	0.012	0.037	0.330	0.741
x Quadratic*Unergative	-0.051	0.037	-1.380	0.168
x Cubic*Unaccusative	-0.008	0.037	-0.212	0.832
x Cubic*Unergative	0.076	0.037	2.062	0.039
x Linear*Inanimate	0.129	0.037	3.503	<0.001
x Linear*Inanimate*Unaccusative	0.044	0.037	1.195	0.232
x Linear*Inanimate*Unergative	-0.002	0.037	-0.043	0.966
x Quadratic*Inanimate	-0.009	0.037	-0.248	0.804
x Quadratic*Inanimate*Unaccusative	-0.131	0.037	-3.555	<0.001
x Quadratic*Inanimate*Unergative	0.046	0.037	1.254	0.210
x Cubic*Inanimate	0.001	0.037	0.003	0.998
x Cubic*Inanimate*Unaccusative	0.112	0.037	3.029	0.002
x Cubic*Inanimate*Unergative	-0.034	0.037	-0.930	0.352

TABLE 3.9: **Summary of the coefficients from the cubic model in the early post-verb frame.**

Pairwise comparisons are shown in Table 3.10. There was an interaction between animacy and verb on the average height of the curve, indicating that the effect of animacy on the magnitude of reactivation was dependent on the verb condition. The average magnitude of reactivation was significantly higher for the animate transitive and animate unergative conditions compared to the inanimate transitive and inanimate unergative conditions, respectively. By contrast, the direction of the effect was the opposite in the unaccusative condition, since the average magnitude of reactivation was significantly higher for the inanimate unaccusative condition compared to the animate unaccusative condition. Among the animate conditions, the average magnitude of reactivation was significantly higher for the unergative condition compared to the unaccusative condition. The average magnitude of reactivation was significantly higher for the unergative and unaccusative conditions compared to the transitive condition. Among the inanimate conditions, the average magnitude of reactivation was significantly higher for the unaccusative condition compared to the transitive and unergative conditions. The average magnitude of reactivation was significantly higher for the unergative condition compared to the transitive condition. Among the prototypical conditions, the average magnitude of reactivation was significantly higher for the animate unergative condition compared to the inanimate unaccusative condition, which in turn displayed a higher magnitude of reactivation than the animate transitive condition. Several differences were also found in the polynomial terms of the curves across conditions. Among the animate conditions, the unaccusative condition displayed an increase in reactivation throughout this timeframe, with a significant positive linear term. The unergative condition displayed an early peak in reactivation, with a significant positive cubic term that corresponded to the highest average magnitude of reactivation during this timeframe. Among the inanimate conditions, the unaccusative condition also displayed an early peak in reactivation, with a significant positive cubic term that corresponded to the highest average magnitude of reactivation during this timeframe among the inanimate conditions. Finally, the inanimate transitive condition also displayed an increase in reactivation throughout this timeframe, with a significant positive linear term.

Conditions	Animate transitive-animate unaccusative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.443	0.033	13.358	<0.001
x Linear	-0.024	0.052	-0.468	0.641
x Quadratic	0.032	0.056	0.572	0.569
x Cubic	-0.010	0.052	-0.191	0.849
x Unaccusative	0.010	0.004	2.804	0.005
x Linear*Unaccusative	0.130	0.031	4.217	<0.001
x Quadratic*Unaccusative	0.012	0.031	0.393	0.694
x Cubic*Unaccusative	-0.008	0.031	-0.253	0.800
Conditions	**Animate transitive-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.443	0.033	13.335	<0.001
x Linear	-0.024	0.069	-0.350	0.728
x Quadratic	0.032	0.055	0.580	0.563
x Cubic	-0.010	0.039	-0.255	0.800
x Unergative	0.030	0.003	8.759	<0.001
x Linear*Unergative	0.018	0.030	0.583	0.560
x Quadratic*Unergative	-0.051	0.030	-1.690	0.091
x Cubic*Unergative	0.076	0.030	2.525	0.012
Conditions	**Animate unaccusative-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.453	0.033	13.655	<0.001
x Linear	0.106	0.079	1.353	0.180
x Quadratic	0.044	0.048	0.925	0.358
x Cubic	-0.018	0.047	-0.379	0.706
x Unergative	0.020	0.004	5.536	<0.001
x Linear*Unergative	-0.113	0.032	-3.529	<0.001
x Quadratic*Unergative	-0.063	0.032	-1.971	0.049
x Cubic*Unergative	0.084	0.032	2.622	0.009

Conditions	Inanimate transitive-inanimate unaccusative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.423	0.031	13.709	<0.001
x Linear	0.105	0.068	1.535	0.129
x Quadratic	0.023	0.060	0.375	0.709
x Cubic	-0.010	0.044	-0.224	0.824
x Unaccusative	0.036	0.004	10.229	<0.001
x Linear*Unaccusative	0.045	0.031	1.460	0.144
x Quadratic*Unaccusative	-0.110	0.031	-3.535	<0.001
x Cubic*Unaccusative	0.104	0.031	3.341	0.001
Conditions	**Inanimate transitive-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.423	0.031	13.713	<0.001
x Linear	0.105	0.070	1.493	0.140
x Quadratic	0.023	0.051	0.443	0.659
x Cubic	-0.010	0.044	-0.222	0.825
x Unergative	0.021	0.004	5.902	<0.001
x Linear*Unergative	-0.113	0.032	-3.579	<0.001
x Quadratic*Unergative	0.004	0.032	0.142	0.887
x Cubic*Unergative	0.042	0.032	1.316	0.188
Conditions	**Inanimate unaccusative-inanimate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.459	0.030	15.488	<0.001
x Linear	0.150	0.068	2.217	0.030
x Quadratic	-0.087	0.059	-1.483	0.142
x Cubic	0.094	0.041	2.279	0.025
x Unergative	-0.015	0.004	-4.229	<0.001
x Linear*Unergative	-0.158	0.031	-5.123	<0.001
x Quadratic*Unergative	0.114	0.031	3.692	<0.001
x Cubic*Unergative	-0.062	0.031	-2.007	0.045

Conditions	Animate transitive-inanimate transitive			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.443	0.032	13.723	<0.001
x Linear	-0.024	0.062	-0.390	0.698
x Quadratic	0.032	0.046	0.684	0.496
x Cubic	-0.010	0.045	-0.219	0.827
x Inanimate	-0.020	0.004	-5.534	<0.001
x Linear*Inanimate	0.129	0.031	4.120	<0.001
x Quadratic*Inanimate	-0.009	0.031	-0.292	0.770
x Cubic*Inanimate	0.000	0.031	0.004	0.997
Conditions	**Animate unergative-inanimate unergative**			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.473	0.032	14.911	<0.001
x Linear	-0.007	0.069	-0.096	0.924
x Quadratic	-0.019	0.048	-0.399	0.691
x Cubic	0.066	0.037	1.786	0.077
x Inanimate	-0.029	0.004	-7.912	<0.001
x Linear*Inanimate	-0.002	0.032	-0.050	0.960
x Quadratic*Inanimate	0.046	0.032	1.459	0.144
x Cubic*Inanimate	-0.034	0.032	-1.083	0.279
Conditions	**Animate unaccusative-inanimate unaccusative**			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.453	0.032	14.180	<0.001
x Linear	0.106	0.067	1.580	0.119
x Quadratic	0.044	0.054	0.807	0.422
x Cubic	-0.018	0.046	-0.388	0.699
x Inanimate	0.009	0.004	1.865	0.042
x Linear*Inanimate	0.044	0.031	1.434	0.152
x Quadratic*Inanimate	-0.131	0.031	-4.264	<0.001
x Cubic*Inanimate	0.112	0.031	3.633	<0.001

Conditions	**Animate transitive-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.443	0.031	14.298	<0.001
x Linear	-0.024	0.054	-0.450	0.654
x Quadratic	0.032	0.053	0.603	0.548
x Cubic	-0.010	0.040	-0.249	0.804
x Unaccusative	0.017	0.004	4.576	<0.001
x Linear*Unaccusative	0.174	0.031	5.542	<0.001
x Quadratic*Unaccusative	-0.119	0.031	-3.777	<0.001
x Cubic*Unaccusative	0.104	0.031	3.298	0.001
Conditions	**Animate unergative-inanimate unaccusative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.473	0.031	15.032	<0.001
x Linear	-0.007	0.070	-0.094	0.926
x Quadratic	-0.019	0.064	-0.300	0.765
x Cubic	0.066	0.043	1.553	0.124
x Unaccusative	-0.014	0.004	-3.876	<0.001
x Linear*Unaccusative	0.157	0.031	5.080	<0.001
x Quadratic*Unaccusative	-0.068	0.031	-2.202	0.028
x Cubic*Unaccusative	0.028	0.031	0.900	0.368

Table 3.10: **Summary of pairwise comparisons of the six conditions (animate unaccusative, animate unergative, animate transitive, inanimate unaccusative, inanimate unergative, inanimate transitive) in the early post-verb frame.**

4.2 Late post-verb frame

Results from the analysis of goodness of fit of the models in this timeframe are presented in Table 3.11. The goodness of fit of the models was analyzed using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models.

	AIC	-2LL	Chisq	*p*-value
x Base	-7172.2	3607.1	-	-
x Intercept	-7272.0	3660.0	105.8141	>0.001
x Linear	-7466.8	3764.4	208.8539	>0.001
x Quadratic	-7465.4	3768.7	8.5363	0.129
x Cubic	-7481.7	3781.9	26.2863	>0.001
x Quartic	-7521.0	3806.5	49.2996	>0.001

TABLE 3.11: **Analysis of goodness of fit of the models in the late post-verb frame.**

The summary of the coefficients of the model is provided in Table 3.12. Results from the quartic model are summarized in Figures 3.14 and 3.15, showing the proportion of fixations to the visual target in the late post-verb timeframe for the agent (unergative and transitive) and theme (unaccusative) conditions, respectively. Results from the model showed a significant positive intercept; this means that the fixations to the visual target were significantly larger than 0. There was a significant negative effect of animacy in the inanimate condition; this means that the average proportion of fixations was significantly lower for the inanimate condition compared to the animate condition. There was a significant negative effect of verb in the unaccusative condition; this means that the average proportion of fixations was significantly lower for the unaccusative condition compared to the transitive condition. Overall, there was a significant positive interaction between animacy and verb on the animate transitive condition.

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.469	0.03	15.81	<0.001
x Linear	0.102	0.045	2.249	0.026
x Quadratic	0.024	0.041	0.581	0.562
x Cubic	-0.057	0.031	-1857	0.064
x Quartic	-0.145	0.031	-4625	<0.001
x Inanimate	-0.049	0.004	-11.516	<0.001
x Unaccusative	-0.02	0.004	-4.647	<0.001
x Unergative	0.009	0.004	2063	0.039

	Estimate	SE	*t*-value	*p*-value
x Inanimate*Unaccusative	0.072	0.006	11.779	<0.001
x Inanimate*Unergative	0.014	0.006	2.376	0.017
x Linear*Unaccusative	-0.152	0.037	-4.056	<0.001
x Linear*Unergative	-0.148	0.037	-3942	<0.001
x Quadratic*Unaccusative	0.04	0.037	1079	0.28
x Quadratic*Unergative	0.025	0.037	0.661	0.509
x Cubic*Unaccusative	0.055	0.037	1459	0.145
x Cubic*Unergative	0.079	0.037	2.109	0.035
x Quartic*Unaccusative	0.187	0.037	5.004	<0.001
x Quartic*Unergative	0.091	0.037	2.44	0.015
x Linear*Inanimate	-0.043	0.037	-1149	0.251
x Linear*Inanimate*Unaccusative	-0.025	0.037	-0.657	0.511
x Linear*Inanimate*Unergative	0.176	0.037	4.708	<0.001
x Quadratic*Inanimate	0.047	0.037	1.253	0.21
x Quadratic*Inanimate*Unaccusative	-0.071	0.037	-1902	0.057
x Quadratic*Inanimate*Unergative	-0.057	0.037	-1.511	0.131
x Cubic*Inanimate	-0.047	0.037	-1.258	0.208
x Cubic*Inanimate*Unaccusative	0.03	0.037	0.792	0.428
x Cubic*Inanimate*Unergative	-0.128	0.037	-3416	0.001
x Quartic*Inanimate	0.145	0.037	3859	<0.001
x Quartic*Inanimate*Unaccusative	-0.058	0.037	-1559	0.119
x Quartic*Inanimate*Unergative	0.152	0.037	4046	<0.001

TABLE 3.12: **Summary of the coefficients from the quartic model in the late post-verb frame.**

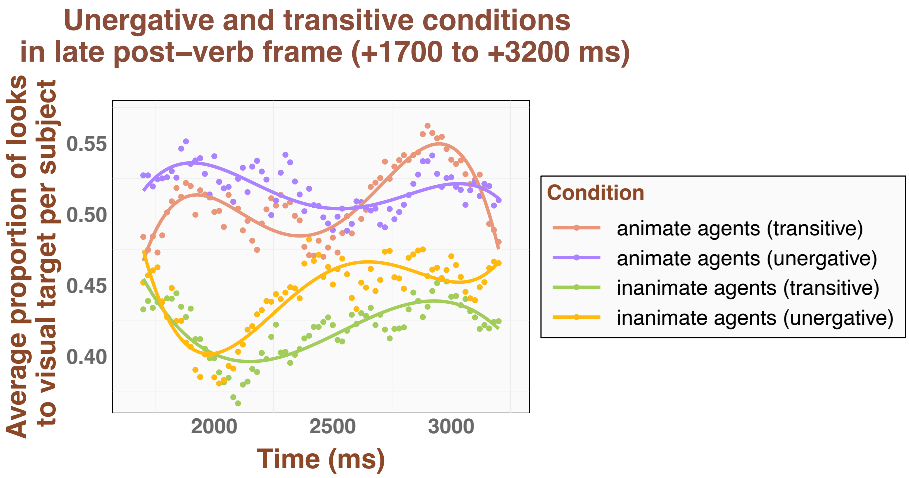

FIGURE 3.14: **Proportion of fixations to the visual target during the late post-verb timeframe for the unergative and transitive conditions. On the *x* axis, 0 corresponds to verb offset.**

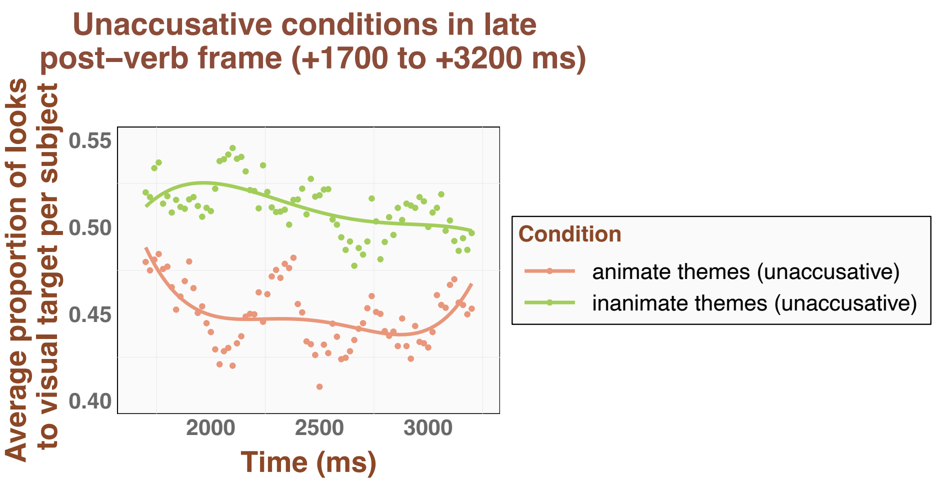

FIGURE 3.15: **Proportion of fixations to the visual target during the late post-verb timeframe for the unaccusative conditions. On the *x* axis, 0 corresponds to verb offset.**

Pairwise comparisons are shown in Table 3.13. There was an interaction between animacy and verb on the average height of the curve, since the effect of animacy on the magnitude of reactivation was dependent on the verb condition. The average magnitude of reactivation was significantly higher for the animate transitive and animate unergative conditions compared to the inanimate transitive and inanimate unergative conditions. By contrast, the direction of the effect was the opposite in the unaccusative condition, since the average magnitude of reactivation was significantly higher for the inanimate unaccusative condition compared to the animate unaccusative condition. Among the animate conditions, the average magnitude of reactivation was significantly higher for the unergative and transitive conditions compared to the unaccusative condition. There was no difference in the average magnitude of reactivation between the unergative and transitive conditions. Among the inanimate conditions, the average magnitude of reactivation was significantly higher for the unaccusative condition compared to the transitive and unergative conditions. The average magnitude of reactivation was significantly higher for the unergative condition compared to the transitive condition. Among the prototypical conditions, the average magnitude of reactivation was significantly higher for agents (unergative and transitive conditions) than themes (unaccusative condition). Several differences were also found in the polynomial terms of the curves across conditions. Among the animate conditions, the unaccusative condition showed a decrease in reactivation throughout this timeframe, with a significant negative linear term. There was also a significant negative linear term for the unergative condition, although the average magnitude of reactivation for this condition was the highest of all six conditions throughout this timeframe. The transitive condition displayed a late peak in reactivation, with a significant negative quartic term. The inanimate transitive condition also displayed a late peak in reactivation, with a significant negative cubic term. The inanimate unergative condition displayed a peak in reactivation towards the middle of this timeframe, with a significant positive linear term. Finally, the inanimate unaccusative condition did not show any significant growth or decrease, displaying the highest average magnitude of reactivation among the inanimate conditions throughout this timeframe.

Conditions	Animate transitive-animate unaccusative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.469	0.034	13.962	<0.001
x Linear	0.102	0.063	1.612	0.111
x Quadratic	0.024	0.045	0.526	0.600
x Cubic	-0.057	0.038	-1490	0.140
x Quartic	-0.145	0.033	-4457	<0.001
x Unaccusative	-0.020	0.003	-5.711	<0.001
x Linear*Unaccusative	-0.152	0.030	-4.984	<0.001
x Quadratic*Unaccusative	0.040	0.030	1327	0.185
x Cubic*Unaccusative	0.055	0.030	1.793	0.073
x Quartic*Unaccusative	0.187	0.030	6149	<0.001
Conditions	**Animate transitive-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.469	0.034	13.951	<0.001
x Linear	0.102	0.062	1.655	0.102
x Quadratic	0.024	0.046	0.513	0.610
x Cubic	-0.057	0.037	-1526	0.130
x Quartic	-0.145	0.035	-4116	<0.001
x Unergative	0.009	0.004	2.399	0.016
x Linear*Unergative	-0.148	0.032	-4.583	<0.001
x Quadratic*Unergative	0.025	0.032	0.768	0.442
x Cubic*Unergative	0.079	0.032	2.452	0.014
x Quartic*Unergative	0.091	0.032	2837	0.005
Conditions	**Animate unaccusative-animate unergative**			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.449	0.032	14.244	<0.001
x Linear	-0.050	0.079	-0.632	0.530
x Quadratic	0.064	0.054	1185	0.240
x Cubic	-0.002	0.036	-0.067	0.947
x Quartic	0.043	0.031	1383	0.169
x Unergative	0.029	0.004	7.780	<0.001
x Linear*Unergative	0.004	0.032	0.133	0.894
x Quadratic*Unergative	-0.016	0.032	-0.485	0.627
x Cubic*Unergative	0.024	0.032	0.753	0.451
x Quartic*Unergative	-0.096	0.032	-2973	0.003

Conditions	Inanimate transitive-inanimate unaccusative			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.420	0.031	13.634	<0.001
x Linear	0.059	0.076	0.780	0.438
x Quadratic	0.071	0.057	1239	0.219
x Cubic	-0.104	0.036	-2888	0.005
x Quartic	0.000	0.036	-0.009	0.993
x Unaccusative	0.052	0.004	14.330	<0.001
x Linear*Unaccusative	-0.133	0.031	-4.252	<0.001
x Quadratic*Unaccusative	-0.078	0.031	-2476	0.013
x Cubic*Unaccusative	0.131	0.031	4.187	<0.001
x Quartic*Unaccusative	-0.015	0.031	-0.493	0.622
Conditions	**Inanimate transitive-inanimate unergative**			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.420	0.031	13.520	<0.001
x Linear	0.059	0.065	0.910	0.366
x Quadratic	0.071	0.055	1288	0.202
x Cubic	-0.104	0.038	-2776	0.007
x Quartic	0.000	0.035	-0.009	0.993
x Unergative	0.023	0.004	6.457	<0.001
x Linear*Unergative	0.072	0.031	2.280	0.023
x Quadratic*Unergative	-0.079	0.031	-2504	0.012
x Cubic*Unergative	-0.002	0.031	-0.058	0.953
x Quartic*Unergative	0.098	0.031	3127	0.002
Conditions	**Inanimate unaccusative-inanimate unergative**			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.471	0.030	15.937	<0.001
x Linear	-0.074	0.075	-0.991	0.325
x Quadratic	-0.007	0.055	-0.131	0.896
x Cubic	0.027	0.038	0.718	0.474
x Quartic	-0.016	0.037	-0.422	0.674
x Unergative	-0.028	0.004	-7.667	<0.001
x Linear*Unergative	0.205	0.032	6.377	<0.001
x Quadratic*Unergative	-0.001	0.032	-0.032	0.974
x Cubic*Unergative	-0.133	0.032	-4.142	<0.001
x Quartic*Unergative	0.114	0.032	3538	<0.001

Conditions	Animate transitive-inanimate transitive			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.469	0.034	13.890	<0.001
x Linear	0.102	0.056	1.819	0.073
x Quadratic	0.024	0.047	0.505	0.615
x Cubic	-0.057	0.038	-1521	0.132
x Quartic	-0.145	0.035	-4163	<0.001
x Inanimate	-0.049	0.004	-13.986	<0.001
x Linear*Inanimate	-0.043	0.031	-1.396	0.163
x Quadratic*Inanimate	0.047	0.031	1522	0.128
x Cubic*Inanimate	-0.047	0.031	-1.528	0.127
x Quartic*Inanimate	0.145	0.031	4687	<0.001

Conditions	Animate unergative-inanimate unergative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.478	0.032	15.055	<0.001
x Linear	-0.045	0.066	-0.688	0.494
x Quadratic	0.048	0.049	0.991	0.325
x Cubic	0.022	0.042	0.528	0.599
x Quartic	-0.053	0.033	-1644	0.103
x Inanimate	-0.035	0.004	-9.724	<0.001
x Linear*Inanimate	0.176	0.031	5.613	<0.001
x Quadratic*Inanimate	-0.057	0.031	-1801	0.072
x Cubic*Inanimate	-0.128	0.031	-4.073	<0.001
x Quartic*Inanimate	0.152	0.031	4824	<0.001

Conditions	Animate unaccusative-inanimate unaccusative			
	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.449	0.030	14.883	<0.001
x Linear	-0.050	0.078	-0.632	0.529
x Quadratic	0.064	0.060	1059	0.293
x Cubic	-0.002	0.039	-0.062	0.951
x Quartic	0.043	0.038	1107	0.271
x Inanimate	0.022	0.004	6.093	<0.001
x Linear*Inanimate	-0.025	0.032	-0.778	0.436
x Quadratic*Inanimate	-0.071	0.032	-2254	0.024
x Cubic*Inanimate	0.030	0.032	0.938	0.348
x Quartic*Inanimate	-0.058	0.032	-1847	0.065

Conditions	Animate transitive-inanimate unaccusative			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.469	0.032	14.538	<0.001
x Linear	0.102	0.074	1.375	0.174
x Quadratic	0.024	0.054	0.441	0.661
x Cubic	-0.057	0.038	-1.505	0.136
x Quartic	0.002	0.004	0.585	0.558
x Unaccusative	-0.177	0.032	-5.576	<0.001
x Linear*Unaccusative	-0.031	0.032	-0.973	0.331
x Quadratic*Unaccusative	0.084	0.032	2.664	0.008
x Cubic*Unaccusative	0.469	0.032	14.538	<0.001
x Quartic*Unaccusative	0.102	0.074	1.375	0.174
Conditions	**Animate unergative-inanimate unaccusative**			
	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.478	0.031	15.442	<0.001
x Linear	-0.045	0.088	-0.517	0.607
x Quadratic	0.048	0.056	0.867	0.389
x Cubic	0.022	0.036	0.602	0.549
x Quartic	-0.007	0.004	-1.842	0.065
x Unaccusative	-0.029	0.032	-0.906	0.365
x Linear*Unaccusative	-0.056	0.032	-1.742	0.081
x Quadratic*Unaccusative	0.005	0.032	0.167	0.867
x Cubic*Unaccusative	0.478	0.031	15.442	<0.001
x Quartic*Unaccusative	-0.045	0.088	-0.517	0.607

TABLE 3.13: **Summary of pairwise comparisons of the six conditions (animate unaccusative, animate unergative, animate transitive, inanimate unaccusative, inanimate unergative, inanimate transitive) in the late post-verb frame.**

5. Discussion

In Experiment 2, I explored how modulating the prototypicality (i.e., the interaction between thematic role and animacy) of the sentential subject affected its processing after verb offset in Spanish. The time course and magnitude of subject reactivation were measured in two time windows: (a) the early post-verb frame, which occurred immediately after verb offset and comprised the beginning of the post-verbal Adjunct, and (b) the late post-verb frame, which comprised the end of the post-verbal Adjunct. The measure indicating magnitude of reactivation is the intercept, since it represents the average height of the curve regarding the proportion of looks to the visual target. The measure indicating time course of subject reactivation are the polynomial terms (e.g., linear, quadratic, cubic, and quartic), which correspond with different patterns of increase and/or decrease in the height of the curve across time. Two hypotheses were considered. On the one hand, the APH*p, which generally predicts that agents will display a larger magnitude of reactivation than themes, also makes the following three predictions regarding prototypicality effects: (P1) that animate agents will display a larger magnitude of reactivation than inanimate agents; (P2) that inanimate themes will display a larger magnitude of reactivation than animate themes; and (P3) that animate agents will display a larger magnitude of reactivation than inanimate themes. On the other hand, the PPH also predicts P1 and P2, but differs from APH*p in the following prediction: (P4) that animate agents will display an equivalent reactivation effect as inanimate themes. To test these hypotheses, I monitored the gaze-fixation patterns of 64 native speakers of Spanish while they were presented simultaneously with an auditory sentence and a visual display containing four pictures. In test trials, one of the pictures, the visual target, was strongly related to the sentential subject.

At the early post-verb frame, I found several differences across conditions both in the magnitude and time course of reactivation. Regarding magnitude, animate agents (unergative condition) displayed a larger reactivation than animate themes (unaccusative condition). That is, the overall height of the curve that indicates looks to the visual target was greater for animate agents than animate themes throughout the entire timeframe. This aspect of the results replicates previous findings (e.g., Experiment 1), and is compatible with both APH*p and PPH predictions, since finding that animate agents reactivate more than animate themes can be accounted for by an agent preference or by a prototypicality preference. The opposite pattern was found in the case of inanimate subjects: inanimate themes (unaccusative condition) displayed a larger reactivation than inanimate agents (unergative and transitive conditions). This aspect of the results provides new data in the reactivation patterns of inanimate subjects, and is also compatible with both APH*p and PPH predictions, since finding that inanimate themes reactivate more than inanimate agents can be accounted for by an agent preference modulated by prototypicality or by a prototypicality preference. In this manner, the results revealed an interaction between thematic role and animacy. The direction (i.e., positive or negative) of the interaction differed between animates and inanimates: whereas animate subjects reactivated more when they were agents, inanimate subjects reactivated more when they were themes. This means that prototypical conditions displayed a higher magnitude of reactivation across the early post-verb frame. However, differences were also found when comparing prototypical conditions: animate agents (unergative condition) displayed a larger reactivation than inanimate themes (unaccusative condition). This aspect of the results is compatible with an overall agent preference modulated by prototypicality as predicted by the APH*p, but not the PPH, since the latter predicts no difference between the prototypical conditions. To sum up, the main finding in the early post-verb frame corresponds with greater reactivation patterns for prototypical conditions; among these, agents reactivated more than themes. It is important to note that I also found differences between the unergative and transitive conditions (i.e., agent subjects) in this timeframe. More specifically, unergative agents displayed a larger reactivation than transitive agents, both in the animate and inanimate conditions. Additionally, the magnitude of reactivation of the animate unaccusative condition was also larger than that of the animate transitive condition in this timeframe. This particular aspect of the results is not predicted by either of the two hypotheses at hand; a discussion on this topic is offered at the end of this section.

Regarding time course, both animate themes (unaccusative condition) and inanimate agents (transitive condition) displayed a pattern of linear growth across the entire early post-verb frame. In other words, the looks to the visual target increased as time progressed throughout the early post-verb frame. Inanimate themes (unaccusative condition) and animate agents (unergative condition) displayed a positive cubic term across this timeframe, thus indicating an increase followed by a decrease followed by an increase in looks to the visual target. The observed time course patterns for animate (unergative condition) and inanimate (transitive condition) agents are compatible with APH*p predictions, since this hypothesis predicts an overall increase of looks to the visual target related to agent subjects within this timeframe. The pattern observed for inanimate themes (unaccusative condition) is also compatible with both APH*p and PPH predictions, since both hypotheses predict an overall increase of looks to the visual target related to prototypical subjects (i.e., inanimate themes) during this time frame. However, the pattern obtained for animate themes (unaccusative condition) cannot be accounted for by either hypothesis.

At the late post-verb frame, I also found several differences across conditions, both in the magnitude and time course of reactivation. Regarding magnitude, animate agents (unergative and transitive conditions) displayed a larger reactivation pattern than animate themes (unaccusative condition). This aspect of the results replicates previous findings (e.g., Experiment 1), and is compatible with both APH*p and PPH predictions. The opposite pattern was found for inanimate subjects: inanimate themes (unaccusative condition) displayed a larger reactivation than inanimate agents (unergative and transitive conditions). As argued in the early post-verb frame, this aspect of the results is compatible with APH*p predictions, but not with the PPH. Results in the late post-verb frame revealed the same interaction between thematic role and animacy as in the previous time window: agents reactivated more when they were animate, whereas themes reactivated more when they were inanimate. Once again, this means that the conditions displaying a higher magnitude of reactivation were prototypical conditions. However, differences were also found in this timeframe when comparing prototypical conditions: animate agents (unergative and transitive conditions) displayed a larger reactivation than inanimate themes (unaccusative condition). This aspect of the results is compatible with an overall agent preference modulated by prototypicality as predicted by the APH*p, but not the PPH, since the latter predicts no difference between the prototypical conditions. To sum up, the main finding in the late post-verb frame also corresponds with greater reactivation patterns for prototypical conditions; among these, agents reactivated more than themes. Contrary to what was found in the early post-verb frame, there were no differences in magnitude of reactivation between the unergative and transitive conditions within this timeframe.

Regarding time course, both animate themes (unaccusative condition) and inanimate agents (unergative condition) displayed a pattern of linear decrease across the entire timeframe. By contrast, inanimate themes (unaccusative condition) and animate agents (unergative condition) displayed a pattern of linear growth across this timeframe, signaling an increase of looks to the visual target as time progressed. Inanimate agents (transitive condition) displayed a negative cubic term, indicating a decrease followed by an increase followed by a decrease in looks to the visual target. Finally, animate agents (transitive condition) displayed a negative quartic term, indicating an increase followed by a decrease followed by an increase followed by a decrease in looks to the visual target during this timeframe. Taken together, the observed time course patterns during this timeframe are compatible with both APH*p and PPH predictions in the case of animate and inanimate themes (unaccusative conditions), animate and inanimate agents (unergative conditions), and inanimate transitive agents. This is due to the fact that both APH*p and PPH predict an overall increase in looks to the visual target for prototypical conditions (animate agents and inanimate themes), and an overall decrease in looks to the visual target for non-prototypical conditions (inanimate agents and animate themes). Contrary to these results, the time course pattern found for animate transitive agents cannot be accounted for by either hypothesis.

The combined results from both time windows of analysis reveal that prototypical conditions displayed greater reactivation patterns than non-prototypical ones, as predicted by both the APH*p and PPH. However, among the prototypical conditions animate agents showed a larger reactivation pattern than inanimate themes; this can only be accounted for by the APH*p. In this manner, listeners spontaneously devoted more attentional resources to the processing of prototypical subjects once they encountered the verb, but differences between prototypical conditions reveal an overall agent preference.

Lastly, I found a difference in the processing of the two agent conditions (unergative and transitive) in the early post-verb frame, with unergative subjects displaying a larger reactivation effect than transitive subjects in both animate and inanimate conditions. There was no difference between the two agent conditions in the late post-verb frame. This particular aspect of the results does not replicate the findings obtained in Experiment 1, and is not predicted by either the APH*p or the PPH. This inconsistence in the pattern of reactivation of agent subjects in the earliest time window could be due to uncontrolled factors prior to data collection, such as a difference in the perceived naturalness of sentences, a difference in verb typicality with respect to the experimental condition (e.g., the unergative verb *brillar* 'shine' could be regarded as more typically active than transitive verb *emitir* 'emit' within the same group of items), or other unconsidered factors. It is also possible that this difference between unergative agents and transitive agents may be due to the defining argument structure differences between the two conditions. Whereas unergative agents are the sole arguments of their verbs, transitive verbs also take a theme argument. As argued in Experiment 1, differences in reactivation between the unergative and transitive condition may be due to the cognitive demands that the processing of an additional argument imposes in the case of the transitive condition. However, it should be noted that differences among agent conditions in the early post-verb frame do not necessarily minimize the relevance of the regularities obtained in all the other comparisons in both timeframes, which otherwise reveal a consistent pattern of results.

6. Conclusion

This study presents new evidence of processing differences between sentential subjects in Spanish by means of eye tracking in the VWP. Participants were presented with SV(O) spoken sentences with unaccusative, unergative and transitive verbs, and both animate and inanimate NPs as sentential subjects. Simultaneously, they viewed visual displays containing four simple pictures; in test trials, the visual target was strongly related to the sentential subject. During the experiment, the time course of gaze fixations to the visual display was monitored in order to explore the impact that thematic role, animacy and their interaction (prototypicality) have on sentential subject processing. In this manner, participants were exposed to six different subject conditions: animate unaccusative (theme), animate unergative (agent), animate transitive (agent), inanimate unaccusative (theme), inanimate unergative (agent), and inanimate transitive (agent).

Two hypotheses were considered. On one hand, the APH*p, which predicts a larger reactivation of agents than themes, as well as a modulation of this general agent preference according to prototypicality. A general agent preference is supported by results obtained in Experiment 1 and other extensive literature (Slobin, 1966; Angiolillo and Goldin-Meadow, 1982; Leslie and Keeble, 1987; Bates et al., 1988; Naigles, 1990; Bever and Sanz, 1997; Goldin-Meadow and Mylander, 1998; Burkhardt et al., 2003; Goldin-Meadow, 2003; Saxe et al., 2005; Spelke and Kinzler, 2007; Friedmann et al., 2008; McAllister et al., 2009; Arunachalam and Waxman, 2010; Hamlin et al., 2011; J. Lee and Thompson, 2011; Noble et al., 2011; Shetreet and Friedmann, 2012; Dryer and Haspelmath, 2013; Hafri et al., 2013; Meltzer-Asscher et al., 2015; Rissman and Goldin-Meadow, 2017; Strickland, 2017; Momma et al., 2018; Rissman and Majid, 2019; Gómez-Vidal et al., 2022). On the other hand, I considered the PPH, which predicts a general preference for prototypical arguments, with no difference between prototypical agents and themes. A general prototypicality preference is also supported by results obtained in previous psycholinguistic research (Frisch and Schlesewsky, 2001; Traxler et al., 2005; Demiral et al., 2008; Philipp et al., 2008; Betancort et al., 2009; Bornkessel-Schlesewsky and Schlesewsky, 2009; Choudhary, 2011; Bourguignon et al., 2012; Kretzschmar et al., 2012; Lowder and Gordon, 2012; Bickel et al., 2015; Muralikrishnan et al., 2015; Foley, 2020).

The main finding in Experiment 2 lies in consistent differences in the magnitude of the reactivation effect between conditions in both timeframes. I interpret this difference in magnitude of reactivation as an indication of the amount of attentional resources or cognitive preference directed towards sentential subjects during sentence comprehension. Prototypical (animate unergative, animate transitive, and inanimate unaccusative) subjects displayed a larger reactivation effect than non-prototypical (inanimate unergative, inanimate transitive, and animate unaccusative) subjects. Additionally, there were differences between prototypical conditions: animate agent subjects displayed a larger reactivation effect than inanimate theme subjects both in early and late post-verb frames. As discussed in section 5, the only exception to this pattern lies in the results obtained for the animate transitive condition in the early post-verb frame. These results reveal a general preference for prototypical arguments, as well as an overall agent preference. These findings can only be accounted for by the APH*p: first, there is evidence to support a preference for prototypical arguments; second, there is evidence to support an overall agent preference among the prototypical conditions. In this manner, the most comprehensive account of Experiment 2 data is given by the APH*p; this hypothesis proposes a preference for prototypical mappings between thematic role and animacy in argument structure processing, while maintaining that prototypical agents are preferred overall.

All in all, these results provide new evidence regarding the impact that the interaction between thematic role and animacy have on argument structure processing. Results show that prototypical arguments are preferred over non-prototypical ones in sentence comprehension, as listeners spontaneously devote more attentional resources to their processing. Importantly, there are significant differences between prototypical arguments, which reveal an overall agent preference. I suggest that this preference for prototypical arguments may be rooted in general cognitive biases that relate to typicality and/or frequency of event realization, since animates are the best exemplars of agency while inanimates are the best exemplars of themes. The overall general preference for animate agents is also widely considered to be rooted in general cognitive biases, and is compatible with the robust findings regarding the difference between agents and themes in psycholinguistic and cognitive science literature. Experiment 2 results thus replicate previous findings obtained in Experiment 1 that support a general agent preference in argument structure processing, while also providing new evidence of the specific ways in which prototypicality effects modulate the agent preference (Sauppe et al., 2023).

Chapter 4. Psychological verbs, experiencers and the question of proto-roles

Abstract

In Experiments 1 and 2, I compared the reactivation patterns of both agents and themes after verb offset, and found consistent differences between the processing of these thematic roles. In order to explore the processing patterns of other roles, I conducted a 2 x 1 experiment with psychological predicates, which are assumed to assign the experiencer role to the event participant undergoing a mental state. The independent variable was verb type (transitive, intransitive), thus yielding two experimental conditions. I contemplated two hypotheses: (i) the Experiencers as a Distinct Category Hypothesis (henceforth EDCH), and (ii) the Proto-Role Hypothesis (henceforth PRH). The EDCH predicts finding the same processing pattern in both experiencer conditions after verb offset. Under my original assumptions, the PRH predicts finding a different processing pattern between experiencer conditions due to semantic differences between predicate types. Forty participants listened to SV(O) sentences while looking at visual displays; in the critical trials, the sentential subject was related to one of the pictures. Results showed that the experimental conditions displayed largely the same processing pattern after the verb. The only exception to this general finding lies in a short time window spanning 600 ms immediately after verb offset, when the visual objects related to intransitive experiencer subjects received a greater proportion of fixations than those related to transitive experiencers. After these analyses had been carried out, I questioned my original assumptions regarding the semantic differences between experimental conditions, which critically affected the predictions of my considered hypotheses. As a result, I conducted a post-hoc analysis in which I combined Experiment 3 data with a selection of Experiment 2 data in order to compare experiencer subjects with both agent and theme subjects. Crucially, these comparisons allowed me to discriminate between the considered hypotheses independently of the correctness of my original assumptions. Results from the post-hoc analysis showed that agent and experiencer subjects displayed the same processing pattern, which differed from the reactivation pattern of theme subjects. These results

are consistent with PRH predictions, since a processing pattern common to agents and assumed experiencers was found, different from the processing pattern of themes. These findings constitute new evidence favoring a proto-role view of thematic role assignment in processing.

1. Introduction

In psychological predicates such as (1), the event participant who undergoes a mental state (i.e., sentential subject *Mary*) is commonly assumed to bear the experiencer role (Belletti and Rizzi, 1988; Pesetsky, 1995; Arad, 1998; Brunetti, 2009).

(1) Mary fears dogs.

Theoretical analyses of thematic roles differ greatly in their understanding of thematic roles as categories, and claims about the experiencer role are a source of particular controversy in the field. On the one hand, list-based theoretical accounts claim that there exists a finite list of thematic roles, each one of them constituting a discrete cognitive category; one such category is the experiencer role (Fillmore, 1971; Levin, 1993; Pesetsky, 1995; Levin and Rappaport-Hovav, 2005, *inter alia*). On the other hand, proto-role proposals claim that thematic relations have a prototype structure, and therefore argue that grammatical function assignment is driven by the proto-role properties a given argument meets (Dowty, 1991; Ackerman and Moore, 2001). More specifically, Dowty's (1991) proto-role theory claims that there exist only two proto-role categories, namely proto-agent and proto-patient; this is the theory of proto-roles that will be explored in detail throughout the chapter. [1]

These opposing views make different claims regarding the processing of assumed experiencer arguments in psycholinguistic research investigating argument structure and thematic role processing. The claims in list-based theories predict finding processing correlates of a distinct experiencer pattern, both uniquely related to the experiencer category and significantly different from the processing patterns of other thematic roles, such as agents or themes. By contrast, the claims in proto-role proposals predict finding different processing patterns for arguments which differ in the number of proto-agent and proto-patient entailments that they meet. More specifically, if a given argument meets more proto-agent entailments than proto-patient ones, the prediction is that the argument will display a proto-agent processing pattern. By contrast, if the argument meets

[1] Note that Dowty's (1991) proposal does not make a distinction between patients and themes.

more proto-patient entailments than proto-agent ones, the prediction is that the argument will display a proto-patient processing pattern. Importantly, and although Dowty's (1991) proposal was not concerned with processing correlates, it could be argued that such a theory of proto-roles allows for processing variability across members of the same proto-category, as it is stated that verbal arguments may bear either or both of the proto-roles to varying degrees. The implications of this particular aspect of this proto-role theory will be discussed in depth in sections 1.2, 2.1 and 4.3.

The main research question that this chapter attempts to tackle has to do with the nature of the experiencer thematic role and the processing correlates that assumed experiencers elicit in sentence processing research, especially in juxtaposition to other previously explored roles (i.e., agents and themes). Although many theoretical analyses have been put forward to demonstrate the existence of an experiencer role as a distinct category, the psycholinguistic evidence suggests that not all experiencers share the same processing patterns (Brennan and Pylkkänen, 2010; Hartshorne et al., 2016; Gattei, París and Shalom, 2021; Do and Kaiser, 2022; Wilson and Dillon, 2022). Furthermore, a review of psycholinguistic and event cognition research in a variety of populations and languages does not report compelling evidence that the experiencer constitutes an abstract "core knowledge" category (Rissman and Majid, 2019). For this reason, the current chapter seeks to fill a gap in experimental research by exploring the processing patterns of the experiencer thematic role in Spanish. More specifically, this chapter presents a Visual World Paradigm (henceforth VWP) study investigating the processing of sentence-initial subjects in psychological predicates. Two types of psychological verbs were selected: (i) transitives (e.g., *amar* 'to love'), and (ii) intransitives (e.g., *divertirse* 'to have fun'). These sentential subjects are considered experiencers according to list-based approaches, whereas Dowty's (1991) proto-role theory allows only for proto-agent or proto-patient thematic role assignment for these—and any—verbal arguments. The main goal in this experiment is to test whether the sentential subjects in both conditions obtain the same processing correlates or not. Thus, this study allows for the collection of new processing data relevant to the exploration of the experiencer thematic role, thematic role categories in general, and argument structure processing.

The structure of this chapter is as follows. First, I will lay out a discussion of psychological predicates as a verb class. In this introduction, I will also present an overview of the experiencer thematic role, together with the two opposing schools of thought that we find in the literature regarding its conceptualization. Last in the introduction, I will discuss relevant findings in the experimental literature investigating the processing of psychological predicates and their event participants. Next, I will present the experimental design of Experiment 3 and the hypotheses considered, as well as other information regarding methodology, materials, procedure and participants. Then, I will provide an account of the data processing steps and statistical analyses that were carried out with the collected data. Next, I will lay out the obtained results together with a brief interpretation of the main findings, which will lead to a discussion of its shortcomings and the possible design flaws of the study as it was originally conceived. This will be done in order to justify the implementation of a post-hoc analysis, which combines Experiment 3 data with a selection of Experiment 2 data with the aim of better addressing the main research question in this chapter, as well as the predictions of the considered hypotheses. At this point, the post-hoc analysis will be presented, including the predictions that the hypotheses make on the combined data, as well as information about the post-hoc analysis design, data processing, data analysis and results. Finally, I will go over the results obtained in all the analyses in the discussion, and present the main findings and conclusions at the end of this chapter.

1.1 Psychological predicates

Most theoretical analyses of argument structure configurations propose grouping predicates into classes based on their semantics and grammatical realizations. Besides unaccusative and unergative predicates, which have already been covered in previous chapters, one such group is the class of psychological (henceforth psych) predicates. In psych predicates such as (1), a participant experiences a mental or emotional state; this participant is commonly assumed to bear the experiencer thematic role (Belletti and Rizzi, 1988; Arad, 1998; Brunetti, 2009).

(1) Mary fears dogs.

The discussion surrounding the interesting properties of psych verbs and their possible analyses and categorizations originated with Belletti and Rizzi's (1988) proposal, who in their seminal paper argued for a classification of Italian psych predicates into three different subclasses. Their classification system is based upon the assumption that psych verbs constitute a linguistically-relevant heterogeneous class in which the experiencer argument is mapped into different syntactic positions, receiving either nominative, accusative or dative case (Belletti and Rizzi, 1988).

Since this categorization of psych verbs was put forward, many authors have attempted to provide their own analyses and categorizations of psych predicates in various languages, including Spanish. These proposals are diverse in nature, and there is widespread disagreement on the number of psych predicate subclasses, semantic and morphosyntactic properties of their arguments, and thematic roles of the event participants involved. Several attempts have been made to replicate Belletti and Rizzi's (1988) original classification in Spanish, proposing three subtypes of psych predicates based on the mapping of the experiencer argument (i.e., *María*) into nominative (2), dative (3) or accusative (4) case (Parodi-Lewin, 1991; Franco, 1992; Fábregas, Marín and McNally, 2012). Other proposals expand this classification system of Spanish psych verbs into up to five subclasses (Vogel and Villada, 2000), including intransitive predicates with experiencer sentential subjects such as (5).

(2) María ama a su hija.

'Mary loves her daughter.'

(3) A María le preocupa su hija.

'Mary is worried about her daughter.'

(4) Su hija preocupa a María.

'Her daughter worries Mary.'

(5) María se divierte mucho en el parque.

'Mary has a lot of fun at the park.'

The semantic properties of intransitive psych verbs like (5) constitute a controversial issue in the literature, especially regarding inchoativity (i.e., the aspectual quality of verbs that indicates the beginning of an action or state) and telicity (i.e., the property of verbs that indicates whether an event has a natural endpoint or completion). While some authors argue that intransitive psych predicates such as (5) do not describe a change of state (Marín and McNally, 2011; Fábregas, Marín and McNally, 2012), others propose that the experiencer in (5) does undergo a change of state (Martí and Fernández, 1992; Arad, 1998). In fact, these authors claim that psych verbs in general do not simply describe mental or emotional states, but rather describe (a) a change from a mental state to another (e.g., *alegrarse* 'to cheer up') or (b) the end result of a mental process after a change has occurred (e.g., *amar* ‘to love’) (Martí and Fernández, 1992). Importantly, Dowty (1991) indicates that the inchoative interpretation of psych predicates like (5) denotes a change of state, which has important implications regarding the predictions in this chapter (see sections 1.2 and 2.1 for a full discussion). It should be noted at this point that there are many linguistic tests and considerations that semanticists and syntacticians take into account in order to determine whether reflexive psychological verbs in Spanish describe a change of state or not. Although these cannot be thoroughly reviewed and discussed here, this point of contention in the literature—whether these verbs denote a change of state—is quite relevant, and will be discussed several times throughout the chapter. For that reason, some of the diagnostic criteria that have been used to claim that *divertirse* psych verbs do not denote a change of state are shown below.

Through a series of eight telicity and dynamicity diagnostics, Marín and McNally (2011) argue that verbs like *divertirse* (5) are stative and atelic, which they take as evidence that these predicates do not denote a change of state. For example, when testing the dynamicity of these verbs, which is typically used to differentiate statives from other aspectual classes, these authors show that verbs like *divertirse* do not allow modification with *lentamente* ‘slowly’, indicating that they are nondynamic (6); this modification is allowed in dynamic verbs (7). Additionally, verbs like *divertirse* are also incompatible with ‘finish’ verbs like *acabar* (8), which points towards them being atelic, unlike *abrirse* in (9).

(6) *María se divirtió lentamente.

‘*Mary had fun slowly.’

(7) La puerta se abrió lentamente.

‘The door opened slowly.’

(8) *María ha acabado de divertirse.

‘*Mary has finished having fun.’

(9) La puerta ha acabado de abrirse.

‘The door has finished opening.’

This, in conjunction with other evidence shown in Marín and McNally (2011), is seen as supporting the idea that psych verbs like *divertirse* do not truly involve a change of state.

In sum, theoretical proposals regarding the classification of psych predicates are diverse, and the semantic properties of psych verbs in each subclass constitutes a salient point of contention, with no definite consensus in the literature. In order to discuss the selection of the two experimental conditions in this study in depth, in the following section I will provide an overview of the experiencer thematic role as it is conceptualized according to the two main theoretical views of thematic roles.

1.2 The experiencer thematic role: opposing schools of thought

As advanced above, there are two main schools of thought regarding the theoretical understanding of thematic roles. On the one hand, list-based accounts claim that experiencers conform one of the discrete categories among a finite list of thematic roles (Fillmore, 1971; Levin, 1993; Pesetsky, 1995; Levin and Rappaport-Hovav, 2005, *inter alia*). On the other hand, Dowty's (1991) proto-role proposal claims that there exist only two proto-role categories, namely proto-agent and proto-patient, and that thematic role assignment is determined by the number of properties of the proto-category that a given argument meets. These opposing views make different claims regarding the processing of assumed experiencer arguments in psycholinguistic research investigating argument structure and thematic role processing, which I will discuss in the following paragraphs.

The claims in list-based theories predict finding processing correlates of a distinct experiencer pattern. In the absence of a hypothesis in the cited works that appropriately fitted my research needs, I have encapsulated the concepts and ideas mentioned in these theoretical proposals in order to formulate the *Experiencers as a Distinct Category Hypothesis* (henceforth EDCH) as it appears in this dissertation. The EDCH claims that psychological predicates such as (1-5) assign the experiencer role to the event participant who undergoes the mental state or emotion in the event. As such, the EDCH makes the following prediction for processing data: that psycholinguistic research investigating the processing patterns of thematic roles will find processing correlates of a distinct experiencer pattern, which will be uniquely related to the experiencer category and significantly different from the processing patterns of other thematic roles, such as agents or themes.

Contrary to this, Dowty's (1991) proto-role proposal questions the existence of experiencers as a distinct category, proposing instead that the thematic role assignment of these event participants is split between proto-agents and proto-patients depending on their semantic properties. More precisely, Dowty's (1991) theory is concerned with *argument* *selection principles*, that is, the principles that determine which thematic roles are associated with which grammatical functions. In this system, verbs assign semantic properties to the arguments involved in the predicate and, according to these properties, grammatical functions are assigned. The most relevant contribution that this author makes with respect to a theory of proto-roles is the differentiation between semantic properties contributing to a proto-agent or a proto-patient role, thus effectively characterizing each proto-role category by means of entailments. In this manner, although Dowty's proposal revolves around the indexing of grammatic functions, and not thematic role assignment per se, it utilizes semantic properties associated with two proto-role categories to do so, which indirectly puts forth a system in which thematic proto-role assignment determines the lexicalization of grammatical functions.

Although Dowty's (1991) seminal proposal was not specifically put forward for sentence processing research, I have brought its main claims here under the name of the *Proto-Role Hypothesis* (henceforth PRH). This hypothesis is not formulated as such in Dowty (1991); in fact, it is not formulated or coined at all, but rather introduced by means of an extensive discussion spanning 72 pages. However, subsequent research citing this author typically refers to his proposal as the proto-role hypothesis. For this reason, I have followed this general trend and adopted the same nomenclature to refer to the hypothesis in Dowty (1991).

The PRH makes the following claims: (i) that there exist two proto-role categories in thematic role assignment, namely proto-agent and proto-patient; and (ii) that the categorization of a given argument into a proto-role is determined by the number of entailments of the proto-category that the argument meets. In this manner, the PRH states that if a given argument meets more proto-agent entailments than proto-patient ones, that argument is assigned a proto-agent thematic role. By contrast, if the argument meets more proto-patient entailments than proto-agent ones, that argument is assigned a proto-patient thematic role. It is also stated that arguments may meet one (or both) of the proto-categories to varying degrees, depending on the semantic properties assigned by the verb. However, it is unclear how this particular aspect of his theory might be accounted for from a psycholinguistic point of view, especially with regards to the processing patterns of arguments that "fall in the cracks" between proto-categories. It should be noted at this point that one of Dowty's main goals was to encourage future work on proto-roles, and that this explicitly included psycholinguistic research that might potentially challenge, refute, question or otherwise expand on this framework. Following in on the author's invitation, throughout this chapter I will provide one of the possible psycholinguistic applications of such a theory in eye-tracking research using the VWP.

The PRH makes a number of predictions for processing data. First, that arguments meeting a greater number of proto-agent entailments will display a proto-agent processing pattern. Second, that arguments meeting a greater number of proto-patient entailments will display a proto-patient processing pattern. Third, that arguments meeting the same number of proto-agent and proto-patient entailments will be correlated with psychometric measures indicating greater processing cost compared to those arguments which meet more proto-role entailments of one category than the other. This is because thematic role assignment is driven by the greatest number of proto-role entailments of one category that a given argument meets. I argue that meeting the same number of entailments in both proto-role categories derives in a greater processing cost for two possible reasons: (a) either because the processing system must assign two proto-roles to the same argument, which I argue is more costly than assigning one; or (b) because the processing system must assign one proto-role to an argument that has an equal claim to the other category, thus making thematic role assignment more costly than in cases where the argument has a clearly greater claim to one of the two proto-roles. It should be noted once more that it is unclear which thematic proto-role will be assigned to an event participant meeting an (approximately) equal number of proto-role entailments in both categories, as this hypothesis contemplates the possibility that these arguments may bear one, neither or both proto-roles. However, I argue here that the PRH still predicts finding relevant psychometric measures that correlate with greater processing cost for such conditions, which suffices for the experimental consideration of this hypothesis in psycholinguistic research.

Therefore, the question of which semantic properties arguments meet becomes of crucial importance for the thematic role assignment system proposed by the PRH (Dowty, 1991). A list of the proto-agent and proto-patient entailments is illustrated in Table 4.1.

Proto-agent	Proto-patient
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 the movement of another participant

TABLE 4.1: **List of proto-agent and proto-patient entailments by proto-category in Dowty's (1991, p. 572) proposal.**

According to this proposal, all experiencer arguments meet the proto-agent entailment of *sentience*, as they must be sentient in order to experience the psychological state or emotion that is denoted in the event. By contrast, only some experiencer arguments may meet proto-patient entailments such as *change of state*. In Dowty's (1991) proposal, it is argued that psych predicates such as (5) allow for an inchoative interpretation, thus denoting a change of state. As a result, and despite the diagnostic criteria provided by Marín and McNally (2011) in section 1.1, I initially followed the assumption that these verbs do denote a change of state, in line with the claims of other authors in the field (Martí and Fernández, 1992; Arad, 1998). Given this assumption, it follows that the experiencer argument in psych predicate (5) meets one proto-agent and one proto-patient entailment. By contrast, the experiencer argument in psych predicate (2) meets one proto-agent entailment, and no proto-patient ones.

(2) María ama a su hija.

(5) María se divierte mucho en el parque.

The PRH makes different predictions when it comes to the processing of the sentential subject in these two psych predicates (2, 5). First, it predicts finding a proto-agent processing pattern in (2), as this argument meets only proto-agent entailments. Second, it predicts finding psychometric measures that correlate with greater processing cost in (5) compared to (2). Once again, given the assumption that the argument in (5) meets an equal number of proto-agent and proto-patient entailments, it is unclear which thematic proto-role this argument should be assigned according to the PRH. However, it should be noted that I argue that the PRH still predicts finding a difference between both predicate types in thematic role processing data.

Some experimental evidence is compatible with the claims of the PRH. In an extensive review of psycholinguistic, event cognition and language typology research, Rissman and Majid (2019) report finding strong evidence for abstract agent and patient thematic roles, alongside a universal bias to distinguish between the two. As for other roles proposed by list-based theories, such as goals, recipients, instruments or experiencers, they report no clear evidence supporting the encoding of different categories. The finding that only agent and patient roles constitute robustly-represented and clearly differentiated categories is compatible with PRH predictions, as this hypothesis proposes only two proto-roles in thematic role assignment. However, it should be noted that the evidence reviewed in Rissman and Majid (2019) does not reveal whether these categories display a prototype structure, as claimed by the PRH.

Besides this review, a few experimental studies in English have explored whether adult informants attribute the semantic properties proposed in Dowty (1991) to the event participants involved in transitive predicates. These results were obtained by means of data annotation tasks in which native speakers indicated which semantic properties they associated with each argument of a transitive predicate; these properties were based on Dowty's proto-agent and proto-patient entailments. In these studies, both sentential subjects and objects were investigated, which were estimated to bear proto-agent and proto-patient roles, respectively. Their findings reveal that sentential subjects obtained significantly more proto-agent than proto-patient properties, while sentential objects obtained significantly more proto-patient than proto-agent properties (Kako, 2006). A similar trend has been found in a corpora annotation study within the field of computational linguistics, where Dowty's (1991) PRH is examined as a possible solution to the syntax-semantics mapping problem of event participants and thematic roles (Reisinger et al., 2015). In this study, both small and large sets of data were annotated by native speakers, who were given transitive sentences and then rated how much they associated a set of fine-grained properties based on the PRH to each argument in the sentence. Their results reveal that sentential subjects were associated with more proto-agent properties than proto-patient ones, while the opposite was true for sentential objects. Furthermore, the authors argue that a fine-grained annotation system of semantic properties based on the PRH results in more accurate role categorization, as opposed to coarse-grained annotation systems of thematic roles (Reisinger et al., 2015). These findings constitute evidence supporting the psycholinguistic validity of Dowty's (1991) proposal, as they suggest that speakers do assign proto-agent and proto-patient semantic properties in a pattern that is compatible with PRH predictions. However, it should be noted that this research involves the categorization of sentential subjects and objects in predicates involving only agents and themes, thus providing little insight into the application of the PRH to the processing of experiencer arguments. In order to tackle the complex question of how these theoretical proposals and processing evidence interact, a review of experiencers in psycholinguistic research is introduced in the following section.

1.3 Experiencers in processing

Psycholinguistic research investigating the processing of psych predicates and experiencer arguments is relatively scarce compared to the exploration of other predicate types and thematic roles. Among the existing studies, the majority of research focuses on the comparison between subject experiencers (1) (e.g., sentential subjects of verbs like *fear*, *love*, *hate*, etc.) and object experiencers (10) (e.g., sentential objects of verbs like *frighten*, *scare*, *worry*, etc.), for which consistent processing differences have been found. This body of research, which will be explored in the following paragraphs, uses a variety of methods, including production and comprehension tasks (also paired with eye tracking), self-paced reading tasks (also paired with magnetoencephalography or MEG), verb pair selection tasks and rating tasks (Manouilidou et al., 2009; Thompson and Lee, 2009; Brennan and Pylkkänen, 2010; Hartshorne et al., 2016; Gattei, París and Shalom, 2021; Zimianiti, Dimitrakopoulou and Tsangalidis, 2021; Do and Kaiser, 2022; Wilson and Dillon, 2022). [2]

(1) Mary fears dogs.

(10) Dogs frighten Mary.

In general, results show that the processing of subject experiencer psych predicates is correlated with a range of psychometric measures associated with lesser processing cost

[2] Note that these studies do not subscribe to a two-way classification of experiencers (i.e., subject and object experiencers only), since the dative experiencer class (e.g., *please*-type verbs) is not rejected, but simply not explored experimentally in most of these studies.

compared to the object experiencer condition in languages like English and Spanish (Brennan and Pylkkänen, 2010; Gattei, París and Shalom, 2021; Do and Kaiser, 2022; Wilson and Dillon, 2022). These measures include shorter speech onset latency values (i.e., earlier production), earlier fixations to a related drawing, lesser reading times and greater accuracy values (Gattei, París and Shalom, 2021; Do and Kaiser, 2022; Wilson and Dillon, 2022). By contrast, the opposite pattern is found for object experiencer psych predicates, as results reveal that their processing correlates with longer speech onset latency values, later fixations to a related drawing, larger reading times and lesser accuracy values compared to the subject experiencer condition (Gattei, París and Shalom, 2021; Do and Kaiser, 2022; Wilson and Dillon, 2022).

Interestingly, the opposite pattern was observed in the comparison of passive sentences containing *fear*-type (11) and *frighten*-type (12) psych verbs in English.

(11) Mary was loved by Ann.

(12) Mary was scared by Ann.

In these studies, results revealed that *frighten*-type passive sentences correlated with earlier production values, earlier fixations to a related drawing, lesser reading times and greater accuracy values (Do and Kaiser, 2022; Wilson and Dillon, 2022). By contrast, *fear*-type passive sentences correlated with later production values, later fixations to a related drawing, longer reading times and lesser accuracy value (Do and Kaiser, 2022; Wilson and Dillon, 2022). Finally, in a study in Spanish comparing subject and object relative clauses, it was found that the processing of psych verbs corresponded with lesser accuracy values and greater cost than the processing of activity verbs (i.e., non-psych verbs) (Gattei, París and Shalom, 2021). Among subject-experiencer and object-experiencer psych verbs, object relatives were preferred in relative clause syntactic structures compared to subject relatives (Gattei, París and Shalom, 2021).

Research investigating populations with aphasia, cognitive impairment or neurodegenerative conditions have also reported this general finding, as object experiencer psych predicates correlated with greater processing cost than those with subject experiencers (Manouilidou et al., 2009; Thompson and Lee, 2009; Zimianiti, Dimitrakopoulou and Tsangalidis, 2021). For example, it was found that , *fear*-type psych verbs in English were more difficult to produce for speakers with agrammatic aphasia compared to the , *frighten*-type condition (Thompson and Lee, 2009). Additionally, it was also found that both control participants and aphasic patients in this study produced a greater number of active sentences with subject experiencer psych verbs than passive sentences, while more passive sentences than active sentences were produced with *fear*-type psych verbs (Thompson and Lee, 2009). This line of research also suggests that the processing of psych predicates is associated with a greater processing cost than non-psych predicates such as transitive sentences describing a physical event. More specifically, Greek speakers with dementia experienced greater difficulty in assigning thematic roles to event participants in psych predicates than in transitive predicates involving an agent and a theme (Zimianiti, Dimitrakopoulou and Tsangalidis, 2021).

Finally, one study investigating the semantic properties of psych verbs finds evidence for an aspectual difference between subject experiencer and object experiencer psych verbs in English, Mandarin and Korean (Hartshorne et al., 2016). In this set of nine experiments, participants were asked to indicate (i) the estimated duration of the mental states described by both *fear*-type and *frighten*-type psych verbs, and (ii) who had caused the mental state. The linguistic stimuli included simple psych predicates for both *fear*-type and *frighten*-type verbs in the past simple, with no adjuncts of time, place or manner. Their results show that most subject experiencer psych verbs convey a habitual attitude, while most object experiencer psych verbs describe specific episodes causing an emotional state; interestingly, they also report finding a slight overlap regarding the semantic features of both conditions (Hartshorne et al., 2016). Overall, these authors conclude that these consistent semantic differences account for differences in the syntactic mappings of the experiencer role in the studied languages. More specifically, they claim that possessing habitual attitudes constitutes a greater claim to subjecthood than undergoing an emotional state caused by an external entity. This accounts for the fact that experiencers with habitual attitudes in *fear*-type predicates are mapped as subjects, whereas experiencers that undergo an emotional state caused by another entity in *frighten*-type predicates are mapped as objects (Hartshorne et al., 2016).

Overall, these findings reveal processing differences between subject experiencers and object experiencers across different languages, populations and tasks. To my knowledge, no research investigating the processing of subject experiencers such as (2, 5) exists, thus greatly limiting the previous experimental literature that may be considered as a reference point for this study. In fact, the psycholinguistic studies investigating the processing of psych predicates and experiencers in Spanish that I have found are mainly relegated to the study of reading comprehension and acceptability judgement differences between

L1 and L2 speakers (Kanwit and Lubbers-Quesada, 2018). Given the findings in the previous literature, as well as the lack of research in the processing of subject experiencers in Spanish, this experimental study seeks to fill a gap in the literature by exploring the processing of subject experiencers in transitive and intransitive sentences in Spanish. This will be done with several goals: on the one hand, to continue to explore general questions such as argument structure and thematic role processing in Spanish; on the other hand, to examine the nature of the experiencer thematic role in an attempt to gather evidence that allows for the discrimination of the considered hypotheses.

2. Experiment 3

Using an experimental design similar to that of Experiments 1 and 2, I examined the processing patterns of sentential subjects in Spanish psych predicates with the aim of exploring the processing of experiencer arguments in different argument structure configurations. Two types of psych predicates were compared in this study: transitives such as (13), whose subjects were estimated to fit proto-agent entailments; and intransitives such as (14), whose subjects were estimated to fit both proto-agent and proto-patient entailments (Dowty, 1991).[3]

(13) El marinero amó a una mujer cubana.

'The sailor loved a Cuban woman.'

(14) El marinero se divirtió mucho en la playa.

'The sailor had a lot of fun at the beach.'

As such, Experiment 3 had a 2 x 1 design with one independent variable: (i) verb type (transitive, intransitive), resulting in the two experimental conditions illustrated in Table 4.2.

[3] These predicate types were selected among the class of psych verbs due to the fact that I wanted to compare sentential subjects with equal morphology in different argument structure configurations.

	Experimental conditions
Verb type	Intransitive
	Transitive

Table 4.2: **Experimental conditions by independent variable.**

I considered two hypotheses. First, the EDCH, which claims that experiencers constitute a distinct thematic role category, and predicts finding a unique processing pattern for experiencer subjects, with no difference between conditions. Second, the PRH, which claims that experiencers are categorized as either proto-agents or proto-patients depending on semantic properties (see section 1.2 for a full discussion). Due to differences in proto-role entailments, this hypothesis predicts finding different processing patterns between conditions, with transitive experiencer subjects displaying a larger reactivation pattern than intransitive experiencer subjects after verb offset due to the added processing cost in the intransitive condition (see section 2.1 for a full discussion of predictions).

At this point, a disclaimer about the entailments met by the sentential subject in the intransitive condition (14) should be introduced. At the time of carrying out the experimental design, I made the assumption that the sentential subjects in intransitive psych predicates such as (14) underwent a change of state, which means that the sentential subjects in the experimental conditions differed in their proto-role entailments. In other words, my understanding of the aforementioned theoretical analyses at that point in time led me to believe that psych predicates (13, 14) showed clear differences in their semantic properties. In turn, this assumption made me consider these predicate types as two appropriate experimental conditions to test the predictions of the EDCH and PRH, since these hypotheses (as interpreted under my assumptions) make different predictions for the selected data (see sections 1.2 and 2.1 for a full discussion). However, the assumption that the sentential subject in the intransitive condition (14) undergoes a change of state is questioned in section 4.3, where I consider it as a possible design flaw of this study. Notwithstanding, and for the sake of clarity and transparency, this chapter will present the experimental conditions, hypotheses and predictions just as they were initially conceived until section 4.3 is presented, where the justification of a post-hoc analysis is introduced. These questions do not, to my mind, undermine the validity of the original study, in which the comparison of transitive and intransitive experiencer subjects was proposed in order to explore their processing patterns.

As in Experiments 1 and 2, I created SV(O) sentences where I measured the magnitude and time course of subject reactivation upon encountering the verb by means of eye tracking in the VWP. Spoken sentences were paired with visual displays containing four simple pictures. In the critical trials, one of the pictures in the visual display was semantically related to the sentential subject (e.g., sentential subject *marinero* 'sailor', related to a depiction of a ship).

2.1 Hypotheses

For Experiment 3, I contemplated two hypotheses. Firstly, the EDCH, which claims that the experiencer is a distinct thematic role category. Secondly, the PRH, which claims that the thematic role assignment of assumed experiencers is split between proto-agents and proto-patients depending on the semantic properties of the event. In this section, I will illustrate the two hypotheses by listing the specific predictions that they make for Experiment 3 data. Predictions will be numbered (e.g., Prediction 0) and referred to throughout the text by means of its abbreviation (e.g., P0).

As with Experiments 1 and 2, all predictions revolve around the differences between conditions in both magnitude and time course of subject reactivation after verb offset, which I contend can be interpreted as showing *preference*. The underlying assumption for such an interpretation is that fixations on a visual object (e.g., a ship) reveal the degree to which a related item (e.g., sentential subject *marinero* 'sailor') is being activated in the participant's mental state. I argue that observing a difference in the magnitude of the reactivation effect between conditions can be interpreted as a difference in the attentional resources that listeners devote toward the sentential subject. If preference is understood in terms of attention to a stimulus, with greater attention denoting greater preference, then a larger reactivation effect indicates a greater preference for that stimulus compared to others with a lesser reactivation effect.

In turn, I argue that this measure can reveal information about the thematic role assignment and processing of assumed experiencers for the following reasons. Previously, I have argued that preverbal subjects must be reactivated after verb presentation in order to integrate the argument and the verb into a single mental representation (Koring, Mak and Reuland, 2012). The results in Experiments 1 and 2 show that all preverbal subjects become reactivated (or, at least, display a sustained activation) when the verb is encountered. In other words, participants devoted some of their attentional resources to the processing of the sentential subject in all the studied predicate types (i.e., unaccusatives, unergatives and transitives). Still, differences in the reactivation patterns of sentential subjects were observed between conditions in Experiments 1 and 2. In both experiments, these differences were motivated by the difference in thematic role of the preverbal arguments, although Experiment 2 also showed that they can be modulated by the prototypicality of said arguments. In any case, the results in Experiments 1 and 2 suggest that arguments bearing a different thematic role display differences in their subject reactivation patterns after verb offset. By contrast, arguments bearing the same thematic role tend to not display differences in their subject reactivation patterns. Following this reasoning, in Experiment 3 I also argue that the magnitude of subject reactivation reveals the magnitude of preference towards the preverbal arguments. Given that there are no prototypicality differences between experimental conditions, finding differences in the reactivation patterns of transitive and intransitive experiencer subjects would reveal a difference in preference. This, in turn, would suggest thematic role differences, which will be explored in detail below with respect to concrete predictions. By contrast, finding no significant differences in the reactivation patterns of the experimental conditions would reveal an equal preference towards both preverbal subjects, effectively showing that they display the same processing pattern. This, in turn, would suggest that they bear the same thematic role.

After these questions regarding interpretability have been addressed, let us consider the EDCH. This hypothesis claims that psychological predicates such as (2, 5) assign the experiencer role to the event participant who undergoes the mental state or emotion in the event. As such, the EDCH makes the following prediction for Experiment 3 data (Prediction 1, P1):

(P1) Transitive experiencer subjects and intransitive experiencer subjects will the display the same pattern of reactivation after the verb.

In other words, this hypothesis predicts there will be no significant differences in the subject reactivation patterns between experimental conditions. Figure 4.1 illustrates P1 according to the EDCH. Graphs illustrating predictions contain a modeled representation of the difference in subject reactivation between conditions, and they are based on a simplified visual representation of Experiment 1 and 2 data. The difference in magnitude of subject reactivation is expressed in proportions (*y* axis), and set within a generalized post-verb timeframe expressed in milliseconds (*x* axis), where 0 represents verb offset.

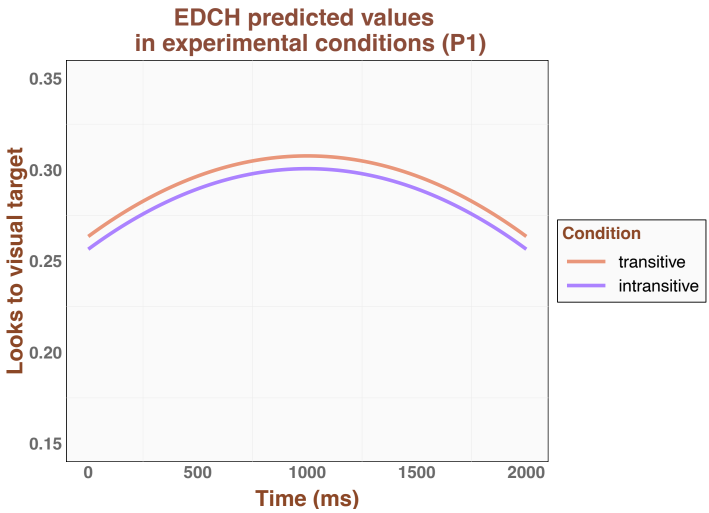

FIGURE 4.1: **Predicted difference in magnitude of subject reactivation between the transitive and intransitive conditions in accordance with the EDCH (P1), where the difference between conditions is not significant.**

Secondly, I also considered the PRH, which claims that psych predicate event participants are assigned either a proto-agent or a proto-patient thematic role based on the semantic properties in the event. In section 1.2, I argued that the selected experimental conditions differ in the entailments that their sentential subjects meet, as the transitive condition only meets proto-agent entailments, while the intransitive condition meets one proto-agent and one proto-patient entailment. More precisely, the transitive sentential subject meets the proto-agent entailment of *sentience*, whereas the intransitive sentential subject meets the proto-agent entailment of *sentience* and the proto-patient entailment of *change of state*. As a consequence, the PRH predicts that the experiencer subject in the transitive condition will display a proto-agent (i.e., agentive) reactivation pattern after verb offset.

Regarding the intransitive condition, the PRH predicts that the experiencer subject will display a delayed reactivation pattern after verb offset due to the added processing cost of having an equal number of proto-role entailments for both proto-role categories. This is because, according to the PRH, thematic role assignment is driven by the greatest number of proto-role entailments of one category that a given argument meets. As a consequence, meeting the same number of entailments in both proto-role categories poses a problem for the thematic role assignment system, thus deriving in a greater processing cost. Importantly, which thematic proto-role should be assigned to such an argument remains unclear under the PRH. However, this hypothesis still predicts finding relevant psychometric measures that correlate with greater processing cost for such condition, as well as significant differences in the processing pattern of intransitive subjects compared to transitive subjects. For Experiment 3 data, I argue that an added processing cost in thematic role assignment after verb offset results in a delay of the thematic role assignment process itself, which in turn brings about a delay in subject reactivation. Thus, the PRH makes the following prediction for Experiment 3 data (Prediction 2, P2), which is illustrated in Figure 4.2:

(P2) Transitive experiencer subjects will display a larger reactivation effect than intransitive experiencer subjects after the verb.

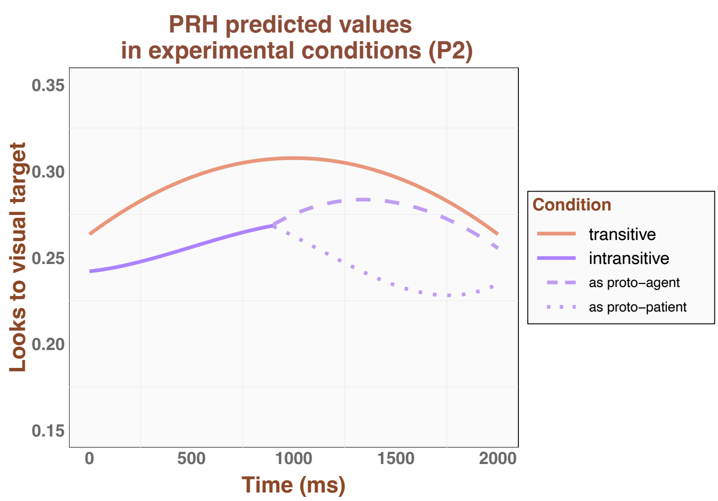

FIGURE 4.2: **Predicted difference in magnitude of subject reactivation between transitive and intransitive experiencer subjects in accordance with the PRH (P2), where the differences between transitive and intransitive conditions are significant to varying degrees depending on the processing pattern (i.e., as proto-agent or as proto-patient).**

Note that the dashed and dotted lines in Figure 4.2 represent the possible thematic role assignment of the intransitive condition after the initial delay in the subject reactivation pattern. More specifically, the dashed line represents the processing pattern of the intransitive experiencer subject as a proto-agent, while the dotted line represents its processing pattern as a proto-patient.

2.2 Methodology

For Experiment 3, I used the same methodology as in Experiments 1 and 2, presenting participants with auditory sentences and visual stimuli simultaneously. Sentences had preverbal subjects in order to measure the reactivation of the preverbal subjects upon verb presentation, i.e., during the post-verb timeframe. This was the selected time window for the analysis because it is at this point that an effect of thematic role could arise, since listeners can only unequivocally assign a thematic role to a preverbal argument once the verb is processed. During the experiment, I monitored the eye fixations of participants to a visual target that was semantically related to the sentential subject in the spoken sentence (e.g., sentential subject *marinero* 'sailor', related to a depiction of a ship). This was done in order to obtain information on the attentional processes of native speakers upon processing the argument(s) of the spoken sentences, following the assumption that a higher number of fixations correlates with greater preference for the related argument.

2.3 Stimuli

Experiment 3 had a 2 x 1 design with one independent variable: (i) verb type (intransitive, transitive). This created a total of two experimental conditions (see Table 4.2). The dependent variable was the proportion of gaze fixations on the visual target. Stimuli comprised 164 trials in total, consisting of 164 unique spoken sentences paired with 127 visual displays containing four simple gray-scale pictures from the Multilingual Picture (MultiPic) databank (Duñabeitia et al., 2018). Out of 164 trials, 80 were experimental trials, and the other 84 were filler trials. Experimental and filler trials were distributed evenly across two lists of stimuli following a Latin square design. Each list of stimuli consisted of 40 experimental trials and 48 filler trials, with a total of 88 trials per list. Each participant was shown one list of stimuli. A complete list of the linguistic stimuli in Experiment 3 is provided in Appendix D.

2.3.1 Sentences

Linguistic stimuli consisted of spoken sentences recorded by a female native speaker of Spanish in a soundproof booth at a comfortable speaking rate. Linguistic stimuli comprised both experimental and filler sentences. Experimental sentences were structured into 5 ROIs, as shown in Table 4.3. As in Experiments 1 and 2, the number of syllables in ROIs 2 and 4 was controlled to better align all experimental sentences at verb offset for the analysis (ROI 2: mean = 25.7, range = 21-30; ROI 4: mean = 20.1, range = 16-29).

ROI number	ROI name	Content
1	**Introduction**	A framing sentence including a variation of "[Someone] said that..."
2	**Subject**	The sentential subject NP, including a PP or AdjP that modified it.
3	**Verb**	The experimental verb (intransitive or transitive).
4	**Post-verb**	The post-verbal Adjunct (of manner, time, place...).
5	**Object/Additional Adjunct**	The sentential (inanimate) object NP (only in the case of transitive sentences) or an additional Adjunct (in the case of intransitive sentences).

TABLE 4.3: **Structure of experimental sentences by ROIs.**

Experimental and filler sentences were paired with visual displays to create experimental and filler trials. In experimental trials, one of the pictures in the visual display was strongly related to the sentential subject in the experimental sentence (e.g., sentential subject *marinero* 'sailor', related to a depiction of a ship). The strength of the semantic relationship between the subject nouns and their visual targets was controlled by means of previous norming studies, as all subject noun and visual target pairs were selected from the pool of strongly-related pairs in Experiments 1 and 2. An example of an experimental trial is given in sentence (6) and Figure 4.3. Note that the square brackets in sentence (6) mark the different ROIs in which experimental sentences were structured (see Table 4.3).

(6) [María dijo que][1] [el marinero anciano de pelo cano, muchas arrugas en la cara y barba larga][2] [amó][3] [muchísimo durante los primeros veranos de su juventud][4] [a una mujer cubana.][5]

'María said that the old sailor with grey hair, a wrinkled face and long beard loved a Cuban woman a lot during the first summers of his youth.'

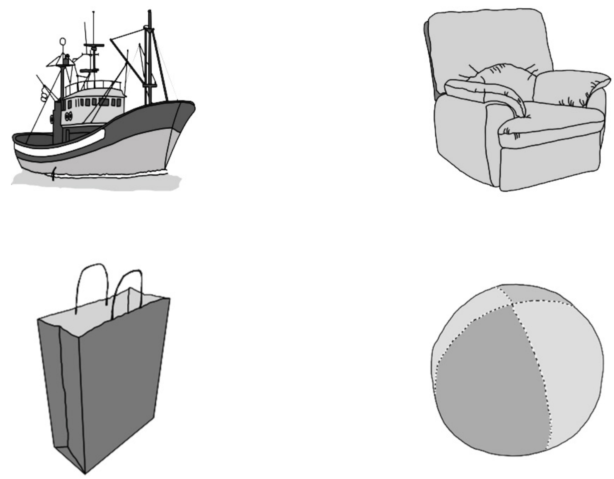

FIGURE 4.3: **Visual display paired with experimental sentence (6), where the visual target is a ship, related to the sentential subject *marinero* 'sailor'.**

Experimental sentences had a mean length of 63 syllables, a range of 56 to 71 syllables, a mean duration of 13266 ms, and an average speech rate of 4.8 syllables per second, with the following values by experimental condition: intransitive condition (mean length = 64.1 syllables, mean duration = 13416 ms, mean speech rate = 4.8 syllables per second); transitive condition (mean length = 61.9 syllables, mean duration = 13117 ms, mean speech rate = 4.7 syllables per second). As considered for Experiment 2, previous research investigating the impact of speech rate in anticipatory eye movements while processing filler-gap dependencies suggests that native speakers benefit most from speech rates between 4.5 and 5.5 syllables per second (Fernandez et al., 2020). The speech rate of experimental sentences fitted within this range for all experimental conditions.

Experimental sentences were created in groups of items following a Latin square design. Because Experiment 3 had two experimental conditions, each group of items contained two sentences, which were identical except for the modulation of verb type (intransitive, transitive).[4] Valence of the selected verbs was controlled in both conditions: half of the selected verbs had a positive valence (e.g., *amar* 'to love'), while the other half had a negative valence (e.g., *odiar* 'to hate'). Verbs were matched in Log Count values across both conditions in the EsPal database (Duchon et al., 2013), with the following values by experimental condition: intransitive condition (mean = 3.003026; maximum = 3.284431; minimum = 1.69897; *SD* = 0.8), transitive condition (mean = 3.121974; maximum = 3.98945; minimum = 1.973128; *SD* = 0.6).[5] Nouns in the subject NPs were also matched in frequency across conditions by checking log count values in the EsPal database (Duchon et al., 2013), with the following values: mean = 3.159377; maximum = 4.026125; minimum = 1.653213; *SD* = 0.8.

Finally, filler sentences contained one word which was directly matched by one of the drawings in the visual display (e.g., *avestruz* 'ostritch', matched to a depiction of an ostrich). Filler sentences were not highly varied in their word order, syntactic structure or length of constituents, but they were varied in the relationship between the sentential subject of the subordinate clause and the upcoming linguistic stimuli. In this manner, one third of filler sentences contained a sentential subject that was strongly related to an upcoming noun (e.g., *campanario* 'bell tower', strongly related to *cigüeña* 'stork'); another third contained a sentential subject that was moderately related to an upcoming noun (e.g., *campanario* 'bell tower', moderately related to *avestruz* 'ostrich'); and another third contained a sentential subject that was unrelated to an upcoming noun (e.g., *campanario* 'bell tower', unrelated to *portería* 'football goal'). This was done in order to minimize the possibility of participants predicting the relationship between the ongoing and upcoming

[4] Sentences belonging to the same group of items also differed in ROI 5 (see Table 4.3), since I gave each condition (intransitive, transitive) a unique ending in order to make the sentences more natural. However, this did not affect data analysis, because the analyzed data was gathered at timeframe prior to the presentation of ROI 5.

[5] Log count values (current minimum value = 0.301030, current maximum value = 7.340494, current average value = 1.332151) are the best value to match words based on word frequency in the EsPal database (Duchon et al., 2013).

linguistic stimuli, as well as the relationship between sentences and visual displays.

2.3.2 Visual displays

Spoken sentences were paired with visual displays (e.g., Figure 4.3) containing four gray-scale pictures from the MultiPic databank (Duñabeitia et al., 2018). Pictures were resized to fill a similar proportion of the screen across visual displays, in order to prevent some objects from appearing larger or smaller than others. Pictures were positioned at the four corners of the screen, and the location of the visual target was counterbalanced across trials. The strength of the semantic relationship between the subject nouns and their visual targets was controlled by means of previous norming studies, as all subject noun and visual target pairs were selected from the pool of strongly-related pairs in Experiments 1 and 2.

2.4 Participants and procedure

Forty students from the University of the Basque Country (UPV/EHU) participated in the experiment (32 = female, mean age = 21.4, *SD* = 1.7). Participants were native speakers of Spanish with normal or corrected-to-normal vision, and no history of language-related pathologies. This study was approved by the ethics board for human research of the University of the Basque Country (CEISH-UPV/EHU). Prior to their participation, participants were properly informed of the procedure and indicated their written consent to participate by signing the document of informed consent. Each session lasted around 30 minutes in total, and they were paid 10 euros for their participation.

The experiment took place in the same facility as Experiments 1 and 2. Participants were seated on a chair with their eyes about 55 cm from a 24” viewing monitor, set at a resolution of 1920 x 1080 pixels. Auditory stimuli were played through two speakers placed at either side of the viewing monitor. The experiment was conducted using Experiment Builder software for experiment presentation (SR Research Ltd, 2020), and eye movements were recorded by an EyeLink 1000 Plus desktop eye tracker sampling at 500 Hz. Because the eye tracker was set up and calibrated in Remote Mode, a chinrest was not used during the procedure. Instead, a target sticker was placed on the center of each participant’s forehead; the eye tracker used this information to make automatic adjustments in order to properly capture the participant’s gaze.

Each session began with a calibration procedure with nine fixation points as recommended for this experimental setup (SR Research Ltd, 2020); if calibration with a 9-point model was unsuccessful, the calibration procedure was carried out with a 5-point model instead. Participants were told that they would hear some recorded linguistic stimuli while static visual displays appeared on the screen. After some of these sentences, a simple comprehension question would appear (see Appendix D for a complete list of the comprehension questions). Comprehension questions were presented in 33 of the total 88 trials per list; the rest of the sentences did not include a comprehension question. During the presentation of a comprehension question, a written question appeared on the center of the screen, alongside two possible answers located at the right and left side of the screen, separated by a vertical line in the center. To respond, participants had to choose the correct answer, and then press the button box button that corresponded to the side of the screen where the correct answer was located (i.e., left or right).

During the session, participants were instructed to look at the visual displays while listening to the spoken stimuli very carefully. In between trials, participants were asked to fixate on a centrally-located cross; they were told that if the eye tracker did not register their eyes fixating on the cross for a limited amount of time, the experiment would be paused and a calibration screen would appear, which they would have to complete in order to resume the experiment. In this manner, I ensured that participants' eye gaze was being properly recorded by the eye tracker before the onset of each trial, while also ensuring that they were fixating to a neutral point on the screen before the presentation of the stimuli began.

During the session, participants first completed a total of five preparation trials while the experimenter was present. During these trials, participants listened to spoken sentences while they viewed visual displays. In three of the five preparation trials, participants answered a comprehension question after listening to the spoken sentence by pressing the left or right button of a button box. In the other two preparation trials, they listened to the spoken sentence and then were presented with the next trial. After the preparation trials, the experimenter left the booth and participants completed the experimental task, in which they also listened to spoken sentences while they viewed visual displays. The presentation of trials was pseudo-randomized using the randomization features available in Experiment Builder software for experiment presentation (SR Research Ltd, 2020); according to this randomization scheme, no more than 2 experimental trials or 2 filler trials could be presented in a row during the experimental task. Trials were separated by a fixation cross that required participants to fixate on the center of the screen during 200 ms (continuously). If this condition was not met during the span of 4000 ms, the experimental task automatically gave way to a calibration procedure like the one completed at the beginning of the session. Once calibration was successfully completed again, the experimental task resumed as normal. This procedure ensured that each participant was presented with the complete set of trials of their assigned list. Figure 4.4 illustrates the scheme of Experiment 3 procedure.

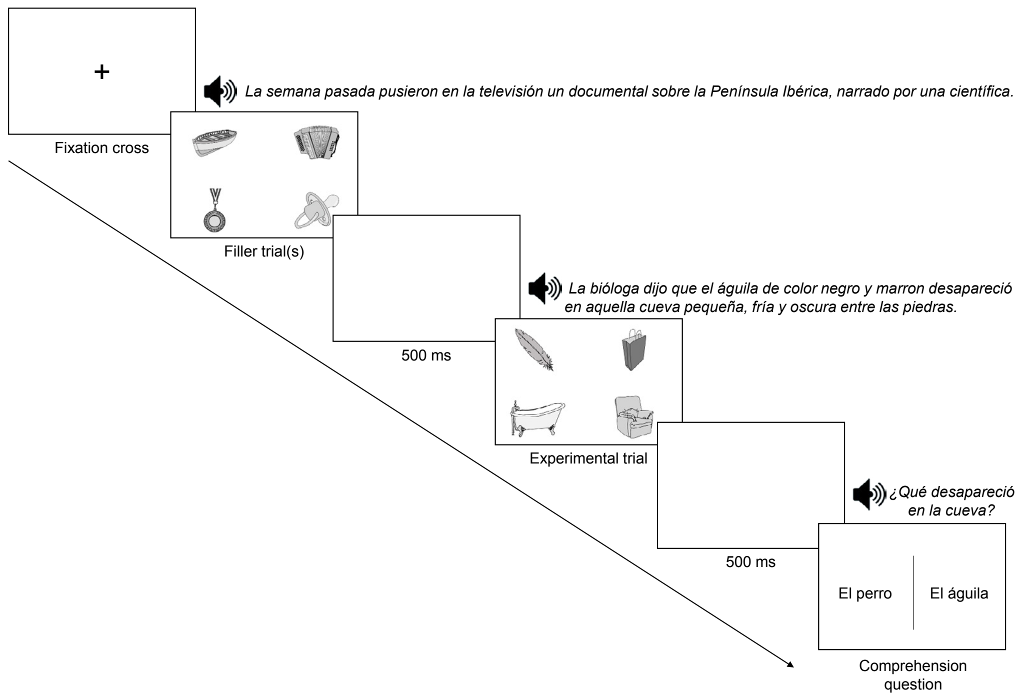

FIGURE 4.4: **Scheme of Experiment 3 procedure, comprising the presentation of one experimental trial, in which the visual target is a ship, related to the subject NP *el marinero* 'the sailor.' Comprehension questions were presented in 33 of the total 88 trials per list.**

3. Data

3.1 Data processing

After data collection, three participants were excluded from the analysis due to poor performance during the experimental task.[6] I followed the procedure described in Experiments 1 and 2 for data processing and analysis. Filler trials were discarded, and only test trials were included in the analysis. Experimental sentences were time-stamped at the onset of each ROI; these values were used to categorize the time course of gaze data into regions that corresponded with the ROIs in the linguistic stimuli. The timeline of eye data was shifted 200 ms down throughout the entire data frame resulting from these steps, in order to account for the estimated time that the human eye needs to program and initiate movement in reaction to auditory stimuli (Matin, Shao and Boff, 1993; Altmann and Kamide, 2004). Trials were centered at verb offset (i.e., the offset of ROI 3 and the onset of ROI 4, which correspond with the 0 ms value in all trials). The position of the eye fixation in the visual display was down-sampled every 20 ms for the analysis. The proportion of fixations to the visual target was calculated in each time bin that corresponded with the presentation of linguistic stimuli (i.e., the ROIs in Table 4.3). This proportion of fixations was taken as an indication of the attention that participants were devoting to the processing of the related spoken stimuli.

3.2 Data analysis

I analyzed the gaze fixation data in two different time windows that corresponded to the presentation of ROI 4: (i) the early post-verb frame, from 200 ms until 1700 ms after verb offset, and (ii) the late post-verb frame, from 1700 ms to 3200 ms after verb offset. The early post-verb frame time values were selected to match the post-verb frame in Experiments 1 and 2. The late post-verb frame time values were selected to match the post-verb frame in Experiment 2, as well as to account for the remaining time of ROI 4 presentation in a time window of comparable duration to that of the early post-verb frame.

6 The criterion for exclusion due to poor performance centered around the participant's ability to successfully maintain a model of calibration for more than a few trials at a time. Inability to do so resulted in the repeated loss of eye-tracking data within trials, which seriously impacted the frequency at which eye-gaze data was gathered. Additionally, this issue caused the experimental task to be interrupted continuously for calibrations. For these reasons, I considered data from these participants to be unfit for analysis.

For each timeframe, three Growth Curve Analysis (henceforth GCA) models (Mirman, Dixon and Magnuson, 2008) were created using the *lme4* package (Bates et al., 2015) in the R programming environment.[7] The dependent variable was the proportion of fixations to the visual target, including *verb* as the predictor, as well as orthogonal polynomials. Orthogonal polynomials were included in all GCA models to capture the temporal dynamics of fixation changes, Treatment contrasts were defined for the predictor: *intransitive* was coded as 0, and *transitive* as 1. The number of models was determined by the shape of the curves observed during the visual exploration of the data. The first model included linear and quadratic polynomials, without interactions; the second model included linear and quadratic polynomials, with a linear interaction; the third model included linear and quadratic polynomials, with a quadratic interaction. Model comparisons were carried out by means of likelihood ratio tests using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. After this, the most parsimonious model was fitted.

In the early post-verb frame, the final model was a quadratic model, where proportion of fixations were modeled as a function of *verb*, including linear and quadratic polynomials their interactions with *verb* and varying (random) intercepts and slopes by participant per each time term: *proportion ~ verb + ot1 + ot2 + verb:ot1 + verb:ot2 +* (*ot1 + ot2* | *participant*). In the late post-verb frame, the final model was also a quadratic model, where proportion of fixations were modeled as a function of *verb*, including linear and quadratic polynomials, their interactions with *verb* and varying (random) intercepts and slopes by participant per each time term: *proportion ~ verb + ot1 + ot2 + verb:ot1 + verb:ot2 +* (*ot1 + ot2* | *participant*). All *p*-values of statistical analyses presented in this chapter were calculated using the *lmerTest* package (Kuznetsova, Brockhoff and Christensen, 2017).

Results from the analysis of goodness of fit of the models in the early post-verb frame and late post-verb frame are presented in Tables 4.4 and 4.5, respectively. The goodness of fit of the models was analyzed using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models (Akaike, 1974; Cavanaugh and Neath, 2019).

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[7] All GCA models were created using the *lme4* package (Bates et al., 2015).

	AIC	-2LL	Chisq	*p*-value
x Base	-150675	75354	-	-
x Intercept	-150680	75357	7.1894	0.007
x Linear	-150684	75360	5.9142	0.015
x Quadratic	-150704	75371	21.8215	<0.001

Table 4.4: **Analysis of goodness of fit of the models in the early post-verb frame.**

	AIC	-2LL	Chisq	*p*-value
x Base	-162951	81491	-	-
x Intercept	-162951	81493	2.6134	0.106
x Linear	-162950	81493	0.2476	0.618
x Quadratic	-162956	81497	8.7280	0.003

Table 4.5: **Analysis of goodness of fit of the models in the late post-verb frame.**

4. Results

4.1 Early post-verb frame

Results from the quadratic model are summarized in Figure 4.5, showing the proportion of fixations to the visual target in the early post-verb timeframe for the transitive and intransitive conditions. The summary of the coefficients of the model is provided in Table 4.6. Results from the model showed a significant positive intercept; this means that the fixations to the visual target were significantly larger than 0. There was a significant negative effect of verb, as the average proportion of fixations for the transitive condition was significantly lower to the intransitive condition in this timeframe. There was a significant positive quadratic term for the intransitive condition, indicating that the average proportion of fixations for this condition decreased and subsequently increased during the course of this timeframe. There was also a significant positive linear term and negative quadratic term for the transitive condition, indicating that the average proportion of fixations for this condition increased and subsequently decreased during the course of this timeframe.

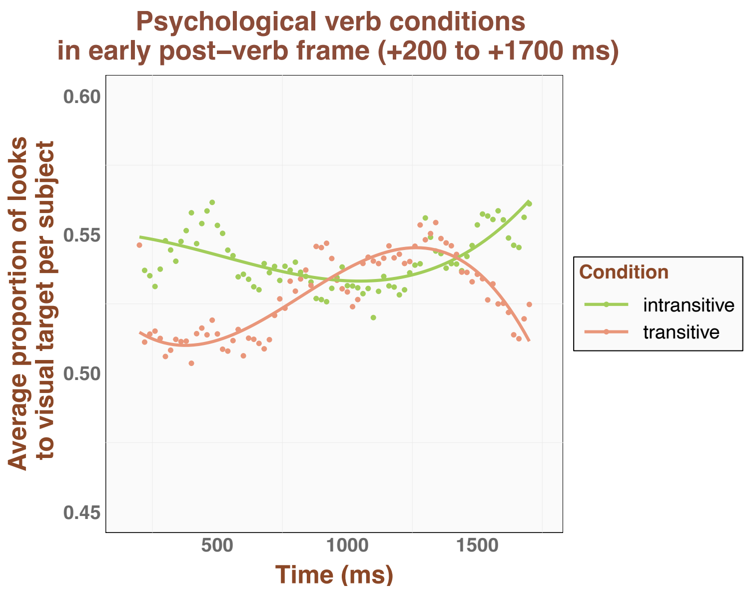

FIGURE 4.5: **Proportion of fixations to the visual target during the early post-verb frame. On the *x* axis, 0 corresponds to verb offset.**

	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.495	0.009	57.121	<0.001
x Linear	0.028	0.022	1.291	0.197
x Quadratic	0.040	0.016	2.570	0.011
x Transitive	-0.015	0.006	-2.492	0.013
x Linear*Transitive	0.058	0.031	1.868	0.062
x Quadratic*Transitive	-0.102	0.022	-4.711	<0.001

TABLE 4.6: **Summary of the coefficients from the quadratic model in the early post-verb frame.**

4.2 Late post-verb frame

Results from the quadratic model are summarized in Figure 4.6, showing the proportion of fixations to the visual target in the late post-verb timeframe for the transitive and intransitive conditions. The summary of the coefficients of the model is provided in Table 4.7. Results from the model showed a significant positive intercept; this means that the fixations to the visual target were significantly larger than 0. There was no significant effect of verb, as there was no significant difference in the average proportion of fixations between conditions in this timeframe. There was a significant negative quadratic term for the transitive condition, indicating that the average proportion of fixations for this condition increased and subsequently decreased during the course of this timeframe. There were no significant linear or quadratic terms for the intransitive condition; this means that the average proportion of fixations neither increased nor decreased significantly during this timeframe for this condition.

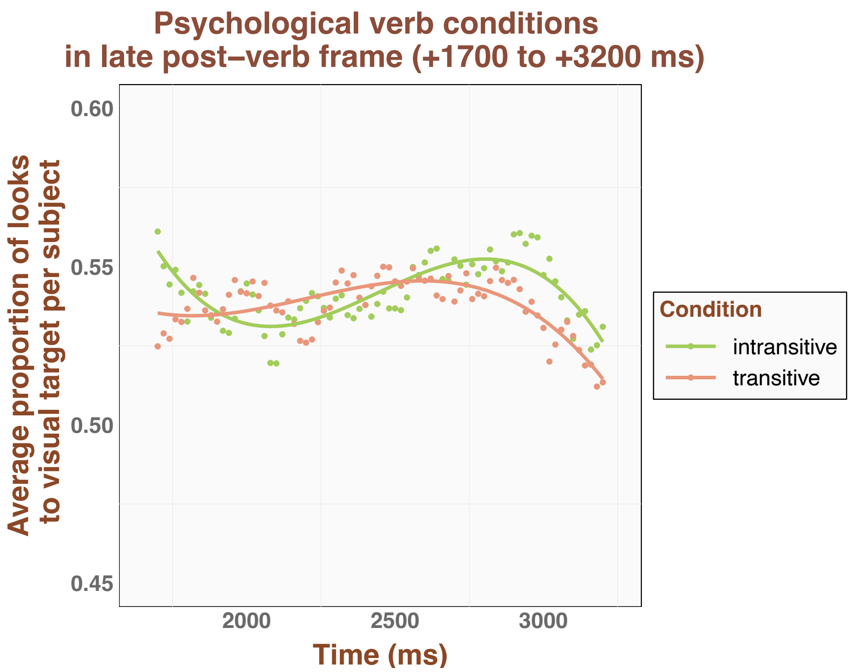

FIGURE 4.6: **Proportion of fixations to the visual target during the late post-verb frame. On the *x* axis, 0 corresponds to verb offset.**

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.498	0.007	68.978	<0.001
x Linear	0.034	0.036	0.936	0.353
x Quadratic	0.021	0.018	1.162	0.246
x Transitive	-0.008	0.006	-1.327	0.185
x Linear*Transitive	-0.014	0.036	-0.376	0.707
x Quadratic*Transitive	-0.075	0.025	-2.965	0.003

TABLE 4.7: **Summary of the coefficients from the quadratic model in the late post-verb frame.**

4.3 Post-hoc analysis

4.3.1 Justification

The analyses laid out in section 3.2 allowed me to compare the processing of transitive and intransitive experiencer subjects after verb offset. The obtained results, presented in sections 4.1 and 4.2, revealed that both transitive and intransitive experiencer subjects largely displayed the same reactivation pattern after encountering the verb. The exception to this general finding lies in the results obtained in the early post-verb frame, when differences in the magnitude of reactivation are found between conditions in a short time window around 600 ms immediately following the presentation of the verb.

The results obtained during the late-post verb frame are compatible with both EDCH and PRH predictions, as it was found that both experiencer subjects shared the same processing pattern at this timeframe. The EDCH predicts that the pattern of reactivation will be the same between conditions due to the fact that a distinct experiencer role category exists and, as such, it is expected that this category will correlate with a unified processing pattern for all experiencers. Parallel to this, the PRH predicts that the pattern of reactivation of the intransitive subject will align with either a proto-agent or proto-patient pattern after verb offset. As a result, and given that the PRH predicts finding a proto-agent processing pattern for the transitive condition, it is compatible with PRH predictions to find no significant differences in the magnitude of reactivation between conditions at this timeframe.

The results obtained during the early-post verb frame are not compatible with either EDCH or PRH predictions, since neither of these hypotheses predicts finding a larger reactivation pattern for the intransitive condition at this timeframe. Crucially, the PRH predicts finding the opposite pattern at this time window, as it predicts that the added processing cost in the intransitive condition (derived from meeting the same number of proto-agent and proto-patient entailments) will lead to a smaller magnitude of reactivation at this timeframe compared to the transitive condition.

Once these analyses had been carried out, I realized that my assumption regarding the proto-patient entailment of intransitive experiencer subjects could potentially constitute a flaw in the study, as it affected the predictions that the considered hypotheses make for Experiment 3 data. While I was designing the study, this assumption seemed legitimized by the theoretical literature covered in the introduction. It was not until I endeavored to interpret my results that I realized that this was simply an assumption, not a proven fact that could be clearly attested experimentally. After careful consideration, and given the diagnostic criteria in Marín and McNally (2011) presented in section 1.1., I entertained the possibility that this assumption was incorrect, and that the experiencer subjects in the intransitive condition do not undergo a change of state, and therefore do not meet any proto-patient entailments. If true, this would mean that the two hypotheses considered, i.e., the EDCH and PRH, make the same predictions for Experiment 3 data.

Having no means to experimentally check the validity of this controversial assumption, I realized that comparisons with other predicate conditions would be necessary to assess hypotheses EDCH and PRH fully. This is because the main question that these hypotheses revolve around has to do with whether experiencers exist as a distinct thematic role category or not. Moreover, if one removes my original assumption from the study, the only question that my original design allows me to explore has to do with whether there are processing differences between transitive and intransitive experiencer subjects. Unfortunately, this means that Experiment 3 data cannot provide experimental evidence to discriminate between either hypothesis, since no comparison between experiencer subjects and other thematic roles (i.e., agents and themes) was made. For these reasons, I decided to carry out a post-hoc analysis to address EDCH and PRH predictions properly.

4.3.2 Hypotheses

Given the mismatch between my original design and my main research question, I decided to carry out a post-hoc analysis combining Experiment 3 data with a selection of Experiment 2 data. The goal of such an analysis was to compare the subject reactivation patterns of experiencer subjects with both agent and theme subjects after verb offset, thus exploring in greater depth the predictions that hypotheses EDCH and PRH make. The detailed reasoning behind carrying out the post-hoc analysis is as follows.

EDCH claims that experiencer arguments constitute a distinct thematic role category, different from other thematic roles such as agents or themes. This hypothesis predicts that the processing of experiencer subjects will not resemble the processing of agent subjects or theme subjects. In this manner, it would be consistent with this hypothesis to find a significant difference in average magnitude of reactivation between experiencer and agent subjects, as well as between experiencer and theme subjects. Such findings would lend support to the claim that experiencer subjects are not, in fact, processed as proto-agents, but rather that they constitute their own thematic role category. In this manner, the EDCH makes the following prediction for agent, experiencer and theme subjects (Prediction 3, P3), as illustrated in Figure 4.7:

(P3) Agent subjects will display a larger reactivation effect than experiencer subjects and theme subjects after the verb; in turn, experiencer subjects will display significant differences compared to that of theme subjects in their reactivation patterns after the verb.

It should be noted that Figure 4.7 illustrates one of the possible reactivation patterns that experiencer subjects may display in terms of average magnitude and time course of reactivation. Other patterns besides this one could also be compatible with P3, as long as the significant differences between conditions outlined in P3 are found.

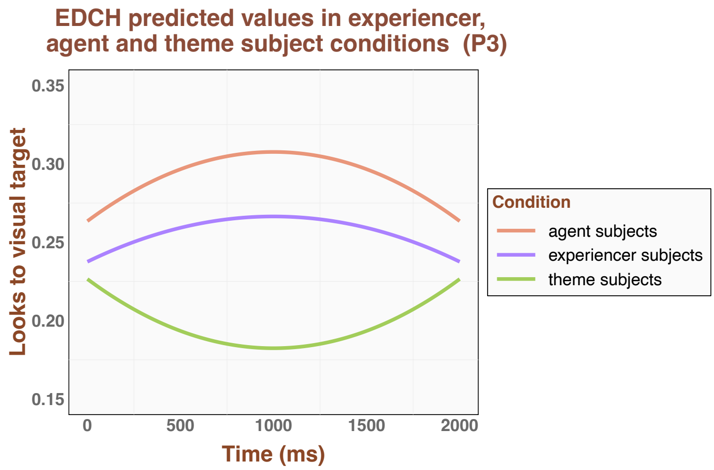

FIGURE 4.7: **Predicted difference in magnitude of subject reactivation between experiencer, agent and theme sentential subjects in accordance with the EDCH (P3), where the difference between conditions is significant across all pair-wise comparisons.**

By contrast, PRH claims that experiencer arguments meeting more proto-agent entailments than proto-patient ones are assigned a proto-agent role, and hence lexicalized as subjects. This hypothesis predicts that the processing of such experiencer arguments will resemble the processing of agent subjects more closely than that of themes. In other words, it would be consistent with this hypothesis to find no significant difference in average magnitude of reactivation between experiencer and agent subjects, as well as significant differences in average magnitude of reactivation between experiencer and theme subjects. In this manner, the PRH makes the following prediction for agent, experiencer and theme subjects (Prediction 4, P4), as illustrated in Figure 4.8:

(P4) Agent subjects and experiencer subjects will the display a larger reactivation effect than theme subjects after the verb, with no significant differences between agent and experiencer conditions.

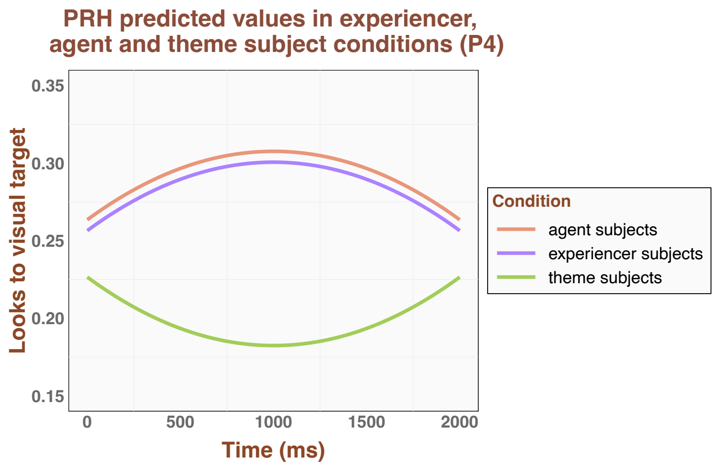

FIGURE 4.8: **Predicted difference in magnitude of subject reactivation between experiencer, agent and theme sentential subjects in accordance with the PRH (P4), where the difference between agent and experiencer subjects is not significant, but the difference between experiencer subjects and theme subjects is significant.**

Figure 4.8 illustrates the reactivation patterns of experiencer, agent and theme subjects in terms of average magnitude and time course of reactivation following the claims of the PRH, and assuming that both agent and experiencer subjects meet proto-agent entailments fully. This assumption is licensed by the results shown in section 4, where (largely) the same processing pattern was found between the transitive and intransitive conditions. Importantly, the PRH claims that the experiencer subjects in the transitive condition meet proto-agent entailments fully. Since late post-verb frame results showed that both experiencer conditions share the same processing pattern, this indicates that the intransitive experiencer condition also meets proto-agent entailments fully under the PRH.

It is worth noting at this point that Dowty's (1991) theory does state that arguments may bear proto-roles to varying degrees. This could potentially, although not necessarily, correlate with significant processing differences within proto-categories in the comparison of arguments meeting the proto-category to varying degrees. This point is not clarified further in his seminal proposal. Given that the post-hoc analysis was carried out following the assumption that both experiencer subjects meet the same number of proto-agent entailments, and thus meet proto-agent entailments fully, I argue that the PRH predicts finding the same processing pattern for agent and experiencer subjects, as reflected in Figure 4.8. Lastly, it should be noted that exploring the possibility of significant variability within proto-role categories in processing is beyond the scope of this chapter, as this was neither a factor considered in the post-hoc analysis nor in the original Experiment 2 and Experiment 3 designs. Most importantly, there was not, to my knowledge, any reason to claim that the agent and experiencer subjects explored in the post-hoc analysis meet proto-agent entailments to different degrees.

Having considered these questions, this post-hoc analysis presents an advantageous opportunity to further explore the nature of experiencers as a thematic role category, and thus address the important questions considered in hypotheses EDCH and PRH. However, the validity of these findings should be carefully considered, since it is true the post-hoc analysis data results from the combination of two different data frames, gathered in two different experimental procedures, and from two different sets of participants. Still, this post-hoc analysis presents an interesting exploration of the available eye-tracking data measuring subject reactivation patterns after verb offset; as such, it has the potential of providing useful insights into these topics, as well as inspiring future research in the fields of argument structure and thematic role processing. In the following paragraphs, the post-hoc analysis is presented in detail, including a description of design considerations, data processing, data analysis and obtained results.

4.3.3 Design and data processing

A number of considerations were taken prior to the selection of Experiment 2 data for the post-hoc analysis. Firstly, it should be noted that there were consistently close similarities between Experiments 2 and 3, especially in terms of methodology, stimuli, participants and procedure. This allowed me to properly align the eye-tracking data across data frames for the analysis and, more importantly, to consider Experiment 2 and 3 data fit for combination. In order to properly match experimental conditions and their variables, the selected Experiment 2 conditions were all animate, since all Experiment 3 sentential subjects were animate as well. In this regard, it is worth noting that Experiment 2 findings revealed an interaction between thematic role and animacy regarding the magnitude of argument reactivation after the verb. As explored in Chapter 3, results showed that animate agent subjects displayed a larger magnitude of reactivation than inanimate agent subjects. By contrast, inanimate theme subjects displayed a larger magnitude of reactivation than animate theme subjects. Despite this interaction between thematic role and animacy, Experiment 2 results also revealed significant differences in the magnitude of subject reactivation between animate agent subjects (unergative and transitive conditions) and inanimate theme subjects (unaccusative condition); in other words, animate agent subjects displayed the largest magnitude of reactivation of all Experiment 2 conditions, independently of prototypicality. For this reason, and due to the fact that animacy was not one of the variables included in Experiment 3 design, I selected three animate conditions with a modulation of verb type (unaccusative, unergative and transitive) from Experiment 2 data.

The number of arguments in predicate conditions was another relevant factor in determining post-hoc analysis comparisons. This is because significant differences between transitive and intransitive subjects bearing the same thematic role had been found in Experiments 1 and 2 at the earliest timeframe. As such, I decided to compare intransitive experiencer subjects with intransitive agent and theme subjects (unergative and unaccusative conditions), while also comparing transitive experiencer subjects with transitive agent subjects and intransitive theme subjects (transitive and unaccusative conditions). In other words, I decided to create two different models for the post-hoc analysis; one including intransitive experiencers (henceforth intransitive model), and the other one including transitive experiencers (henceforth transitive model). In both sets of comparisons, the unaccusative condition was included in order to compare experiencer subjects with both agents and themes.

Regarding the determination of a timeframe, I selected the late post-verb frame as the only time window for the post-hoc analysis, since Experiment 2 and 3 results had shown that the processing patterns of sentential subjects bearing different thematic roles are most distinct at this later timeframe. In this manner, the analyzed time window spanned from 1700 ms to 3200 ms after verb offset. Finally, data from Experiment 2 was not processed beyond the procedure already described in chapter 3, except for a simple extraction in which I isolated the selected conditions from the Experiment 2 data frame and merged them with the Experiment 3 data frame. Both sets of data were aligned according to time values. After that, each of the two resulting data frames used in the post-hoc analysis contained three experimental conditions, which are illustrated in Tables 4.8 and 4.9.

	Conditions in intransitive model
Thematic role of subject	Experiencer subject (intransitive)
	Agent subject (unergative)
	Theme subject (unaccusative)

TABLE 4.8: **Conditions in the post-hoc analysis intransitive model by independent variable.**

	Conditions in transitive model
Thematic role of subject	Experiencer subject (transitive)
	Agent subject (transitive)
	Theme subject (unaccusative)

TABLE 4.9: **Conditions in post-hoc analysis transitive model by independent variable.**

As mentioned above, I created two post-hoc analysis data frames to carry out two separate three-way comparisons among the experimental conditions. On the one hand, I selected experiencer subjects (intransitive), agent subjects (unergative) and theme subjects (unaccusative) as the conditions analyzed in the intransitive model (Table 4.8). These conditions were chosen because I wanted to compare the processing pattern of intransitive experiencer subjects with that of intransitive agent subjects (unergative condition) and intransitive theme subjects (unaccusative condition). This would allow me to check the predictions of hypotheses EDCH and PRH (see section 4.3.2 for a full discussion). On the other hand, I also selected experiencer subjects (transitive), agent subjects (transitive) and theme subjects (intransitive) as the conditions analyzed in the transitive model (Table 4.9). It should be noted that even though it was possible to make a three-way comparison among intransitive conditions, the same was not possible for transitive experiencers, since no predicates containing sentence-initial sentential objects were available in Experiment 2 data.

4.3.4 Data analysis

Once I had created the two sets of data detailed above, I carried out a post-hoc analysis in which I compared Experiment 3 conditions with the selected Experiment 2 conditions in the late post-verb frame. More specifically, I created two final models, each comparing experiencer subjects with agent and theme subjects.

For the intransitive conditions (see Table 4.8), four GCA models (Mirman, Dixon and Magnuson, 2008). The dependent variable was the proportion of fixations to the visual target, including *verb* as the predictor, as well as orthogonal polynomials. Treatment contrasts were defined for the predictor, where the experiencer subject condition was coded as the reference level. The number of models was determined by the shape of the curves observed during the visual exploration of the data. The first model included linear, quadratic and cubic polynomials, without interactions; the second model included linear, quadratic and cubic polynomials, with a linear interaction; the third model included linear, quadratic and cubic polynomials, with a quadratic interaction; the fourth model included, linear, quadratic and cubic polynomials, with a cubic interaction. Model comparisons were carried out by means of likelihood ratio tests using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. After this, the most parsimonious model was fitted. The final intransitive model was a cubic model, where proportion of fixations were modeled as a function of *verb*, including linear, quadratic and quartic polynomials, their interaction with *verb* and varying (random) intercepts and slopes by participant per each condition: *proportion ~ verb + ot1 + ot2 + ot3 + verb:ot1 + verb:ot2 + verb:ot3 + (ot1 + ot2 + ot3 | participant)*. All p-values were calculated using the *lmerTest* package (Kuznetsova, Brockhoff and Christensen, 2017).

For the transitive conditions (see Table 4.9), five GCA models (Mirman, Dixon and Magnuson, 2008) were created using the *lme4* package (Bates et al., 2015) in the R programming environment. The dependent variable was the proportion of fixations to the visual target, including *verb* as the predictor, as well as orthogonal polynomials. Treatment contrasts were defined for the predictor, where the experiencer subject condition was coded as the reference level. The number of models was determined by the shape of the curves observed during the visual exploration of the data. The first model included linear, quadratic, cubic and quartic polynomials, without interactions; the second model included linear, quadratic, cubic and quartic polynomials, with a linear interaction; the third model included linear, quadratic, cubic and quartic polynomials, with a quadratic interaction; the fourth model included linear, quadratic, cubic and quartic polynomials, with a cubic interaction; the fifth model included linear, quadratic, cubic and quartic polynomials, with a quartic interaction. Model comparisons were carried out by means of likelihood ratio tests using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models. After this, the most parsimonious model was fitted. The final transitive model was a quartic model, where proportion of fixations were modeled as a function of *verb*, including linear, quadratic, cubic and quartic polynomials, their interaction with *verb* and varying (random) intercepts and slopes by participant per each condition: *proportion ~ verb + ot1 + ot2 + ot3 + ot4 + verb:ot1 + verb:ot2 + verb:ot3 + verb:ot4 + (ot1 + ot2 + ot3 + ot4 | participant)*.

Results from the analysis of goodness of fit of the models for the intransitive and transitive conditions are presented in Tables 4.10 and 4.11, respectively. The goodness of fit of the models was analyzed using Akaike's Information Criterion (AIC), and the change in the -2 times log-likelihood was used to assess the significance of the additional terms in the nested models (Akaike, 1974; Cavanaugh and Neath, 2019).

	AIC	**-2LL**	**Chisq**	***p*-value**
x Base	-27030	13530	-	-
x Intercept	-27146	13590	120.4887	<0.001
x Linear	-27192	13615	49.6007	<0.001
x Quadratic	-27196	13619	8.3904	0.015
x Cubic	-27220	13633	27.2807	<0.001

TABLE 4.10: **Analysis of goodness of fit of the models in the late post-verb frame for the intransitive conditions.**

	AIC	-2LL	Chisq	*p*-value
x Base	-25749	12896	-	-
x Intercept	-25802	12924	57.0625	<0.001
x Linear	-25826	12938	27.7079	<0.001
x Quadratic	-25842	12948	20.1233	<0.001
x Cubic	-25846	12952	7.6969	0.021
x Quartic	-25883	12973	41.4968	<0.001

TABLE 4.11: **Analysis of goodness of fit of the models in the late post-verb frame for the transitive conditions.**

4.3.5 Results

Results from the cubic model are summarized in Figure 4.9, showing the proportion of fixations to the visual target in the late post-verb timeframe for the intransitive conditions. The summary of the coefficients of the model is provided in Table 4.12. Results from the model showed a significant positive intercept; this means that the fixations to the visual target were significantly larger than 0. There was a significant negative effect of verb in the unaccusative condition; this means that the average proportion of fixations was significantly lower for the unaccusative condition compared to the intransitive experiencer condition. There was no significant effect of verb between the intransitive experiencer condition and the unergative condition, as there was no significant difference in the average proportion of fixations between both conditions in this timeframe. There was a significant negative cubic term for the intransitive experiencer condition, indicating that the average proportion of fixations for this condition decreased, increased and subsequently increased during the course of this timeframe. There was a significant negative linear term as well as a significant positive cubic term for the unergative and unaccusative conditions; this means that the average proportion of fixations for these conditions increased, decreased and subsequently increased during the course of this timeframe.

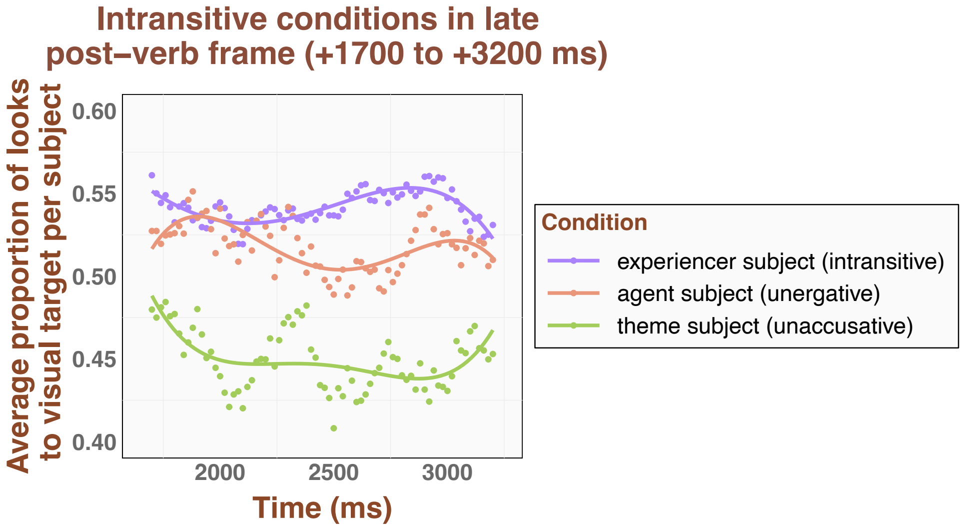

FIGURE 4.9: **Proportion of fixations to the visual target during the late post-verb frame for the intransitive conditions. On the *x* axis, 0 corresponds to verb offset.**

	Estimate	**SE**	***t*-value**	***p*-value**
(Intercept)	0.479	0.021	22.474	<0.001
x Linear	0.101	0.054	1.877	0.065
x Quadratic	0.022	0.042	0.526	0.600
x Cubic	-0.109	0.028	-3.875	<0.001
x Unergative	-0.001	0.003	-0.474	0.635
x Unaccusative	-0.030	0.003	-9.890	<0.001
x Linear*Unergative	-0.147	0.029	-5.133	<0.001
x Linear*Unaccusative	-0.151	0.029	-5.283	<0.001
x Quadratic*Unergative	0.026	0.029	0.928	0.353

	Estimate	SE	*t*-value	*p*-value
x Quadratic*Unaccusative	0.042	0.029	1.478	0.139
x Cubic*Unergative	0.131	0.027	4.826	<0.001
x Cubic*Unaccusative	0.106	0.027	3.927	<0.001

TABLE 4.12: **Summary of the coefficients from the cubic model in the late post-verb frame for the intransitive conditions.**

Results from the quartic model are summarized in Figure 4.10, showing the proportion of fixations to the visual target in the late post-verb timeframe for the intransitive conditions. The summary of the coefficients of the model is provided in Table 4.13. The transitive experiencer condition is set as the reference level, whereas the transitive condition included in Table 4.13 refers to the transitive predicate condition containing an agent sentential subject. Results from the model showed a significant positive intercept; this means that the fixations to the visual target were significantly larger than 0. There was a significant negative effect of verb in the unaccusative condition; this means that the average proportion of fixations was significantly lower for the unaccusative condition compared to the transitive experiencer condition. There was no significant effect of verb between the transitive experiencer condition and the transitive condition, as there was no significant difference in the average proportion of fixations between both conditions in this timeframe. There was a significant negative cubic term for the transitive experiencer condition, indicating that the average proportion of fixations for this condition decreased, increased and subsequently increased during the course of this timeframe. There was a significant negative linear term, a significant positive quadratic term, a significant positive cubic term as well as a significant positive quartic term for the unaccusative condition; this means that the average proportion of fixations significantly decreased during this timeframe, displaying an increase, decrease and subsequent increase towards the end of this time window. There was a significant positive quadratic term as well as a significant negative quartic term for the transitive condition, indicating that the average proportion of fixations for this condition displayed two consecutive increases and decreases during the course of this timeframe.

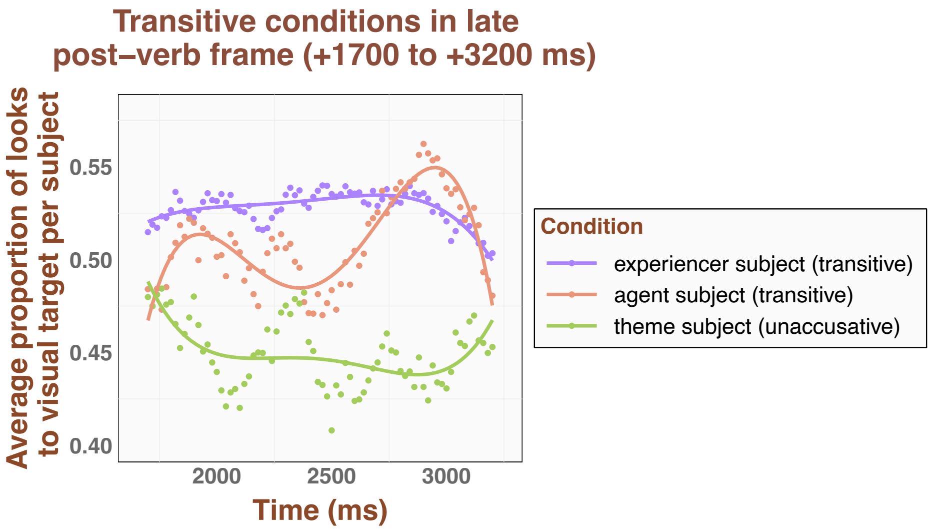

FIGURE 4.10: **Proportion of fixations to the visual target during the late post-verb frame for the transitive conditions. On the *x* axis, 0 corresponds to verb offset.**

	Estimate	SE	*t*-value	*p*-value
(Intercept)	0.471	0.023	20.815	<0.001
x Linear	0.056	0.056	0.995	0.323
x Quadratic	-0.033	0.045	-0.732	0.466
x Cubic	-0.093	0.037	-2.480	0.015
x Quartic	-0.029	0.030	-0.949	0.345
x Transitive	-0.001	0.003	-0.417	0.677
x Unaccusative	-0.021	0.003	-6.471	<0.001
x Linear*Transitive	0.046	0.033	1.402	0.161
x Linear*Unaccusative	-0.106	0.033	-3.192	0.001
x Quadratic*Transitive	0.056	0.034	1.679	0.093

	Estimate	SE	*t*-value	*p*-value
x Quadratic*Unaccusative	0.097	0.034	2.884	0.004
x Cubic* Transitive	0.036	0.031	1.141	0.254
x Cubic*Unaccusative	0.090	0.031	2.886	0.004
x Quartic* Transitive	-0.116	0.028	-4.099	<0.001
x Quartic*Unaccusative	0.071	0.028	2.516	0.012

TABLE 4.13: **Summary of the coefficients from the cubic model in the late post-verb frame for the transitive conditions.**

5. Discussion

In Experiment 3, I explored how modulating the verb type (i.e., transitive, intransitive) of a predicate with an experiencer sentential subject affected its processing after verb offset in Spanish. Importantly, I originally assumed that these conditions differed in their proto-role entailments for thematic role assignment according to Dowty (1991). The time course and magnitude of subject reactivation were measured in two different time windows: (a) the early post-verb frame, which occurred immediately after verb offset and comprised the beginning of the post-verbal Adjunct, and (b) the late post-verb frame, which comprised the end of the post-verbal Adjunct. The measure indicating magnitude of reactivation is the intercept, since it represents the average height of the curve regarding the proportion of looks to the visual target. The measure indicating time course of subject reactivation are the polynomial terms (e.g., linear, quadratic, cubic, and quartic), which correspond with different patterns of increase and/or decrease in the height of the curve across time.

Two hypotheses were considered. On the one hand, the EDCH, which predicts that experiencer subjects will display the same pattern of reactivation after verb offset (P1). On the other hand, the PRH (under my original assumptions) predicts that transitive experiencers will display a larger pattern of subject reactivation than intransitive experiencers after verb offset (P2). To test these hypotheses, I monitored the gaze-fixation patterns of 40 native speakers of Spanish while they were presented simultaneously with an auditory sentence and a visual display containing four pictures. In test trials, one of the pictures, the visual target, was strongly related to the sentential subject.

At the early post-verb frame, I found differences across conditions both in the magnitude and time course of reactivation. Regarding magnitude, intransitive experiencers displayed a larger reactivation than transitive experiencers. That is, the overall height of the curve that indicates looks to the visual target was greater for intransitive experiencers than transitive experiencers in this timeframe. This aspect of the results replicates previous findings (e.g., Experiment 2), in which the reactivation pattern of intransitive subjects displays a greater magnitude than that of transitive subjects at this time frame. Regarding time course, intransitive experiencers displayed a positive quadratic term at the early post-verb frame, thus indicating a decrease followed by an increase in looks to the visual target. The opposite pattern was found for transitive experiencers, which displayed a positive linear and negative quadratic term at this timeframe. This indicates an increase followed by a decrease in looks to the visual target. The observed magnitude and time course patterns for the transitive and intransitive conditions are not compatible with either EDCH or PRH predictions (P1, P2). In the case of the EDCH, this hypothesis predicts no differences in the reactivation pattern between conditions during this timeframe; however, significant differences were found, both in magnitude and in time course of reactivation. In the case of the PRH, this hypothesis predicts finding a larger magnitude of reactivation in the transitive condition compared to the intransitive condition in this timeframe. This is because this hypothesis predicts that the added processing cost in the intransitive condition will lead to a smaller magnitude of reactivation at this timeframe compared to the transitive condition. In turn, this prediction is derived from my initial assumption that the sentential subject in condition meets the same number of proto-agent and proto-patient entailments. However, the opposite result was found. In this manner, the results obtained in this timeframe cannot be accounted for by either hypothesis under my original assumptions. A detailed discussion regarding these issues is offered alongside the introduction of the post-hoc analysis later in this section.

At the late post-verb frame, I also found differences across conditions, but this time only in the time course of reactivation. Regarding magnitude, both transitive and intransitive experiencers displayed an equivalent reactivation pattern. That is, there were no differences in the overall height of the curve that indicates looks to the visual target between conditions in this timeframe. Regarding time course, transitive experiencers displayed a negative quadratic term at the late post-verb frame, thus indicating an increase followed by a decrease in looks to the visual target. There were no significant linear or quadratic terms for the intransitive condition; this means that the average looks to the visual target neither increased nor decrease significantly during this timeframe. The observed magnitude and time course patterns for the transitive and intransitive conditions are compatible with both EDCH and PRH predictions (P1, P2). In the case of the EDCH, this hypothesis predicts no differences in the reactivation pattern between conditions during this timeframe; no significant differences in magnitude of reactivation were found at this timeframe. In the case of the PRH, this hypothesis predicts that the thematic role assignment of the intransitive condition after the initial delay in subject reactivation pattern will align with either a proto-agent and/or a proto-patient processing pattern. Again, this prediction is derived from my initial assumption that the sentential subject in condition meets the same number of proto-agent and proto-patient entailments. Since the PRH predicts finding a proto-agent processing pattern for the transitive condition, it is compatible with PRH predictions to find no significant differences in the magnitude of reactivation between conditions at this timeframe. In this manner, the results obtained in this timeframe can be accounted for by either hypothesis. A detailed discussion regarding these issues is offered alongside the introduction of the post-hoc analysis later in this section.

The combined results from both time windows of analysis reveal that transitive and intransitive experiencer subjects largely displayed the same reactivation pattern after encountering the verb. The exception to this finding lies in the results obtained in the early post-verb frame, when differences in the magnitude of reactivation are found between conditions in a short time window around 600 ms immediately following the presentation of the verb. The results obtained during the late-post verb frame are compatible with both EDCH and PRH predictions. However, the results obtained during the early-post verb frame are not compatible with either EDCH or PRH predictions, since neither of these hypotheses predicts finding a larger reactivation pattern for the intransitive condition at this timeframe. After careful consideration, I entertained the possibility that my assumption regarding the proto-role entailments of the intransitive condition was incorrect, and that the experiencer subjects in the intransitive condition do not meet any proto-patient entailments. If true, this would mean that the two hypotheses considered make the same predictions for Experiment 3 data, rendering it impossible to discriminate between the two. As a consequence, I carried out a post-hoc analysis to address EDCH and PRH predictions properly; this analysis combined Experiment 3 data with a selection of Experiment 2 data.

In this post-hoc analysis, I explored how modulating the thematic role (i.e., agent, experiencer, theme) of a preverbal sentential subject affected its processing after verb offset in Spanish. Importantly, I no longer assumed that the transitive and intransitive experiencer conditions differed in their proto-role entailments for thematic role assignment according to Dowty (1991). The time course and magnitude of subject reactivation were measured in one time window, i.e., the late post-verb frame, which comprised the end of the post-verbal Adjunct. The measure indicating magnitude of reactivation is the intercept, since it represents the average height of the curve regarding the proportion of looks to the visual target. The measure indicating time course of subject reactivation are the polynomial terms (e.g., linear, quadratic, cubic, and quartic), which correspond with different patterns of increase and/or decrease in the height of the curve across time. Two models were created for the post-hoc analysis in order to carry out different comparisons across conditions. The first model was the intransitive model, including intransitive experiencer subjects from Experiment 3 data, as well as intransitive agent subjects (unergative condition) and intransitive theme subjects (unaccusative condition) from Experiment 2 data. The second model was the transitive model, including transitive experiencer subjects from Experiment 3 data, as well as transitive agent subjects (transitive condition) and intransitive theme subjects (unaccusative condition) from Experiment 2 data.

Two hypotheses were considered. On the one hand, the EDCH, which predicts that agent subjects will display a larger reactivation effect than experiencer subjects and theme subjects after the verb; in turn, experiencer subjects will display significant differences compared to that of theme subjects in their reactivation patterns after the verb (P3). On the other hand, the PRH predicts that agent subjects and experiencer subjects will the display a larger reactivation effect than theme subjects after the verb, with no significant differences between agent and experiencer conditions (P4).

Among the intransitive conditions, I found differences between conditions both in magnitude and time course of subject reactivation. Regarding magnitude, both agent and experiencer subjects displayed an equivalent reactivation pattern. That is, there were no differences in the overall height of the curve that indicates looks to the visual target between agent and experiencer conditions in this timeframe. However, experiencer subjects displayed a larger reactivation pattern than theme subjects, indicating that the overall looks to the visual target were significantly higher for the experiencer condition compared to the theme condition. Regarding time course, the experiencer condition displayed a negative cubic term at the late post-verb frame, thus indicating a decrease, followed by an increase and a subsequent decrease in looks to the visual target. Both agent and theme conditions showed a negative linear term and a positive cubic term, indicating that the looks to the visual target increased, decreased and then increased again throughout this timeframe. The observed patterns in magnitude of reactivation are compatible with PRH predictions (P4), as it was found that agent and experiencer subjects displayed a larger reactivation effect than theme subjects after the verb, with no significant differences between agent and experiencer conditions. By contrast, these results are not compatible with EDCH predictions (P3).

In the transitive model, I also found differences between conditions both in magnitude and time course of subject reactivation. As in the intransitive model, both agent and experiencer subjects displayed an equivalent reactivation pattern regarding magnitude of reactivation. That is, there were no differences in the overall height of the curve that indicates looks to the visual target between agent and experiencer conditions in this timeframe. However, experiencer subjects displayed a larger reactivation pattern than theme subjects, indicating that the overall looks to the visual target were significantly higher for the experiencer condition compared to the theme condition. Regarding time course, the experiencer condition also displayed a negative cubic term at the late post-verb frame, thus indicating a decrease, followed by an increase and a subsequent decrease in looks to the visual target. The theme condition showed a negative linear term, a positive quadratic term, a positive cubic term and a positive quartic term. This means that the average looks to the visual target displayed a sequence of increases and decreases twice throughout this timeframe. The agent condition displayed a positive quadratic term as well as a negative quartic term, thus indicating that the average looks to the visual target showed two consecutive increases and decreases during the course of this timeframe. Once again, the observed patterns in magnitude of reactivation are compatible with PRH predictions (P4), as it was found that agent and experiencer subjects displayed a larger reactivation effect than theme subjects after the verb, with no significant differences between agent and experiencer conditions. By contrast, these results are not compatible with EDCH predictions (P3).

The combined results from both sets of analyses reveal that transitive and intransitive experiencer subjects display largely equivalent processing patterns in terms of magnitude and time course of subject reactivation after the verb. When both of these conditions were compared with both agent and theme subjects in the post-hoc analysis, the results showed that the subject reactivation patterns of agents and assumed experiencers aligned, as no significant differences were found between the two conditions in either of the comparisons. By contrast, significant differences were found between theme subjects and assumed experiencer subjects, as the latter displayed a greater magnitude of subject reactivation in both comparisons. All in all, these findings lend support to the PRH, which claims that experiencers assume either a proto-agent or proto-patient thematic role based on semantic properties. In this manner, the obtained results suggest that the assumed experiencer subjects explored in this chapter are not experiencers at all, but rather form part of the proto-agent category proposed by Dowty (1991) in the PRH. As in Experiments 1 and 2, I suggest that the differences found between the transitive and intransitive psych predicate conditions at the early post-verb frame may be due to the differences in argument structure between conditions. Whereas intransitive subjects were the sole arguments of their verbs, transitive psych verbs also took an additional post-verbal argument. The lower magnitude of reactivation of the transitive subject in the early post-verb frame may be due to the cognitive demands that the processing of an additional argument imposes for this condition. However, I believe that the differences among psych verb conditions found in the early post-verb frame do not necessarily minimize the relevance of the regularities obtained in all the other comparisons in both timeframes, which otherwise reveal a consistent pattern of results.

6. Conclusion

This study presents new evidence of processing differences between sentential subjects in Spanish psych predicates by means of eye tracking in the VWP. Participants were presented with SV(O) spoken sentences with transitive and intransitive psych verbs while they viewed visual displays containing four simple pictures. In test trials, the visual target was strongly related to the sentential subject. During the experiment, the time course of gaze fixations to the visual display was monitored in order to explore the impact of psych verb type on sentential subject processing and the processing correlates of assumed experiencers. After the experiment, the gathered data was analyzed as originally intended, and subsequently combined with a selection of Experiment 2 data in order to compare experiencer subjects with both agent and theme subjects in a post-hoc analysis.

Two hypotheses were considered. On one hand, the EDCH, which predicts the same reactivation pattern for both experiencer conditions, a larger reactivation of agents than experiencers, and significant differences between experiencers and themes in their pattern of subject reactivation. This hypothesis is based on list-based theoretical accounts of thematic roles, which propose that experiencers constitute a distinct and discrete thematic role (Fillmore, 1971; Levin, 1993; Levin and Rappaport-Hovav, 2005; Pesetsky, 1995, inter alia). On the other hand, I considered the PRH, which predicts differences between the two experiencer conditions (under my original assumptions), a significant difference in magnitude of reactivation between experiencers and themes, and no differences between experiencers and agents. This hypothesis is based on Dowty's (1991) proto-role proposal. A small number of experimental studies present evidence that the arguments of canonical transitive predicates are significantly associated with the proto-agent and proto-patient properties proposed by the PRH (Kako, 2006; Reisinger et al., 2015). Regarding the EDCH, some psycholinguistic evidence suggests that experiencer arguments display several processing patterns, not a unified one; this is not supported by EDCH predictions (Brennan and Pylkkänen, 2010; Hartshorne et al., 2016; Gattei, París and Shalom, 2021; Do and Kaiser, 2022; Wilson and Dillon, 2022).

The main finding in Experiment 3 lies in the consistent differences in the magnitude of the reactivation effect between conditions in all the analyzed data frames and time windows. I interpret this difference in magnitude of reactivation as an indication of the amount of attentional resources or cognitive preference directed towards sentential subjects during sentence comprehension, which in Experiments 1 and 2 has been shown to correlate consistently with thematic differences. In the first analyses, transitive and intransitive experiencer subjects displayed largely the same pattern of reactivation, except for a short time window spanning around 600 ms immediately after verb offset, in which the intransitive condition displayed a greater magnitude of reactivation compared to the transitive condition. In the post-hoc analyses, agent subjects (unergative and transitive conditions) and experiencer subjects (intransitive and transitive conditions) displayed a larger reactivation effect than theme subjects (unaccusative condition) after the verb. These results reveal a common processing pattern shared between agents and experiencers, which differs from the processing pattern of themes. These findings can only be accounted for by the PRH. This hypothesis proposes that thematic roles have a prototype structure, and that there exist two proto-categories in thematic role assignment: proto-agents and proto-patients.

All in all, these results provide new evidence regarding the thematic role processing of sentential subjects of psych predicates in Spanish, which are commonly assumed to bear the experiencer role (Belletti and Rizzi, 1988; Martí and Fernández, 1992; Pesetsky, 1995; Arad, 1998; Vogel and Villada, 2000; Brunetti, 2009; Marín and McNally, 2011; Fábregas, Marín and McNally, 2012). Results show that sentential subjects of both transitive and intransitive psych predicates display a proto-agent processing pattern, equivalent to the processing pattern of agent subjects, and different from the processing pattern observed for theme subjects. Importantly, no unique experiencer pattern was found. Thus, Experiment 3 presents new findings supporting the view that thematic role processing involves the categorization of arguments into one of two proto-role categories, i.e., proto-agents or proto-patients (Dowty, 1991), by examining thematic role processing patterns using eye tracking in the VWP.

Chapter 5.
General conclusions

The present dissertation set out to investigate the processing of arguments in different predicate types in Spanish, a nominative-accusative language with highly limited case-marking morphology. The overall goal was to investigate the factors that determine the processing pattern of sentential subjects, as well as to explore the structure of thematic role categories in processing. Specifically, I focused on (a) whether and how thematic role impacts the processing patterns of sentential subjects in transitive and intransitive predicates (Chapter 2), (b) whether and how key semantic features such as animacy interact with thematic role in the processing patterns of said sentential subjects (Chapter 3), and (c) whether the gathered data can reveal information about how thematic roles are represented as cognitive categories in processing with respect to list-based or proto-role theories (Chapter 4). For that purpose, I gathered eye-tracking data using the Visual World Paradigm, as well as offline rating data in norming studies for the creation of experimental materials. In summary, the main contributions of this dissertation are the following:

1. I provided novel evidence that unaccusative and unergative sentential subjects display different processing patterns, with unergative and transitive subjects showing a shared processing pattern. Moreover, this difference in processing pattern is argued to reveal a difference in preference, streaming from the attentional resources devoted to the processing of agents and themes. This constitutes strong evidence that thematic role is a key factor that determines the activation of sentential subjects in processing, and that speakers display an attentional preference towards agents compared to themes.

2. I provided novel evidence that prototypicality of the sentential subjects significantly modulates processing patterns of agents and themes. In this manner, the interaction between the feature of animacy and thematic role played a significant role in the activation levels of the sentential subjects during sentence comprehension, with prototypical arguments (animate agents and

inanimate themes) being preferred over non-prototypical ones (inanimate agents and animate themes). In conjunction with these prototypicality effects, a general preference towards agents compared to themes was still observed.

3. I failed to find evidence of a unique experiencer role processing pattern in both transitive and intransitive psychological predicates. This finding is not compatible with list-based theories of thematic roles that propose the experiencer role as a unique and distinct thematic role category. By contrast, I found evidence of a shared processing pattern between agents and experiencer sentential subjects, both in transitive and intransitive psychological predicates. This validates the psycholinguistic consideration of a proto-role theory of thematic roles that is based upon a few proto-role categories, such as proto-agents and proto-patients, operating as cluster categories during thematic role assignment.

4. I showed that norming studies in which participants indicate the semantic associations between items by means of ratings on a scale do not necessarily predict the eye-gaze data of participants presented with auditory and visual stimuli consisting of those same items. This suggests that carrying out visual norming studies constitutes a better method than rating tasks for predicting eye-gaze data revealing the semantic associations between auditory and visual stimuli.

1. Main findings

In Chapter 2, I focused on the effect of thematic role in the processing of sentential subjects in unaccusative, unergative and transitive predicates. Psycholinguistic research investigating these predicate types consistently report finding differences between unaccusative and unergative predicates, which differ in the thematic role of their subjects, as unaccusatives take a theme as a single argument, while unergatives take an agent. The main point of disagreement in the literature has to do with the interpretation of such findings: while some have considered them as evidence for the Unaccusative Hypothesis (Kegl, 1995; Bever and Sanz, 1997; Burkhardt et al., 2003; M. Lee and Thompson, 2004; Friedmann et al., 2008; McAllister et al., 2009; J. Lee and Thompson, 2011; Koring et al., 2012; Meltzer-Asscher et al., 2015; Momma et al., 2018, *inter alia*), others view these results as evidence supporting the Agent First Hypothesis (Ferreira, 2003; Bornkessel and Schlesewsky, 2006a; Laka and Erdocia, 2012; Lamers, 2012; Bisang et al., 2013; Huang et al., 2013, *inter alia*). Importantly, no psycholinguistic investigation to date had been devoted to discriminating between the two hypotheses. In Experiment 1, I addressed this gap by investigating the processing patterns of agent (unergative and transitive conditions) and theme (unaccusative condition) sentential subjects during sentence comprehension. I used eye tracking in the VWP, which captured the visual attention that listeners spontaneously devoted towards visual objects related to the sentential subject. While the UH predicts a delayed reactivation of unaccusative subjects compared to unergatives after the presentation of the verb, the AFH predicts an overall larger reactivation of agent subjects than themes, with no delayed peak of reactivation in the unaccusative condition. Results show that the time course and magnitude of the gaze-fixation patterns are fully compatible with the predictions made by the AFH, but not with those of the UH, as agent subjects displayed a larger reactivation effect than theme subjects after verb offset, and no delayed peak of reactivation was found for theme subjects.

In Chapter 3, I investigated the effect of prototypicality in the processing of sentential subjects in unaccusative, unergative and transitive predicates. Prototypicality of an argument was determined by the interaction between two factors: (a) thematic role, and (b) animacy (Dowty, 1991; Bornkessel and Schlesewsky, 2006b; Bornkessel-Schlesewsky and Schlesewsky, 2009; Paczynski and Kuperberg, 2011). This interaction renders four combinations of prototypical or non-prototypical agents and themes: prototypical arguments (animate agents and inanimate themes) and non-prototypical ones (inanimate agents and animate themes). Prototypicality of arguments has been shown to strongly impact sentence processing, with prototypical mappings being preferred and/or less costly than non-prototypical ones (Angiolillo and Goldin-Meadow, 1982; Frisch and Schlesewsky, 2001; Traxler et al., 2005; Demiral et al., 2008; Philipp et al., 2008; Betancort et al., 2009; Bornkessel-Schlesewsky and Schlesewsky, 2009; Ibbotson and Tomasello, 2009; Bourguignon et al., 2012; Kretzschmar et al., 2012; Lowder and Gordon, 2012; Bickel et al., 2015; Muralikrishnan et al., 2015; Foley, 2020; Sauppe et al., 2023). Importantly, this factor was not considered in Experiment 1.

In Experiment 2, I entertained the possibility that prototypicality effects could account for Experiment 1 results without appealing to a general agent preference. I addressed this gap by investigating the processing patterns of prototypical and non-prototypical agent (unergative and transitive conditions) and theme (unaccusative conditions) sentential subjects using eye tracking in the VWP. I considered two hypotheses. First, the Agent Preference Hypothesis, as modulated by prototypicality effects, which predicts a larger magnitude of subject reactivation for prototypical conditions than non-prototypical ones, as well as a larger activation for prototypical agent compared to prototypical themes. Second, the Prototypicality Preference Hypothesis, which predicts a larger magnitude of subject reactivation for prototypical conditions than non-prototypical conditions overall, with no significant difference between prototypical agent and theme conditions. Results show that the time course and magnitude of the gaze-fixation patterns are compatible with the predictions made by the APH as modulated by prototypicality effects, but not with those of the PPH, as prototypical conditions elicited a larger reactivation effect than non-prototypical conditions, and prototypical agent conditions displayed a larger reactivation after the verb than the prototypical theme condition.

Taken together, evidence from Chapters 2 and 3 suggests that thematic role plays a determining role in the activation pattern of sentential subjects, as general agent preference is found; this is consistent with previous results in psycholinguistics, neurolinguistics, cognitive science and other related fields (Slobin, 1966; Goldin-Meadow and Feldman, 1977; Angiolillo and Goldin-Meadow, 1982; Goldin-Meadow, 2003; Dryer, 2005; Goldin-Meadow et al., 2008; Arunachalam and Waxman, 2010; Kemmerer, 2012; Cohn and Paczynski, 2013; Dryer and Haspelmath, 2013; Gómez-Vidal et al., 2022, *inter alia*). Importantly, I showed that this general agent preference is also modulated—but not overridden—by prototypicality. More precisely, results show that animate agents are preferred over animate themes, and that prototypical arguments (animate agents and inanimate themes) are preferred over non-prototypical ones (inanimate agents and animate themes). Still, prototypical agents (animate agents) are preferred over prototypical themes (inanimate themes). This indicates that the effect of thematic role on argument processing is stronger than that of prototypicality in the determination of processing patterns revealed by visual attention, and that appealing to a general agent preference modulated by prototypicality effects is needed in order to account for the ample constellation of results in previous works.

In Chapter 4, I tested the hypothesis that thematic role categories display a proto-role structure. For that purpose, I examined the processing of sentential subjects in both transitive and intransitive psychological predicates, which are commonly assumed to bear an experiencer thematic role (Fillmore, 1971; Nishigauchi, 1984; Belletti and Rizzi, 1988; Levin, 1993; Levin and Rappaport-Hovav, 1995; Pesetsky, 1995, *inter alia*). List-based theories of thematic roles claim that the experiencer role constitutes a discreet and distinct category (Fillmore, 1971; Nishigauchi, 1984; Belletti and Rizzi, 1988; Levin, 1993; Levin and Rappaport-Hovav, 1995; Pesetsky, 1995, *inter alia*), and therefore predict finding a distinctly unique processing pattern for experiencers, different from that of agents and themes. By contrast, proto-role accounts of thematic role assignment such as Dowty's (1991) claim that these arguments are either assigned a proto-agent or proto-patient thematic role based on semantic characteristics met by the argument. Importantly, the question of how thematic roles are structured as categories is a relevant topic that has not received much attention in the experimental literature investigating thematic role and argument structure processing. In fact, most of this body of research has been devoted to exploring processing differences across event participants, and not necessarily with the underlying mental representation of thematic roles as categories (Slobin, 1966; Angiolillo and Goldin-Meadow, 1982; Leslie and Keeble, 1987; Bates et al., 1988; Naigles, 1990; Bever and Sanz, 1997; Goldin-Meadow and Mylander, 1998; Burkhardt et al., 2003; M. Lee and Thompson, 2004; Saxe et al., 2005; Hamlin et al., 2007, 2011; Spelke and Kinzler, 2007; Friedmann et al., 2008; McAllister et al., 2009; Arunachalam and Waxman, 2010; Brennan and Pylkkänen, 2010; J. Lee and Thompson, 2011; Noble et al., 2011; Shetreet and Friedmann, 2012; Hafri et al., 2013; Siewierska, 2013; Meltzer-Asscher et al., 2015; Hartshorne et al., 2016; Rissman and Goldin-Meadow, 2017; Momma et al., 2018; Rissman and Majid, 2019; Gattei et al., 2021; Do and Kaiser, 2022; Gómez-Vidal et al., 2022; Wilson and Dillon, 2022, *inter alia*), with the exception of a few studies (Kako, 2006; Reisinger et al., 2015).

In Experiment 3, I addressed this gap by investigating the processing patterns of hypothesized experiencer sentential subjects in transitive and intransitive psychological predicates using eye tracking in the VWP. Initially, I assumed that there was a significant semantic difference between the transitive and intransitive conditions, according to which list-based accounts predict finding the same processing pattern for the sentential subject in both conditions, i.e., a unique experiencer pattern. By contrast, Dowty's (1991) Proto-Role Theory predicts finding different processing patterns for the sentential subject across conditions, i.e., a proto-agent pattern for the transitive condition and a proto-patient pattern for the intransitive condition. The first analyses showed that the transitive and intransitive conditions displayed largely the same processing pattern. At this point, I questioned my initial assumptions regarding the semantic properties of the experimental conditions, which critically affected the predictions of the considered hypotheses. To that end, I conducted a post-hoc analysis in which I combined Experiment 3 data with a selection of Experiment 2 data in order to compare experiencer subjects with both agent and theme subjects. Crucially, these comparisons allowed me to discriminate between the considered hypotheses independently of the correctness of my original assumptions. Results from the post-hoc analysis show that agent and experiencer subjects displayed the same processing pattern, which differed from the reactivation pattern of theme subjects. These results are consistent with Proto-Role Theory predictions, since a processing pattern common to agents and assumed experiencers was found, different from the processing pattern of themes. This constitutes evidence in favor of a proto-role view of thematic roles in language processing, in which a few maximally-different categories suffice to account for thematic role processing patterns during real-time sentence comprehension. Taken together, evidence from Chapters 2, 3 and 4 supports the existence of both agent and theme categories in the mental representation of speakers, revealing significant differences in their activation levels once the verb has been encountered; these differences in processing patterns are in accordance with previous results (Goldin-Meadow and Feldman, 1977; Angiolillo and Goldin-Meadow, 1982; Ferreira, 2003; Bornkessel and Schlesewsky, 2006a; Goldin-Meadow et al., 2008; Laka and Erdocia, 2012; Lamers, 2012; Bisang et al., 2013; Huang et al., 2013; Rissman and Majid, 2019, *inter alia*). Crucially, findings in Chapter 4 tentatively support the psycholinguistic validity of a proto-role approach for event participants, where there are only two major thematic role categories: proto-agent and proto-patient.

Finally, evidence from the norming studies included in Chapter 3 highlights the importance of selecting appropriate methodologies during the design phase of eye-tracking experimental research. Prior to Experiment 2, I conducted an online norming study in which participants rated the relationship between a word and a picture using a scale from 1-7. Results from said norming study indicated a main effect of animacy on the scale ratings, by which on average participants gave higher ratings to those pairs in which the word was an animate entity, compared to those pairs in which the word was inanimate. In order to examine whether this effect could be task contingent, I carried out a visual norming study in which I presented the pairs of items by means of the VWP while I recorded participants' spontaneous eye-gaze upon images. In this manner, words were presented auditorily and the corresponding pictures were shown as one of four drawings within a visual display. Results show that there was no significant difference in the magnitude or time course of fixations upon the related picture between the animate and inanimate conditions. This suggests that rating tasks do not constitute optimal predictors for eye-gaze data revealing fine-grained semantic associations between auditory and visual stimuli, and that opting for visual norming studies might constitute better methods for informing upon eye-tracking studies during design phases.

2. Future research

In Chapters 2 and 3, I have provided evidence that thematic role and its interaction with animacy are key factors determining the activation of sentential subjects, as they greatly impact argument reactivation patterns after verb offset. However, it is still unclear how these factors affect the processing of sentential objects in SVO languages like Spanish. Such an exploration would allow for the comparison of themes with different syntactic functions (e.g., unaccusative subjects compared to transitive objects), as well as themes in different argument structures (e.g., transitive objects compared to ditransitive objects). This, in turn, would allow researchers to tackle complex questions regarding (a) the processing impact of syntactic function while thematic role is kept constant, or (b) how thematic role assignment occurs in post-verbal arguments compared to preverbal ones. Moreover, it is still unclear whether all verbal arguments must be active in the mental representation of listeners at the same time for sentence comprehension to take place successfully and, if so, whether all arguments display the same level of activation or not. In this regard, it is possible that activation levels may be significantly affected by important factors such as cognitive salience, antecedent complexity or length of dependency. These questions should be addressed in future studies.

In Chapter 4, I have provided evidence supporting a proto-role account of thematic roles regarding the reactivation patterns of sentential subjects after verb offset. This evidence comes from Spanish, a nominative-accusative language with highly limited case-marking morphology; in fact, the linguistic stimuli created for data collection in this dissertation do not contain overt case-marking morphology in the critical arguments, i.e., the sentential subjects. Because of these characteristics, the psycholinguistic validity of a proto-role theory such as Dowty's (1991) should be further explored in future studies, especially in languages with rich case-marking morphology, such as Basque, and especially with respect to other traditionally-accepted thematic roles (e.g., instruments, goals, and sources) in order to obtain a more comprehensive understanding of argument structure processing and thematic role representation.

Appendix A.
Resumen en castellano

La investigación psicolingüística sobre la estructura argumental y los roles temáticos es esencial para la comprensión del lenguaje a nivel del predicado. A pesar de su centralidad en la teoría lingüística, pocos estudios han investigado directamente los roles temáticos en procesamiento (Bourguignon et al., 2012; Hafri, Papafragou y Trueswell, 2013; Kowalski y Huang, 2017; Sauppe et al., 2023; Ünal et al., 2024), lo que ha resultado en escasa evidencia sobre sus patrones de procesamiento y estructura subyacente como categorías cognitivas. En esta tesis doctoral, busco llenar este vacío investigando el procesamiento de los sujetos oracionales en diferentes estructuras argumentales en español. Específicamente, investigo dos factores (el rol temático y la prototipicidad) que afectan a la activación de los sujetos oracionales en la representación mental de los hablantes durante la comprensión de oraciones, y cómo estos patrones pueden aportar información sobre la estructura de los roles temáticos como categorías cognitivas. Utilizando el seguimiento ocular y el Paradigma del Mundo Visual, llevé a cabo tres experimentos que exploran (a) el impacto del rol temático (Capítulo 2) y la prototipicidad (Capítulo 3) en los patrones de procesamiento de los sujetos en predicados inacusativos, inergativos y transitivos, y (b) el procesamiento de los sujetos oracionales en predicados psicológicos para investigar la representación de los roles temáticos como categorías cognitivas (Capítulo 4). Los resultados muestran una preferencia general por los agentes, modulada por la prototipicidad, en el procesamiento de los sujetos oracionales en oraciones inacusativas, inergativas y transitivas. Además, presento evidencia compatible con una teoría de proto-roles temáticos, encontrando que los sujetos agentes y los sujetos experimentantes comparten un mismo patrón de procesamiento, distinto al de los sujetos tema.

1. Resumen de los capítulos

Capítulo 2

Los predicados intransitivos se clasifican en dos grupos dependiendo del rol temático de su único argumento (Perlmutter, 1978). Así, en los predicados inacusativos el argumento recibe el rol de *tema* (1), mientras que en los predicados inergativos el argumento recibe el rol de *agente* (2).

(1) La atleta cayó.

(2) La atleta corrió.

Esta clasificación fue propuesta para dar cuenta sistemáticamente de las propiedades heterogéneas observadas dentro de la clase de predicados intransitivos. Más concretamente, se ha observado que los predicados inacusativos e inergativos muestran propiedades sintácticas diferentes, especialmente en lo que respecta a la marcación de caso, orden de palabras o selección de verbos auxiliares (ver Perlmutter, 1978, para una discusión completa). La exploración de estas diferencias sintácticas y semánticas culminó en la formulación de la *Hipótesis Inacusativa* (HI, de aquí en adelante), que sostiene que la sintaxis de los predicados inacusativos (1) es más compleja que la de los inergativos (2) (Perlmutter, 1978; Burzio, 1986).

La investigación psicolingüística que ha puesto a prueba la HI ha encontrado diferencias en procesamiento entre los predicados inacusativos e inergativos. Estos estudios presentan resultados que reflejan un mayor coste de procesamiento para los predicados inacusativos en comparación con los inergativos. Esto, a su vez, apoya la idea de que los predicados inacusativos entrañan una mayor complejidad sintáctica (Kegl, 1995; Bever y Sanz, 1997; Burkhardt, Piñango y Wong, 2003; M. Lee y Thompson, 2004; Friedmann et al., 2008; McAllister et al., 2009; J. Lee y Thompson, 2011; Koring, Mak y Reuland, 2012; Meltzer-Asscher et al., 2015; Momma, Slevc y Phillips, 2018).

No obstante, otras líneas de investigación que también exploran el procesamiento de predicados con temas y agentes no hacen mención alguna a la HI en su interpretación de los resultados, a pesar de que encuentran diferencias significativas entre las condiciones. Por ejemplo, en procesamiento oracional, se ha encontrado evidencia de una preferencia por los agentes como argumento inicial en contextos sintácticos ambiguos en diversas lenguas, incluyendo el inglés, alemán, euskera y mandarín (Ferreira, 2003; Bornkessel y Schlesewsky, 2006a; Laka y Erdocia, 2012; Lamers, 2012; Bisang, Wang y Bornkessel-Schlesewsky, 2013; Huang et al., 2013). Estos resultados son interpretados como evidencia a favor de la *Hipótesis de Agente Inicial* (HAI, de aquí en adelante), que sostiene que los hablantes prefieren procesar la primera frase nominal ambigua de una oración como un agente. Los estudios de adquisición encuentran también un resultado similar, especialmente en estudios de producción, en los que se presenta evidencia de que los niños prefieren producir estructuras de agente inicial, tanto en la modalidad oral como signada del lenguaje (Goldin-Meadow y Feldman, 1977; Angiolillo y Goldin-Meadow, 1982; Goldin-Meadow y Mylander, 1998). Por último, estudios en el campo de percepción de eventos que emplean metodologías de seguimiento ocular encuentran que los participantes muestran diferencias significativas en relación a las fijaciones (i.e. el mantenimiento de la mirada en un punto fijo durante alrededor de 200 ms o más) al observar ilustraciones estáticas o dinámicas con dos participantes. De este modo, los estudios informan de una serie de efectos: (a) preferencia a realizar las primeras fijaciones sobre agentes comparado con temas (Webb, Knott y MacAskill, 2010), (b) reconocimiento del rol temático más temprano y/o rápido para agentes comparado con temas (Segalowitz, 1982), y (c) preferencia atencional global hacia los agentes comparado con los temas (Robertson y Suci, 1980; Hamlin, Wynn y Bloom, 2007; Hamlin et al., 2011; Cohn y Paczynski, 2013).

En conjunto, la evidencia presentada por estos estudios revela una serie de fenómenos implicados en el procesamiento diversos que se han considerado como evidencia favorable a dos hipótesis diferentes, la HI y la HAI. Determinar cuál de estas dos hipótesis es más consistente con los resultados obtenidos es una de las tareas pendientes de la psicolingüística actual. Con el objetivo de llenar este vacío en la literatura experimental, llevé a cabo el Experimento 1, en el que consideré las predicciones de ambas hipótesis en un mismo experimento. En este experimento, exploré los patrones de procesamiento de sujetos preverbales con diferente rol temático, en un total de tres condiciones experimentales: (i) predicados inacusativos, cuyo sujeto es un tema; (ii) predicados inergativos, cuyo sujeto es un agente; y (iii) predicados transitivos, cuyo sujeto es un agente.

Como metodología, empleé la técnica de seguimiento ocular dentro del Paradigma del Mundo Visual (PMV, de aquí en adelante), que consiste en la presentación simultánea de estímulos auditivos y estímulos visuales. La metodología empleada fue, a grandes rasgos, la misma para todos los experimentos de esta tesis doctoral (Experimentos 1-3).

El funcionamiento de los experimentos según esta metodología es como sigue. Los participantes escuchan oraciones a la vez que ven estímulos en una pantalla; cada oración se presenta junto a cuatro imágenes estáticas. En los ítems experimentales, el sujeto de la oración (ej., *el ratón*) está semánticamente relacionado con una de las imágenes en la pantalla (ej. un dibujo de un queso).

Este método permite capturar la atención visual que los participantes dedican de manera espontánea hacia los diferentes objetos visuales de la pantalla de manera precisa y sincronizada con el estímulo auditivo (Tanenhaus, 2007). La mayor proporción de fijaciones sobre los objetos semánticamente relacionados con el estímulo auditivo se interpreta como indicativa de diversos procesos cognitivos, especialmente relativos a la representación, activación y atención de ítems léxicos en la mente de los hablantes (Tanenhaus, 2007). Por tanto, en los Experimentos 1-3, interpreté la proporción de fijaciones sobre el objeto visual semánticamente relacionado con el sujeto de la oración como una medida relativa a la activación de ese ítem léxico en la representación mental de los participantes del experimento. Siguiendo a Koring, Mak y Reuland (2012), asumo que los sujetos preverbales deben ser reactivados después de la presentación del verbo para integrar a ambos en una única representación mental, y poder así interpretar el evento.

Las hipótesis consideradas fueron dos. En primer lugar, la HI, que predice una reactivación retardada del sujeto inacusativo después del verbo, pero no del sujeto inergativo o transitivo. Esto es porque la HI sostiene que el sujeto de los predicados inacusativos empieza la derivación como objeto de la oración y que, por tanto, experimenta un paso extra en su derivación para lexicalizarse como sujeto (Perlmutter, 1978; Burzio, 1986). Este paso adicional en su derivación sintáctica predice encontrar una reactivación del sujeto preverbal después del verbo en procesamiento, ya que esta es la posición base de este argumento de acuerdo con la HI. En segundo lugar, la HAI predice una reactivación de mayor magnitud para sujetos agentes (condiciones inergativa y transitiva) que para sujetos tema (condición inacusativa) después del verbo. Esto se debe a que la HAI propone una preferencia por asignar el rol de agente a la primera frase nominal ambigua de una oración, ya que los hablantes muestran una preferencia atencional hacia los agentes en comparación a los temas. Es importante recordar que, dentro del PMV, y teniendo en cuenta el diseño del Experimento 1, las fijaciones sobre el objeto visual revelan el transcurso de la activación del sujeto semánticamente relacionado en la mente de los participantes. Por ello, sostengo que observar una diferencia en la magnitud del efecto de reactivación del sujeto después del verbo puede ser interpretada como una diferencia significativa en los recursos atencionales que los participantes dedican hacia el sujeto de la oración. Esta, a su vez, releva diferencias en términos de preferencia.

Los resultados obtenidos muestran que tanto el transcurso temporal como la magnitud del efecto de reactivación son plenamente compatibles con las predicciones de la HAI, pero no con las de la HI. Esto es así porque encontré una mayor proporción de fijaciones al objecto visual semánticamente relacionado con el sujeto de la oración cuando este era un agente (condiciones inergativa y transitiva) que cuando era un tema (condición inacusativa). Además, no encontré evidencia de un pico de reactivación retardado en la condición inacusativa, tal y como predice la HI. En conjunto, esta evidencia es compatible con una preferencia atencional hacia los agentes en comparación a los temas.

Capítulo 3

El objetivo principal de este capítulo es investigar el efecto de la prototipicidad en el procesamiento de los sujetos inacusativos, inergativos y transitivos. La prototipicidad es un concepto clave en psicología, ciencia cognitiva y lingüística, haciendo referencia a cuán típico o representativo es un elemento con respecto a la categoría a la que pertenece. En el caso de los argumentos verbales, la prototipicidad de un argumento se determina principalmente a través de la interacción de dos factores: (i) papel temático y (ii) animacidad (Dowty, 1991; Bornkessel y Schlesewsky, 2006a; Bornkessel-Schlesewsky y Schlesewsky, 2009; Paczynski y Kuperberg, 2011). De este modo, los agentes prototípicos son animados, mientras que los agentes no prototípicos son inanimados. Por el contrario, los temas prototípicos son inanimados, mientras que los temas no prototípicos son animados.

La evidencia experimental sugiere que tanto la animacidad como la prototipicidad de los argumentos verbales tienen un gran impacto en el procesamiento de las oraciones, ya que los resultados apuntan a una preferencia hacia entidades animadas comparadas con las inanimadas (Kriegeskorte et al., 2008; Poulin-Dubois, Crivello y Wright, 2015; Abdai et al., 2017), así como una preferencia a los argumentos prototípicos en comparación a los no prototípicos (Bourguignon et al., 2012; Kretzschmar et al., 2012; Lowder y Gordon, 2012; Bickel et al., 2015; Muralikrishnan et al., 2015; Foley, 2020; Sauppe et al., 2023). Precisamente, la prototipicidad no fue considerada como factor en el diseño del Experimento 1, ya que todos los sujetos eran animados, lo que derivó en la comparación entre argumentos prototípicos (condiciones inergativa y transitiva) con argumentos no prototípicos (condición inacusativa).

Por todo ello, en el capítulo 3 consideré la posibilidad de que los resultados obtenidos en el Experimento 1 pudieran explicarse aludiendo a un efecto de prototipicidad en procesamiento, sin apelar por tanto a una preferencia agentiva. Para ello, llevé a cabo el Experimento 2, en el que exploré los patrones de procesamiento de sujetos oracionales modulando su prototipicidad, i.e. la interacción entre animacidad y rol temático. Como estímulos lingüísticos, utilicé predicados inacusativos, inergativos y transitivos, en los que modulé la prototipicidad del sujeto preverbal. Esto me permitió comparar los patrones de reactivación postverbal de seis condiciones experimentales: sujetos inacusativos prototípicos (temas inanimados), sujetos inacusativos no prototípicos (temas animados), sujetos inergativos prototípicos (agentes animados), sujetos inergativos no prototípicos (agentes inanimados), sujetos transitivos prototípicos (agentes animados), y sujetos transitivos no prototípicos (agentes inanimados). Como metodología, empleé el seguimiento ocular dentro del PMV, de modo que el Experimento 2 funcionaba de acuerdo a lo ya establecido en el capítulo 2.

Consideré dos hipótesis. En primer lugar, la *Hipótesis de Preferencia Agentiva modulada por efectos de prototipicidad* (HPA*p, de aquí en adelante), que propone una preferencia atencional general hacia los agentes comparados con los temas, modulada por la prototipicidad de los argumentos. Esta hipótesis predice encontrar una mayor magnitud de reactivación en las condiciones prototípicas comparadas a las no prototípicas, así como una mayor magnitud de reactivación en los agentes prototípicos comparados con los temas prototípicos. En segundo lugar, la *Hipótesis de Preferencia de Prototipicidad* (HPP, de aquí en adelante) propone una preferencia atencional general hacia los argumentos prototípicos comparados con los no prototípicos. Esta hipótesis predice encontrar una mayor magnitud de reactivación en las condiciones prototípicas comparadas a las no prototípicas, sin diferencias significativas entre agentes y temas prototípicos.

Los resultados obtenidos muestran unos patrones de reactivación compatibles con las predicciones de la HPA*p, pero no con las de la HPP. Esto es así porque encontré una mayor magnitud de reactivación de los sujetos en condiciones prototípicas comparadas con las no prototípicas, así como una mayor magnitud de reactivación en los agentes prototípicos que en los temas prototípicos. Estos resultados muestran evidencia de una preferencia atencional general hacia los agentes modulada por la prototipicidad ya que, aunque se encuentra que los argumentos prototípicos son preferidos ante los no prototípicos, entre las condiciones prototípicas los agentes son preferidos ante los temas.

Capítulo 4

El principal objetivo de este capítulo es investigar los patrones de procesamiento de sujetos de predicados psicológicos transitivos e intransitivos. Los predicados psicológicos son aquellos cuyos verbos denotan una emoción o estado mental de uno de sus argumentos (ej. *amar*, *divertirse*, etc.). Muchas teorías de roles temáticos sostienen que los verbos psicológicos asignan el rol temático de experimentante a uno de sus argumentos (Fillmore, 1971; Nishigauchi, 1984; Belletti y Rizzi, 1988; Levin, 1993; Levin y Rappaport-Hovav, 1995; Pesetsky, 1995, *inter alia*). Estas teorías asumen que los papeles temáticos conforman categorías discretas y distintivas unas de otras, y proponen una lista de roles temáticos (ej. agente, paciente, tema, experimentante, instrumento, etc.) para dar cuenta de las relaciones sistemáticas entre propiedades semánticas y las realizaciones sintácticas de los argumentos. Estas ideas sobre la naturaleza de roles temáticos como categorías no son compartidas por las teorías de proto-roles (Dowty, 1991; Ackerman y Moore, 2001). Más concretamente, la *Hipótesis de Proto-roles* (HPR, de aquí en adelante) de Dowty (1991) gira alrededor de dos proto-categorías: el proto-agente y el proto-paciente. Esta visión sobre los papeles temáticos propone que estas dos proto-categorías son suficientes para dar cuenta de la realización temática de todos los argumentos verbales, y por tanto sostiene que los argumentos de predicados psicológicos, que otras teorías consideran como experimentantes, son en realidad proto-agentes o proto-pacientes en función de sus propiedades semánticas.

Aunque los papeles temáticos han recibido alguna atención experimental (Altmann, 1999; Manouilidou et al., 2009; Bourguignon et al., 2012; Kowalski y Huang, 2017; Sauppe et al., 2023), la mayoría de esta investigación no los estudia directamente, sino que hace referencia a ellos por tener relación con su objeto de estudio principal (Kelly, Bock y Keil, 1986; Trueswell, Tanenhaus y Garnsey, 1994; Boland et al., 1995; Altmann, 1999; Frisch y Schlesewsky, 2001; Dahan y Tanenhaus, 2004; Kretzschmar et al., 2012; Buckle, Lieven y Theakston, 2017, *inter alia*). Por ello, la cuestión de cómo se estructuran los roles temáticos en tanto que categorías cognitivas es un tema de gran relevancia para la psicolingüística y la ciencia cognitiva que apenas ha recibido atención en la literatura experimental.

El objetivo principal del Experimento 3 es llenar este vacío experimental mediante la investigación de los patrones de procesamiento de los sujetos de predicados psicológicos transitivos e intransitivos. Como metodología, empleé el seguimiento ocular en conjunción con el PMV, siguiendo el método descrito en el capítulo 2. Comparé dos condiciones experimentales: (i) predicados con verbos psicológicos intransitivos (ej. *divertirse*), y (ii) predicados con verbos psicológicos transitivos (ej. *amar*). Inicialmente, asumí que estas dos condiciones difieren en sus propiedades semánticas, de tal modo que el sujeto de la condición intransitiva experimenta un cambio de estado, pero el de la condición transitiva no lo hace (Martí y Fernández, 1992; Arad, 1998). Este punto es crucial en relación a las predicciones de la HPR sobre los datos, ya que se asume que el sujeto transitivo solo cumple con entrañamientos de proto-agente, mientras que el sujeto intransitivo cumple con un entrañamiento de proto-agente y uno de proto-paciente.

Consideré dos hipótesis. En primer lugar, la *Hipótesis del Experimentante como Categoría Distintiva* (HECD, de aquí en adelante), según las ideas de teorías de roles temáticos basadas en listas (Fillmore, 1971; Nishigauchi, 1984; Belletti y Rizzi, 1988; Levin, 1993; Levin y Rappaport-Hovav, 1995; Pesetsky, 1995, *inter alia*). Esta hipótesis sostiene que el experimentante es un rol temático discreto y distintivo con respecto a otros papeles temáticos (ej. agentes, temas, etc.). Esta hipótesis predice encontrar un patrón de procesamiento propio de los experimentantes en ambas condiciones experimentales, sin diferencias significativas entre condiciones. En segundo lugar, consideré la HPR, que sostiene que los argumentos verbales reciben el papel temático de proto-agente o proto-paciente en función de sus propiedades semánticas. De este modo, y asumiendo que los sujetos de la condición intransitiva experimentan un cambio de estado (Dowty, 1991), esta hipótesis predice encontrar un patrón de reactivación de proto-agente en la condición transitiva, y un patrón de reactivación que se corresponda con un mayor coste de procesamiento para la condición intransitiva. Esto es porque el sujeto de la condición intransitiva cumpliría con ambos proto-roles en un mismo grado, proto-agente y proto-paciente, asumiendo que tiene un entrañamiento de ambas categorías: *capacidad de sentir* (proto-agente) y *cambio de estado* (proto-paciente). En cambio, el sujeto de la condición transitiva solo cumple con un entrañamiento de proto-agente: *capacidad de sentir*. Dado que en los Experimentos 1 y 2 encontré evidencia de que los agentes se corresponden con un patrón de procesamiento de mayor magnitud que otros roles, la HPR predice una mayor magnitud de reactivación del sujeto transitivo comparado con el intransitivo después del verbo.

Los resultados indican que ambas condiciones muestran principalmente el mismo patrón de procesamiento, aunque se observan diferencias significativas en la ventana temporal más temprana analizada. Además, consideré importante cuestionar en este punto mi suposición inicial sobre la diferencia semántica entre condiciones, por afectar esta críticamente las predicciones de las hipótesis consideradas, y por ser este un tema controvertido en la literatura (Marín y McNally, 2011). Para ello, llevé a cabo un análisis post-hoc en el que combiné una selección de los datos del Experimento 2 con los datos del Experimento 3 para comparar los sujetos de predicados psicológicos con los sujetos inacusativos, inergativos y transitivos ya explorados. Estas condiciones experimentales se incluyeron con el objetivo de poder interpretar los resultados como favorables a una u otra de las hipótesis consideradas, independientemente de la corrección de mi suposición inicial sobre el cambio de estado en los predicados psicológicos. Con estos datos, la HECD predice encontrar un patrón de procesamiento distintivo para los sujetos de predicados psicológicos (i.e. hipotéticos experimentantes), diferente del de los agentes y los temas. Por otro lado, la HPR predice encontrar el mismo patrón de procesamiento para los sujetos de predicados psicológicos y los sujetos de predicados inergativos y transitivos, ya que todos estos sujetos cumplen con los entrañamientos de proto-agente. Además, esta hipótesis predice encontrar diferencias significativas entre el patrón de procesamiento de estos sujetos y los sujetos inacusativos, que cumplen con los entrañamientos de proto-paciente.

Los resultados indican que los sujetos de predicados psicológicos comparten un mismo patrón de procesamiento con los sujetos de predicados inergativos y transitivos, mostrando a su vez una mayor magnitud de reactivación que los sujetos de predicados inacusativos. Estos resultados constituyen evidencia favorable a la HPR, ya que se encuentra un patrón de procesamiento común a sujetos que cumplen con los entrañamientos de proto-agente, y este patrón es distinto del de los sujetos que cumplen los entrañamientos de proto-paciente.

2. Contribuciones principales

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

1. Presento evidencia de que los sujetos inacusativos e inergativos muestran patrones de procesamiento diferentes, y que, además, los sujetos inergativos y transitivos muestran un mismo patrón de procesamiento. En relación a la interpretación de estos resultados, defiendo que esta diferencia en los patrones de procesamiento revela una diferencia en la preferencia a dichos argumentos verbales, derivada de los recursos atencionales que los parti-

cipantes dedican al procesamiento de agentes y temas. Esto constituye evidencia sólida de que el rol temático de los argumentos verbales es un factor clave que determina la activación de los mismos durante el procesamiento, y que los hablantes muestran una preferencia atencional hacia los agentes en comparación con los temas.

2. Presento evidencia de que la prototipicidad de los sujetos preverbales modula significativamente los patrones de procesamiento de agentes y temas. De esta manera, la interacción entre el rasgo de animacidad y el rol temático tiene un impacto significativo en los niveles de activación de los sujetos durante la comprensión de oraciones, siendo los argumentos prototípicos (agentes animados y temas inanimados) preferidos sobre los no prototípicos (agentes inanimados y temas animados). Junto con estos efectos de prototipicidad, se observa también una preferencia general hacia los agentes en comparación con los temas.

3. No he encontrado evidencia de un patrón de procesamiento único para el rol de experimentante en predicados psicológicos, tanto transitivos como intransitivos. Este hallazgo no es compatible con las teorías basadas en listas de roles temáticos, que proponen el rol de experimentante como un papel temático distintivo y descomponible en rasgos discretos. Por el contrario, sí presento evidencia de un patrón de procesamiento compartido entre los agentes y los hipotéticos experimentantes, tanto en predicados psicológicos transitivos como intransitivos. Esto valida la consideración psicolingüística de una teoría de proto-roles de los papeles temáticos, basada en dos proto-roles, i.e. proto-agente y proto-paciente, los cuales operan como proto-categorías durante la asignación de roles temáticos.

4. Muestro evidencia de que los estudios normativos en los que los participantes indican las asociaciones semánticas entre elementos mediante valoraciones en una escala no predicen de forma óptima los datos de seguimiento ocular de participantes expuestos a estímulos auditivos y visuales consistentes en esos mismos elementos. Esto sugiere que la realización de estudios normativos visuales constituye un mejor método que las tareas de calificación para predecir los datos de seguimiento ocular que revelan las asociaciones semánticas entre estímulos auditivos y visuales.

Appendix B.
Supplementary materials to Chapter 2

1. Norming study results showing mean ratings of the strongly-related noun pairs

Noun 1	Noun 2	Mean rating
anciano 'old man'	*bastón* 'cane'	4,69
arquero 'archer'	*flecha* 'arrow'	4,98
barbero 'barber'	*barba* 'beard'	4,87
barrendero 'sweeper'	*escoba* 'broom'	4,87
bebé 'baby'	*biberón* 'baby bottle'	4,87
bombero 'firefighter'	*camión de bomberos* 'firetruck'	4,98
canario 'canary'	*jaula de pájaro* 'bird cage'	4,7
cantante 'singer'	*micrófono* 'microphone'	4,81
carpintero 'carpenter'	*madera* 'wood'	4,76
cartero 'mailman'	*buzón* 'mailbox'	4,92
científico 'scientist'	*microscopio* 'microscope'	4,63
conductor 'driver'	*coche* 'car'	4,85
conejo 'rabbit'	*zanahoria* 'carrot'	4,7
costurera 'seamstress'	*aguja de coser* 'sewing needle'	4,92
electricista 'electrician'	*bombilla* 'light bulb'	4,72
escritor 'writer'	*máquina de escribir* 'typewriter'	4,69

Noun 1	Noun 2	Mean rating
explorador 'explorer'	*mapa* 'map'	4,9
gallina 'hen'	*huevo* 'egg'	4,96
leñador 'lumberjack'	*tronco* 'log'	4,9
limpiadora 'cleaner'	*fregona* 'mop'	4,63
marinero 'sailor'	*barco* 'ship'	4,94
músico 'musician'	*violín* 'violin'	4,69
oculista 'oculist'	*gafas* 'glasses'	4,9
pájaro 'bird'	*nido* 'nest'	4,96
párroco 'priest'	*iglesia* 'church'	4,94
peluquera 'hairdresser'	*peine* 'comb'	4,92
percusionista 'drummer'	*tambor* 'drum'	4,81
perro 'dog'	*hueso* 'bone'	4,8
pescador 'fisherman'	*caña de pescar* 'fishing pole'	4,87
piloto 'pilot'	*avión*' airplane'	4,96
preso 'inmate'	*esposas* 'handcuffs'	4,63
ratón 'mouse'	*queso* 'cheese'	4,72
reina 'queen'	*corona* 'crown'	4,9
sacerdote 'priest'	*cruz*' cross'	4,74

2. Norming study results showing mean ratings of the weakly-related noun pairs

Noun 1	Noun 2	Mean rating
asesino 'murderer'	*microscopio* 'microscope'	0,67
atleta 'athlete'	*mapa* 'map'	0,67
bebé 'baby'	*barba* 'beard'	0,27
cachorro 'puppy'	*nido* 'nest'	0,72
chico 'boy'	*bastón* 'cane'	0,41
chimpancé 'chimpanzee'	*queso* 'cheese'	0,29
doctor 'doctor'	*caña de pescar* 'fishing pole'	0,32
directora 'principal'	fregona 'mop'	0,3
empresaria 'business woman'	*aguja de coser* 'sewing needle'	0,67
entrenador 'coach'	*coche* 'car'	0,78
estudiante 'student'	*tambor* 'drum'	0,5
florista 'florist'	*flecha* 'arrow'	0,16
frutera 'green grocer'	*gafas* 'glasses'	0,69
gimnasta 'gymnast'	*micrófono* 'microphone'	0,14
hámster 'hamster'	*hueso* 'bone'	0,38
informático 'computer technician'	*cruz* 'cross'	0,25
jirafa 'giraffe'	*jaula de pájaro* 'bird cage'	0,07
lémur 'lemur'	*biberón* 'baby bottle'	0,23
lince 'lynx'	*zanahoria* 'carrot'	0,34
logopeda 'speech therapist'	*camión de bomberos* 'firetruck'	0,07
marmota 'groundhog'	*huevo* 'egg'	0,25

Noun 1	Noun 2	Mean rating
matemático ‘mathematician’	*tronco* ‘log’	0,21
modista ‘dressmaker’	*buzón* ‘mailbox’	0,2
paciente ‘patient’	*escoba* ‘broom’	0,12
periodista ‘journalist’	*madera* ‘wood’	0,21
pianista ‘pianist’	*bombilla* ‘light bulb’	0,29
pintor ‘painter’	*avión* ‘plane’	0,34
policía ‘police officer’	*peine* ‘comb’	0,45
presentador ‘host’	*barco* ‘ship’	0,21
psicólogo ‘psychologist’	*esposas* ‘handcuffs’	0,3
rehén ‘hostage’	*corona* ‘crown’	0,12
revisor ‘reviser’	*iglesia* ‘church’	0,21
taxista ‘taxi driver’	*violín* ‘violin’	0,2
viajero ‘traveler’	*máquina de escribir* ‘typewriter’	0,81

3. Norming study results showing mean ratings of the weakly-related verb-noun pairs

Noun	Verb	Mean rating
anciano ‘old man’	*gritar* ‘shout’	1,72
anciano ‘old man’	*llegar* ‘arrive’	1
arquero ‘archer’	*aparecer* ‘appear’	0,54
arquero ‘archer’	*pasar* ‘go by’	0,4
asesino ‘murderer’	*llevar* ‘carry, wear’	0,69
atleta ‘athlete’	*matar* ‘kill’	0,09
barbero ‘barber’	*bailar* ‘dance’	0,27
barbero ‘barber’	*traer* ‘bring’	0,36
barrendero ‘sweeper’	*arreglar* ‘fix’	1,05
bebé ‘baby’	*arreglar* ‘fix’	0,2
bebé ‘baby’	*bailar* ‘dance’	0,87
bebé ‘baby’	*traer* ‘bring’	0,58
bombero ‘firefighter’	*girar* ‘turn’	0,8
bombero ‘firefighter’	*tocar* ‘play’	0,45
cachorro ‘puppy’	*morir* ‘die’	1,2
cachorro ‘puppy’	*saltar* ‘jump’	1,98
canario ‘canary’	*nadar* ‘swim’	0,12
canario ‘canary’	*pasar* ‘go by’	0,23
cantante ‘singer’	*limpiar* ‘clean’	0,18
cantante ‘singer’	*llamar* ‘call’	0,63
carpintero ‘carpenter’	*andar* ‘walk’	0,74

Noun	Verb	Mean rating
carpintero ‘carpenter’	*nacer* ‘be born’	0,63
cartero ‘mailman’	*comer* ‘eat’	1,05
cartero ‘mailman’	*contar* ‘tell, count’	1,6
chico ‘boy’	*gritar* ‘shout’	1,83
chico ‘boy’	*llegar* ‘arrive’	0,98
chimpancé ‘chimpanzee’	*caer* ‘fall’	0,87
chimpancé ‘chimpanzee’	*nacer* ‘be born’	1,52
científico ‘scientist’	*llevar* ‘carry, wear’	0,5
conductor ‘driver’	*pasear* ‘stroll’	1,6
conejo ‘rabbit’	*crecer* ‘grow’	1,67
conejo ‘rabbit’	*girar* ‘turn’	0,56
costurera ‘seamstress’	*correr* ‘run’	0,56
costurera ‘seamstress’	*desaparecer* ‘disappear’	0,25
doctor ‘doctor’	*limpiar* ‘clean’	1,29
doctor ‘doctor’	*morir* ‘die’	1,43
directora ‘principal’	*preparar* ‘prepare’	1,83
electricista ‘electrician’	*andar* ‘walk’	0,7
electricista ‘electrician’	*llevar*’ carry, wear’	0,74
empresaria ‘business woman’	*correr* ‘run’	0,96
empresaria ‘business woman’	*desaparecer* ‘disappear’	0,47
entrenador ‘coach’	*pasear* ‘stroll’	1,2
escritor ‘writer’	*matar* ‘kill’	1,01
escritor ‘writer’	*nadar* ‘swim’	0,34

Noun	Verb	Mean rating
estudiante ‘student’	*preparar* ‘prepare’	1,32
explorador ‘explorer’	*matar* ‘kill’	0,47
florista ‘florist’	*aparecer* ‘appear’	0,32
florista ‘florist’	*pasar* ‘go by’	0,29
frutera ‘green grocer’	*pasear* ‘stroll’	0,7
frutera ‘green grocer’	*salir* ‘go out’	0,5
gallina ‘hen’	*correr* ‘run’	1,85
gallina ‘hen’	*desaparecer* ‘disappear’	0,49
gimnasta ‘gymnast’	*limpiar* ‘clean’	0,27
gimnasta ‘gymnast’	*llamar* ‘call’	0,4
hámster ‘hamster’	*caer* ‘fall’	0,69
hámster ‘hamster’	*caminar* ‘walk’	1,69
informático ‘computer technician’	*despertar* ‘wake up’	0,5
informático ‘computer technician’	*tocar* ‘touch’	0,9
jirafa ‘giraffe’	*nadar* ‘swim’	0,21
jirafa ‘giraffe’	*pasar* ‘go by’	0,49
lémur ‘lemur’	*arreglar* ‘fix’	0,03
leñador ‘lumberjack’	*gritar* ‘shout’	1,34
leñador ‘lumberjack’	*salir* ‘go out’	0,58
limpiadora ‘cleaner’	*preparar* ‘prepare’	1,5
lince ‘lynx’	*crecer* ‘grow’	1,76
lince ‘lynx’	*girar* ‘turn’	0,49
logopeda ‘speech therapist’	*girar* ‘turn’	0,2

Noun	Verb	Mean rating
logopeda 'speech therapist'	*tocar* 'touch'	0,43
marinero 'sailor'	*aparecer* 'appear'	0,96
marinero 'sailor'	*caminar* 'walk'	0,96
marmota 'groundhog'	*correr* 'run'	1,14
marmota 'groundhog'	*desaparecer* 'disappear'	0,63
matemático 'mathematician'	*gritar* 'shout'	0,54
matemático 'mathematician'	*salir* 'go out'	0,67
modista 'dressmaker'	*comer* 'eat'	1,18
modista 'dressmaker'	*contar* 'tell, count'	1,2
músico 'musician'	*hablar* 'speak'	1,61
músico 'musician'	*llegar* 'arrive'	0,9
oculista 'oculist'	*pasear* 'stroll'	0,58
oculista 'oculist'	*salir* 'go out'	0,52
paciente 'patient'	*arreglar* 'fix'	1,34
pájaro 'bird'	*morir* 'die'	1,49
pájaro 'bird'	*saltar* 'jump'	1,38
párroco 'priest'	*llamar* 'call'	1,52
peluquera 'hairdresser'	*comer* 'eat'	1,1
peluquera 'hairdresser'	*contar* 'tell, count'	1,43
percusionista 'drummer'	*preparar* 'prepare'	1,7
percusionista 'drummer'	*andar* 'walk'	1,49
periodista 'journalist'	*nacer*' be born'	0,65
perro 'dog'	*caer* 'fall'	0,61

Noun	Verb	Mean rating
perro 'dog'	*caminar* 'walk'	1,65
pescador 'fisherman'	*limpiar* 'clean'	2
pescador 'fisherman'	*morir* 'die'	1,27
pianista 'pianist'	*andar* 'walk'	0,63
pianista 'pianist'	*llevar* 'carry, wear'	0,32
piloto 'pilot'	*despertar* 'wake up'	0,56
piloto 'pilot'	*hablar* 'speak'	1,78
pintor 'painter'	*despertar* 'wake up'	0,58
pintor 'painter'	*hablar* 'speak'	1,05
policía 'police officer'	*comer* 'eat'	1,47
policía 'police officer'	*contar* 'tell, count'	1,16
presentador 'host'	*aparecer* 'appear'	1,81
presentador 'host'	*caminar* 'walk'	1,07
preso 'inmate'	*bailar* 'dance'	0,54
preso 'inmate'	*crecer* 'grow'	0,52
psicólogo 'psychologist'	*bailar* 'dance'	0,74
psicólogo 'psychologist'	*crecer* 'grow'	1,74
ratón 'mouse'	*caer* 'fall'	0,43
ratón 'mouse'	*nacer* 'be born'	1,76
rehén 'hostage'	*saltar* 'jump'	1,1
rehén 'hostage'	*traer* 'bring'	0,83
reina 'queen'	*saltar* 'jump'	0,38
reina 'queen'	*traer* 'bring'	0,32

Noun	Verb	Mean rating
revisor 'reviser'	*llamar* 'call'	1,87
sacerdote 'priest'	*despertar* 'wake up'	0,4
sacerdote 'priest'	*tocar* 'touch'	1,09
taxista 'taxi driver'	*hablar* 'speak'	1,96
taxista 'taxi driver'	*llegar* 'arrive'	1,98
viajero 'traveler'	*matar* 'kill'	0,29

4. Experimental sentences used in Experiment 1

(1)

a) María dijo que el pájaro de color marrón clarito murió totalmente en silencio la noche de Año Nuevo.

b) María dijo que el cachorro de color marrón clarito murió totalmente en silencio la noche de Año Nuevo.

(2)

a) Elena dijo que la florista con camisa y sombrero apareció después del último programa de la tarde.

b) Elena dijo que el arquero con camisa y sombrero apareció después del último programa de la tarde.

(3)

a) La señora dijo que el ratón negro, peludo y grande cayó ese día por las escaleras del edificio.

b) La señora dijo que el chimpancé negro, peludo y grande cayó ese día por las escaleras del edificio.

(4)

a) El hombre dijo que el hámster blanco de la vecina cayó por la ventana del salón esa mañana.

b) El hombre dijo que el perro blanco de la vecina cayó por la ventana del salón esa mañana.

(5)

a) La chica dijo que el músico vestido con traje y corbata llegó rápidamente al lago del parque natural.

b) La chica dijo que el taxista vestido con traje y corbata llegó rápidamente al lago del parque natural.

(6)

a) La mujer dijo que el chimpancé gris con la barriga rosa nació sobre las tres y cuarto de la madrugada.

b) La mujer dijo que el ratón gris con la barriga rosa nació sobre las tres y cuarto de la madrugada.

(7)

a) El inspector dijo que el pescador de la aldea de al lado murió en su propia casa durante las vacaciones.

b) El inspector dijo que el doctor de la aldea de al lado murió en su propia casa durante las vacaciones.

(8)

a) Juan dijo que el matemático de barba larga y rizada salió de la casa con un gran saco de patatas.

b) Juan dijo que el leñador de barba larga y rizada salió de la casa con un gran saco de patatas.

(9)

a) El chico dijo que el arquero de gran fama y renombre pasó rápidamente por delante de la tienda.

b) El chico dijo que la florista de gran fama y renombre pasó rápidamente por delante de la tienda.

(10)

a) El caballero dijo que el informático de cejas muy pobladas despertó de su largo y profundo sueño al instante.

b) El caballero dijo que el sacerdote de cejas muy pobladas despertó de su largo y profundo sueño al instante.

(11)

a) El médico dijo que el preso sentado en el banco del parque creció mucho en los últimos años de su adolescencia.

b) El médico dijo que el psicólogo sentado en el banco del parque creció mucho en los últimos años de su adolescencia.

(12)

a) La profesora dijo que el presentador vestido con una bata apareció de la nada en medio del recibidor de la casa.

b) La profesora dijo que el marinero vestido con una bata apareció de la nada en medio del recibidor de la casa.

(13)

a) El niño dijo que la costurera alta, delgada y esbelta desapareció aquella mañana de otoño entre la bruma.

b) El niño dijo que la empresaria alta, delgada y esbelta desapareció aquella mañana de otoño entre la bruma.

(14)

a) El amigo dijo que el chico de ojos azul verdoso llegó al puerto esa mañana con una amplia sonrisa.

b)El amigo dijo que el anciano de ojos azul verdoso llegó al puerto esa mañana con una amplia sonrisa.

(15)

a) La mujer dijo que el piloto pelirrojo y con pecas despertó en una casa vacía después de muchos días.

b) La mujer dijo que el pintor pelirrojo y con pecas despertó en una casa vacía después de muchos días.

(16)

a) María dijo que la marmota más ruidosa de todas desapareció misteriosamente una tarde de invierno.

b) María dijo que la gallina más ruidosa de todas desapareció misteriosamente una tarde de invierno.

(17)

a) El hombre dijo que el carpintero más conocido de la ciudad nació exactamente el mismo día que su esposa.

b) El hombre dijo que el periodista más conocido de la ciudad nació exactamente el mismo día que su esposa.

(18)

a) Juan dijo que la frutera joven y vivaracha salió de la tienda de electrónica bastante rápido.

b) Juan dijo que la oculista joven y vivaracha salió de la tienda de electrónica bastante rápido.

(19)

a) Pedro dijo que el canario de mirada inteligente pasó rápidamente por detrás de la ventana.

b) Pedro dijo que la jirafa de mirada inteligente pasó rápidamente por detrás de la ventana.

(20)

a) El padre dijo que el lince pequeño y asustadizo creció mucho durante su estancia en aquella casa.

b) El padre dijo que el conejo pequeño y asustadizo creció mucho durante su estancia en aquella casa.

(21)

a) María dijo que el psicólogo vestido con ropa de abrigo bailó toda la noche en una discoteca de la ciudad.

b) María dijo que el preso vestido con ropa de abrigo bailó toda la noche en una discoteca de la ciudad.

(22)

a) La niña dijo que el marinero con muchos tatuajes caminó un buen rato por los pasillos del edificio.

b) La niña dijo que el presentador con muchos tatuajes caminó un buen rato por los pasillos del edificio.

(23)

a) El paciente dijo que la empresaria de pelo corto y moreno corrió por el paseo de la playa durante horas.

b) El paciente dijo que la costurera de pelo corto y moreno corrió por el paseo de la playa durante horas.

(24)

a) La reportera dijo que el anciano de grandes ojos azules gritó toda la noche por el jardín de su casa.

b) La reportera dijo que el chico de grandes ojos azules gritó toda la noche por el jardín de su casa.

(25)

a) El pasajero dijo que el pintor con camisa y corbata azul habló con poca claridad por la megafonía.

b) El pasajero dijo que el piloto con camisa y corbata azul habló con poca claridad por la megafonía.

(26)

a) Su amigo dijo que la gallina de color blanco y marrón corrió por la parcela dando vueltas en círculos.

b) Su amigo dijo que la marmota de color blanco y marrón corrió por la parcela dando vueltas en círculos.

(27)

a) El vecino dijo que el periodista de anciana edad y pelo blanco anduvo por toda la casa con preocupación y miedo.

b) El vecino dijo que el carpintero de anciana edad y pelo blanco anduvo por toda la casa con preocupación y miedo.

(28)

a) El presidente dijo que la oculista de pelo negro y rizado paseó por toda la oficina con los brazos en jarras.

b) El presidente dijo que la frutera de pelo negro y rizado paseó por toda la oficina con los brazos en jarras.

(29)

a) El niño dijo que la jirafa de color amarillo nadó en el riachuelo durante un cuarto de hora.

b) El niño dijo que el canario de color amarillo nadó en el riachuelo durante un cuarto de hora.

(30)

a) El cazador dijo que el conejo de orejas grandes y peludas giró sobre sí mismo en una milésima de segundo.

b) El cazador dijo que el lince de orejas grandes y peludas giró sobre sí mismo en una milésima de segundo.

(31)

a) María dijo que el bebé rubio, regordete y alegre bailó por la tienda con una sonrisa de oreja a oreja.

b) María dijo que el barbero rubio, regordete y alegre bailó por la tienda con una sonrisa de oreja a oreja.

(32)

a) La niña dijo que el perro pequeñito y miedoso caminó perdido durante todo el día y toda la noche.

b) La niña dijo que el hámster pequeñito y miedoso caminó perdido durante todo el día y toda la noche.

(33)

a) Su amigo dijo que el cachorro más pequeño de la tienda saltó rápidamente por encima de la mesa.

b) Su amigo dijo que el pájaro más pequeño de la tienda saltó rápidamente por encima de la mesa.

(34)

a) El vecino dijo que el leñador con tatuajes en los brazos gritó como loco por los caminos montaña abajo.

b) El vecino dijo que el matemático con tatuajes en los brazos gritó como loco por los caminos montaña abajo.

(35)

a) El paciente dijo que el taxista muy callado y tímido habló ese día con muchísima seguridad.

b) El paciente dijo que el músico muy callado y tímido habló ese día con muchísima seguridad.

(36)

a) La reportera dijo que el bombero con la nariz torcida giró sobre sí mismo lentamente y con mucho miedo.

b) La reportera dijo que el logopeda con la nariz torcida giró sobre sí mismo lentamente y con mucho miedo.

(37)

a) El niño dijo que el pianista pelirrojo americano anduvo por las calles de la ciudad feliz y tranquilo.

b) El niño dijo que el electricista pelirrojo americano anduvo por las calles de la ciudad feliz y tranquilo.

(38)

a) El presidente dijo que el escritor latinoamericano nadó con fuertes brazadas río arriba y contracorriente.

b) El presidente dijo que el viajero latinoamericano nadó con fuertes brazadas río arriba y contracorriente.

(39)

a) La periodista dijo que el entrenador muy experimentado paseó nervioso por la habitación una y otra vez.

b) La periodista dijo que el conductor muy experimentado paseó nervioso por la habitación una y otra vez.

(40)

a) El pasajero dijo que la reina de pelo rizado y canoso saltó del helicóptero con la ayuda de los agentes.

b) El pasajero dijo que la rehén de pelo rizado y canoso saltó del helicóptero con la ayuda de los agentes.

(41)

a) El cliente dijo que el cartero de pelo negro y tupido comió rápidamente y con muchísimo entusiasmo un helado de chocolate.

b) El cliente dijo que la modista de pelo negro y tupido comió rápidamente y con muchísimo entusiasmo un helado de chocolate.

(42)

a) La directora dijo que el logopeda de camisa de cuadros tocó con mucha calma y una habilidad sorprendente una canción al piano.

b) La directora dijo que el bombero de camisa de cuadros tocó con mucha calma y una habilidad sorprendente una canción al piano.

(43)

a) La madre dijo que la peluquera de grandes ojos verdes contó cuidadosamente y de manera muy pausada el número de asistentes.

b) La madre dijo que la policía de grandes ojos verdes contó cuidadosamente y de manera muy pausada el número de asistentes.

(44)

a) El padre dijo que la gimnasta alta, morena y esbelta limpió afanosamente durante toda la tarde su estantería de premios.

b) El padre dijo que la cantante alta, morena y esbelta limpió afanosamente durante toda la tarde su estantería de premios.

(45)

a) La reportera dijo que la cantante más bajita de todas llamó muchísimas veces esa mañana de otoño a su madre.

b) La reportera dijo que la gimnasta más bajita de todas llamó muchísimas veces esa mañana de otoño a su madre.

(46)

a) El narrador dijo que el viajero de barba larga y blanca mató de manera efectiva y con sus propias manos una serpiente.

b) El narrador dijo que el escritor de barba larga y blanca mató de manera efectiva y con sus propias manos una serpiente.

(47)

a) La profesora dijo que el electricista más conocido de la cuidad llevó rápida y cuidadosamente en su sombrero las joyas robadas.

b) La profesora dijo que el pianista más conocido de la cuidad llevó rápida y cuidadosamente en su sombrero las joyas robadas.

(48)

a) El inspector dijo que la policía simpática y alegre comió al lado de las escaleras relucientes un sándwich de queso.

b) El inspector dijo que la peluquera simpática y alegre comió al lado de las escaleras relucientes un sándwich de queso.

(49)

a) El reportero dijo que el sacerdote más joven de todo el grupo tocó con sus propias manos y sin una pizca de miedo el veneno.

b) El reportero dijo que el informático más joven de todo el grupo tocó con sus propias manos y sin una pizca de miedo el veneno.

(50)

a) El inspector dijo que la rehén retenida en la embajada trajo dentro de su bolso de cuentas azules y negras una pistola.

b) El inspector dijo que la reina retenida en la embajada trajo dentro de su bolso de cuentas azules y negras una pistola.

(51)

a) El cliente dijo que la limpiadora con cara larga y triste preparó muy adecuadamente esa misma mañana la ruta de la excursión.

b) El cliente dijo que la directora con cara larga y triste preparó muy adecuadamente esa misma mañana la ruta de la excursión.

(52)

a) La directora dijo que el paciente de grandes ojos vivarachos arregló con paciencia, alegría y mucha tranquilidad aquel ordenador.

b) La directora dijo que el barrendero de grandes ojos vivarachos arregló con paciencia, alegría y mucha tranquilidad aquel ordenador.

(53)

a) La madre dijo que el bebé de pelo muy oscuro arregló muy lentamente y con sus pequeños deditos la pistola.

b) La madre dijo que el lémur de pelo muy oscuro arregló muy lentamente y con sus pequeños deditos la pistola.

(54)

a) El padre dijo que el doctor cansado y magullado limpió de forma concienzuda y hasta la perfección su pulsera de la suerte.

b) El padre dijo que el pescador cansado y magullado limpió de forma concienzuda y hasta la perfección su pulsera de la suerte.

(55)

a) La reportera dijo que el párroco jovencito y sin experiencia llamó con voz temblorosa por la megafonía a su superior.

b) La reportera dijo que el revisor jovencito y sin experiencia llamó con voz temblorosa por la megafonía a su superior.

(56)

a) El narrador dijo que el estudiante de brazos delgaduchos preparó en su horno pirolítico de última generación un bacalao riquísimo.

b) El narrador dijo que el percusionista de brazos delgaduchos preparó en su horno pirolítico de última generación un bacalao riquísimo.

(57)

a) La profesora dijo que el explorador más atrevido del grupo mató con muchísimo esfuerzo y ya casi sin aliento al oso.

b) La profesora dijo que el atleta más atrevido del grupo mató con muchísimo esfuerzo y ya casi sin aliento al oso.

(58)

a) El inspector dijo que el asesino de pelo extraño y puntiagudo llevó durante todo el transcurso de la película un sombrero en la cabeza.

b) El inspector dijo que el científico de pelo extraño y puntiagudo llevó durante todo el transcurso de la película un sombrero en la cabeza.

(59)

a) El reportero dijo que el barbero vestido con camisa azul trajo con las manos y los brazos llenos a rebosar todos los juguetes.

b) El reportero dijo que el bebé vestido con camisa azul trajo con las manos y los brazos llenos a rebosar todos los juguetes.

(60)

a) El vecino dijo que la modista más amable del pueblo contó ante la petición de sus amigos y colegas su historia.

b) El vecino dijo que el cartero más amable del pueblo contó ante la petición de sus amigos y colegas su historia.

5. Filler sentences used in Experiment 1

61. El niño exclamó: ¡Qué gigantesca es la pecera de tu salón llena de peces de color naranja y amarillo!

62. La mujer dijo que esa misma mañana se había caído la iglesia más antigua del pueblo debido al terremoto.

63. El amigo le preguntó: ¿Está el faro de la parte exterior de la ría lo suficientemente habitable para las vacaciones de verano?

64. Su amiga dijo que la novia al final no se compró la camiseta azul de rayas rojas y blancas en el viaje a Nueva York.

65. La princesa exclamó: ¡Un payaso con la cara pintada se ha comido de un bocado el helado de ese niño!

66. Su novia le preguntó: ¿Qué tipo de comida está comiendo el elefante del circo ambulante?

67. El comentarista dijo que el hombre no saltó lo suficientemente alto durante el partido de la semifinal.

68. La cuentacuentos relató que aquella noche la bruja de gorro negro y puntiagudo voló montada en su escoba mágica por encima de la ciudad.

69. La reportera preguntó enfadada: ¿Se puede saber cómo ha entrado un murciélago en mi despacho a las doce y media del mediodía?

70. El niño dijo que la mochila se rompió sola como por arte de magia en el patio del colegio durante el recreo.

71. La madre exclamó: ¡Cuidado! Ese biberón quema muchísimo por la parte de abajo, pero no por la de arriba.

72. La niña preguntó: ¿Se ha ido ya ese abejorro tan gordo y peludo de la entrada de la casa?

73. La enfermera dijo que la tirita se empapó de la sangre del paciente moribundo al instante.

74. La profesora exclamó: ¡Qué grande era aquel globo de la fiesta de la primera comunión de Pedro!

75. La mujer confesó que la bañera no goteaba desde el lunes, sino desde la mañana del miércoles.

76. El hombre exclamó: ¡Cuidado! La bolsa de papel reciclado se está volando con esta ventolera horrible.

77. El inspector preguntó: ¿A qué ritmo crece aproximadamente la barba de un hombre adulto promedio?

78. El escritor dijo que aquella mariquita posada sobre su pluma de escribir no le molestaba en absoluto.

79. La veterinaria exclamó sorprendida: ¡Con qué facilidad y qué rápido ha abierto este pulpo la rosca de la botella de vidrio!

80. El inspector preguntó: ¿Se puede saber cuánto tiempo lleva oxidado y sucio el banco más antiguo y emblemático de la ciudad?

81. La vecina afirmó que ninguno de sus cinturones de hebilla se había caído por la ventana del patio de luces del edificio.

82. La policía dijo que la bomba localizada en el interior del banco explotará en aproximadamente veinticinco minutos.

83. María preguntó: ¿La caja de cartón llena de figuritas de decoración del salón es para mí o no?

84. La abuela le espetó: ¿No te hace mucho daño en el costado y en la espalda ese sujetador tan apretado?

85. El estudiante de arquitectura dijo que el puente construido encima del río se derrumbará por el peso excesivo y el mal estado del soporte en el terreno.

86. Una alumna preguntó: ¿A qué temperatura se derrite normalmente la mantequilla de leche de vaca?

87. La azafata dijo que un cactus de púas enormes le pinchó la mano durante su viaje por el desierto de Gobi.

88. El nativo americano preguntó: ¿Dónde se habrá metido la piragua de madera de secuoya con todas las provisiones?

89. El cuentacuentos relató que esa noche el reloj dio las doce de la noche con trece campanadas en vez de doce.

90. El cocinero preguntó: ¿En qué momento se habrá escapado de la olla el cangrejo rojo de la pinza rota?

91. La mujer afirmó que su nuevo dentista era sin duda alguna y con diferencia el mejor de toda la ciudad.

92. El hombre preguntó: ¿Entonces tu médico se fue de la consulta al momento sin decir absolutamente nada?

93. La vecina gritó: ¡Cuidado! ¡El fuego ya se ha extendido por las escaleras, y por el rellano del primer piso también!

94. El pescador exclamó: ¡Aquel pez gigantesco se resistió como un demonio atrapado en la red de pesca!

95. El niño preguntó: ¿Y entonces qué deseo le concedió al final de la película el genio de la lámpara mágica?

96. El inspector preguntó: ¿Qué objeto destruyó supuestamente el fantasma en la casa encantada de su abuela?

97. El historiador dijo que aquel rey no gobernó como un tirano, sino como un auténtico y generoso líder.

98. El padre comentó que debido a la falta de viento la cometa no se elevó del suelo casi nada aquella tarde de invierno.

99. El hombre egipcio aseguró que aquel escarabajo proveniente de las dunas de Egipto no tenía una maldición, sino poderes mágicos.

100. El ama de llaves dijo que el cortacésped del jardín se estropeó justamente en la peor época del año.

101. La madre explicó que aquella hoja de árbol no se había secado bien debido a la humedad de ese lugar.

102. El veterinario preguntó: ¿Qué come exactamente un león adulto dentro de un parque natural sin presas en libertad?

103. La niña preguntó: ¿Dónde se ha escondido la lagartija de color verde y amarillo del terrario de reptiles?

104. La chica exclamó: ¡Una llama de pelo blanco y rizado me escupió en toda la cara durante la visita al parque natural!

105. El biólogo exclamó: ¡Ese macaco se ha comido todas las galletas de chocolate de la caja recién abierta!

106. El vecino preguntó: ¿Por qué calles del pueblo se paseó aquel día el alce de casi dos metros de altura?

107. La mujer comentó que la trampa para ratones no se accionó debidamente en las instalaciones de la granja.

108. La nutricionista afirmó que una hamburguesa de vaca no es una buena elección para una comida saludable y equilibrada.

109. El padre exclamó: ¿Por qué está hecho añicos el espejo redondo del salón de la casa de los abuelos?

110. El cura preguntó: ¿Dónde se encontraba a esas horas la monja de la orden de las Carmelitas?

Appendix C.
Supplementary materials to Chapter 3

1. Noun and visual target pairs used in online norming study

Trial type	Noun	Visual target
test	águila ‘eagle’	feather
test	águila ‘eagle’	nest
test	águila ‘eagle’	wing
test	autobús ‘bus’	car
test	autobús ‘bus’	taxi
test	bicicleta ‘bicycle’	motorcycle
test	bicicleta ‘bicycle’	tricycle
test	bombero ‘firefighter’	fire extinguisher
test	bombero ‘firefighter’	hose
test	camion ‘truck’	bus
test	camion ‘truck’	tyre
test	cañón ‘cannon’	bomb
test	cañón ‘cannon’	dynamite
test	coche ‘car’	steering wheel
test	coche ‘car’	taxi
test	conductor ‘driver’	bus
test	conductor ‘driver’	truck
test	delfín ‘dolphin’	fishbone
test	delfín ‘dolphin’	sea wave
test	diamante ‘diamond’	necklace
test	diamante ‘diamond’	ring
test	fotógrafa ‘photographer’	camera
test	futbolista ‘football player’	ball
test	futbolista ‘football player’	goal

Trial Type	Noun	Visual Target
test	hoja 'leaf'	plant
test	hoja 'leaf'	tree
test	marinero 'sailor'	anchor
test	marinero 'sailor'	ship
test	moto 'motorcycle'	bicycle
test	moto 'motorcycle'	car
test	músico 'musician'	piano
test	músico 'musician'	violin
test	policía 'police officer'	gun
test	policía 'police officer'	rifle
test	soldado 'soldier'	rifle
test	soldado 'soldier'	tank
test	submarine 'submarine'	ship
test	submarine 'submarine'	periscope
test	velero 'sailboat'	ship
test	velero 'sailboat'	sea wave
filler	ángel 'angel'	cloud
filler	ángel 'angel'	devil
filler	atleta 'athlete'	injury
filler	atleta 'athlete'	torch
filler	Australia	koala
filler	Australia	boomerang
filler	camiseta 'shirt'	needle
filler	camiseta 'shirt'	yarn
filler	Caperucita Roja 'Little Red Riding Hood'	basket
filler	Caperucita Roja 'Little Red Riding Hood'	lumberjack
filler	cocina 'kitchen'	soap
filler	cocina 'kitchen'	washing machine
filler	establo 'stables'	pig
filler	establo 'stables'	wheelbarrow
filler	foca 'seal'	wolf
filler	foca 'seal'	zebra

Trial Type	Noun	Visual Target
filler	galaxia ‘galaxy’	planet
filler	galaxia ‘galaxy’	spaceship
filler	gato ‘cat’	hare
filler	gato ‘cat’	leopard
filler	Harry Potter	wizard
filler	Harry Potter	glasses
filler	hogar ‘home’	antenna
filler	hogar ‘home’	window
filler	huevo ‘egg’	bird
filler	huevo ‘egg’	breakfast
filler	lluvia ‘rain’	lake
filler	lluvia ‘rain’	well
filler	mudanza ‘move’	box
filler	mudanza ‘move’	house
filler	Navidad ‘Christmas’	fir
filler	Navidad ‘Christmas’	present
filler	paciente ‘patient’	ambulance
filler	paciente ‘patient’	vaccine
filler	Peter Pan	fairy
filler	Peter Pan	shadow
filler	pingüino ‘penguin’	ice cube
filler	pingüino ‘penguin’	whale
filler	sujetador ‘bra’	robe
filler	sujetador ‘bra’	woman
filler	ajedrez ‘chess’	planet
filler	ajedrez ‘chess’	rocket
filler	astronauta ‘astronaut’	chessboard
filler	astronauta ‘astronaut’	pawn
filler	Biblia ‘Bible’	mouth
filler	Biblia ‘Bible’	tooth
filler	bruja ‘witch’	cross
filler	bruja ‘witch’	shrine

Trial Type	Noun	Visual Target
filler	cartero ‘mailman’	lightbulb
filler	cartero ‘mailman’	plug
filler	cocinera ‘cook’	nurse
filler	cocinera ‘cook’	vaccine
filler	compra ‘shopping’	deck of cards
filler	compra ‘shopping’	rabbit
filler	dentista ‘dentist’	puddle
filler	dentista ‘dentist’	snow
filler	electricidad ‘electricity’	axe
filler	electricidad ‘electricity’	timber
filler	espada ‘sword’	shoe
filler	espada ‘sword’	shoelaces
filler	hospital	mailbox
filler	hospital	stamp
filler	jardinero ‘gardener’	bottle
filler	jardinero ‘gardener’	leg
filler	leñador ‘lumberjack’	gladiator
filler	leñador ‘lumberjack’	shield
filler	lluvia ‘rain’	mountain
filler	lluvia ‘rain’	sheep
filler	luna ‘moon’	cooking pot
filler	luna ‘moon’	oven
filler	mago ‘wizard’	bag
filler	mago ‘wizard’	money
filler	nieve ‘snow’	paint brush
filler	nieve ‘snow’	painting
filler	pastor ‘shepherd’	ice cube
filler	pastor ‘shepherd’	rain
filler	pintura ‘painter’	sun
filler	pintura ‘painter’	twilight
filler	sidra ‘apple cider’	flower
filler	sidra ‘apple cider’	grass mower

2. Noun and visual target pairs used in visual norming study

Trial type	Noun	Visual target
test	águila 'eagle'	feather
test	autobús 'bus'	car
test	bicicleta 'bicycle'	tricycle
test	bombero 'firefighter'	hose
test	camion 'truck'	tyre
test	cañón 'cannon'	bomb
test	coche 'car'	steering wheel
test	conductor 'driver'	bus
test	delfín 'dolphin'	sea wave
test	diamante 'diamond'	necklace
test	fotógrafa 'photographer'	camera
test	futbolista 'football player'	ball
test	hoja 'leaf'	plant
test	marinero 'sailor'	ship
test	moto 'motorcycle'	bicycle
test	músico 'musician'	piano
test	policía 'police officer'	gun
test	soldado 'soldier'	tank
test	submarine 'submarine'	periscope
test	velero 'sailboat'	sea wave
filler	actriz 'actress'	*NA*
filler	balanza 'scale'	*NA*
filler	calculadora 'calculator'	*NA*
filler	cesta 'basket'	*NA*
filler	faro 'lighthouse'	*NA*
filler	flauta 'flute'	*NA*
filler	hormiga 'ant'	*NA*
filler	impresora 'printer'	*NA*
filler	jamón 'ham'	*NA*

Trial Type	Noun	Visual Target
filler	leñador 'lumberjack'	*NA*
filler	llave 'key'	*NA*
filler	manta 'blanket'	*NA*
filler	ojo 'eye'	*NA*
filler	oso 'bear'	*NA*
filler	parque 'park'	*NA*
filler	pintura 'painter'	*NA*
filler	puerta 'door'	*NA*
filler	robot	*NA*
filler	serpiente 'snake'	*NA*
filler	tijeras 'scissors'	*NA*

3. Experimental sentences used in Experiment 2

(1)

a) La bióloga dijo que el águila de color negro y marrón desapareció en aquella cueva pequeña, fría y oscura entre las piedras.

b) La bióloga dijo que el águila de color negro y marrón voló en aquella cueva pequeña, fría y oscura impulsada por el viento.

c) La bióloga dijo que el águila de color negro y marrón secó en aquella cueva pequeña, fría y oscura la superficie del suelo.

d) La bióloga dijo que la hoja de color negro y marrón desapareció en aquella cueva pequeña, fría y oscura entre las piedras.

e) La bióloga dijo que la hoja de color negro y marrón voló en aquella cueva pequeña, fría y oscura impulsada por el viento.

f) La bióloga dijo que la hoja de color negro y marrón secó en aquella cueva pequeña, fría y oscura la superficie del suelo.

(2)

a) El general dijo que el soldado con la bandera verde se desplomó delante de la torreta de los alemanes como a cámara lenta.

b) El general dijo que el soldado con la bandera verde explotó delante de la torreta de los alemanes debido a una detonación inesperada.

c) El general dijo que el soldado con la bandera verde mató delante de la torreta de los alemanes a tres soldados enemigos.

d) El general dijo que el cañón con la bandera verde se desplomó delante de la torreta de los alemanes como a cámara lenta.

e) El general dijo que el cañón con la bandera verde exploto delante de la torreta de los alemanes debido a una detonación inesperada.

f) El general dijo que el cañón con la bandera verde mató delante de la torreta de los alemanes a tres soldados enemigos.

(3)

a) La clienta dijo que la fotógrafa más cara de la agencia surgió de repente desde detrás del murito de piedra de forma inesperada.

b) La clienta dijo que la fotógrafa más cara de la agencia saltó de repente desde detrás del murito de piedra después de tropezarse.

c) La clienta dijo que la fotógrafa más cara de la agencia rozó de repente desde detrás del murito de piedra el altar de los novios.

d) La clienta dijo que la bicicleta más cara de la agencia surgió de repente desde detrás del murito de piedra de forma inesperada.

e) La clienta dijo que la bicicleta más cara de la agencia saltó de repente desde detrás del murito de piedra después de tropezarse.

f) La clienta dijo que la bicicleta más cara de la agencia rozó de repente desde detrás del murito de piedra el altar de los novios.

(4)

a) El historiador dijo que el músico con un mensaje de los rusos se inclinó hacia la derecha justo delante del muro muy lentamente.

b) El historiador dijo que el músico con un mensaje de los rusos circuló hacia la derecha justo delante del muro para hacer su señal secreta.

c) El historiador dijo que el músico con un mensaje de los rusos orientó hacia la derecha justo delante del muro la cámara de espionaje.

d) El historiador dijo que el submarino con un mensaje de los rusos se inclinó hacia la derecha justo delante del muro muy lentamente.

e) El historiador dijo que el submarino con un mensaje de los rusos circuló hacia la derecha justo delante del muro para hacer su señal secreta.

f) El historiador dijo que el submarino con un mensaje de los rusos orientó hacia la derecha justo delante del muro la cámara de espionaje.

(5)

a) El capitán dijo que el marinero con un dibujo de sirena se hundió muy lentamente entre aquellas algas marrones después del naufragio.

b) El capitán dijo que el marinero con un dibujo de sirena navegó muy lentamente entre aquellas algas marrones hasta llegar a la playa.

c) El capitán dijo que el marinero con un dibujo de sirena vertió muy lentamente entre aquellas algas marrones el whiskey que llevaba.

d) El capitán dijo que el velero con un dibujo de sirena se hundió muy lentamente entre aquellas algas marrones después del naufragio.

e) El capitán dijo que el velero con un dibujo de sirena navegó muy lentamente entre aquellas algas marrones hasta llegar a la playa.

f) El capitán dijo que el velero con un dibujo de sirena vertió muy lentamente entre aquellas algas marrones el whiskey que llevaba.

(6)

a) La reportera dijo que la policía con un logo en el lateral se tropezó en el charco de aceite vertido en la entrada con un bidón.

b) La reportera dijo que la policía con un logo en el lateral patinó en el charco de aceite vertido en la entrada del hospital.

c) La reportera dijo que la policía con un logo en el lateral mojó en el charco de aceite vertido en la entrada la cuerda que arrastraba.

d) La reportera dijo que el camión con un logo en el lateral se tropezó en el charco de aceite vertido en la entrada con un bidón.

e) La reportera dijo que el camión con un logo en el lateral patinó en el charco de aceite vertido en la entrada del hospital.

f) La reportera dijo que el camión con un logo en el lateral mojó en el charco de aceite vertido en la entrada la cuerda que arrastraba.

(7)

a) La mujer dijo que el delfín de color gris plateado se posó encima de la plataforma de la exhibición muy delicadamente.

b) La mujer dijo que el delfín de color gris plateado brilló encima de la plataforma de la exhibición con los rayos de sol.

c) La mujer dijo que el delfín de color gris plateado emitió encima de la plataforma de la exhibición un brillo muy intenso.

d) La mujer dijo que el diamante de color gris plateado se posó encima de la plataforma de la exhibición muy delicadamente.

e) La mujer dijo que el diamante de color gris plateado brilló encima de la plataforma de la exhibición con los rayos de sol.

f) La mujer dijo que el diamante de color gris plateado emitió encima de la plataforma de la exhibición un brillo muy intenso.

(8)

a) El periodista dijo que el bombero de la película de acción apareció entre nubes de gas negro por el pasillo con una mujer encima.

b) El periodista dijo que el bombero de la película de acción transitó entre nubes de gas negro por el pasillo acelerando a tope.

c) El periodista dijo que el bombero de la película de acción destrozó entre nubes de gas negro por el pasillo una de las ventanas.

d) El periodista dijo que la moto de la película de acción apareció entre nubes de gas negro por el pasillo con una mujer encima.

e) El periodista dijo que la moto de la película de acción transitó entre nubes de gas negro por el pasillo acelerando a tope.

f) El periodista dijo que la moto de la película de acción destrozó entre nubes de gas negro por el pasillo una de las ventanas.

(9)

a) La comentarista dijo que el futbolista más veloz de la competición se cayó por el campo cubierto de polvo y arena pendiente abajo.

b) La comentarista dijo que el futbolista más veloz de la competición corrió por el campo cubierto de polvo y arena hasta superar los 50 km/h.

c) La comentarista dijo que el futbolista más veloz de la competición persiguió por el campo cubierto de polvo y arena al supuesto ladrón.

d) La comentarista dijo que el coche más veloz de la competición se cayó por el campo cubierto de polvo y arena pendiente abajo.

e) La comentarista dijo que el coche más veloz de la competición corrió por el campo cubierto de polvo y arena hasta superar los 50 km/h.

f) La comentarista dijo que el coche más veloz de la competición persiguió por el campo cubierto de polvo y arena al supuesto ladrón.

(10)

a) El repartidor dijo que el conductor procedente de Bilbao se desvaneció a la llegada de su novia al muelle del puerto sin dejar rastro.

b) El repartidor dijo que el conductor procedente de Bilbao pitó a la llegada de su novia al muelle del puerto con tres fuertes bocinazos.

c) El repartidor dijo que el conductor procedente de Bilbao trajo a la llegada de su novia al muelle del puerto un paquete a su nombre.

d) El repartidor dijo que el autobús procedente de Bilbao se desvaneció a la llegada de su novia al muelle del puerto sin dejar rastro.

e) El repartidor dijo que el autobús procedente de Bilbao pitó a la llegada de su novia al muelle del puerto con tres fuertes bocinazos.

f) El repartidor dijo que el autobús procedente de Bilbao trajo a la llegada de su novia al muelle del puerto un paquete a su nombre.

(11)

a) El científico dijo que el águila apoyada en el suelo desapareció bajo la sombra de aquel peñasco en la montaña en un abrir y cerrar de ojos.

b) El científico dijo que el águila apoyada en el suelo voló bajo la sombra de aquel peñasco en la montaña con una ráfaga de brisa.

c) El científico dijo que el águila apoyada en el suelo secó bajo la sombra de aquel peñasco en la montaña la tierra de su alrededor.

d) El científico dijo que la hoja apoyada en el suelo desapareció bajo la sombra de aquel peñasco en la montaña en un abrir y cerrar de ojos.

e) El científico dijo que la hoja apoyada en el suelo voló bajo la sombra de aquel peñasco en la montaña con una ráfaga de brisa.

f) El científico dijo que la hoja apoyada en el suelo secó bajo la sombra de aquel peñasco en la montaña la tierra de su alrededor.

(12)

a) La militar dijo que el soldado escondido detrás del tronco se desplomó en un visto y no visto en medio de la retirada delante de su general.

b) La militar dijo que el soldado escondido detrás del tronco explotó en un visto y no visto en medio de la retirada al pisar una granada.

c) La militar dijo que el soldado escondido detrás del tronco mató en un visto y no visto en medio de la retirada a ocho hombres.

d) La militar dijo que el cañón escondido detrás del tronco se desplomó en un visto y no visto en medio de la retirada delante de su general.

e) La militar dijo que el cañón escondido detrás del tronco explotó en un visto y no visto en medio de la retirada al pisar una granada.

f) La militar dijo que el cañón escondido detrás del tronco mató en un visto y no visto en medio de la retirada a ocho hombres.

(13)

a) El profesor dijo que la fotógrafa rápida, ligera y elegante surgió de repente por detrás de la esquina del pasillo del instituto.

b) El profesor dijo que la fotógrafa rápida, ligera y elegante saltó de repente por detrás de la esquina del pasillo asustando a su compañera.

c) El profesor dijo que la fotógrafa rápida, ligera y elegante rozó de repente por detrás de la esquina del pasillo el botón de la alarma.

d) El profesor dijo que la bicicleta rápida, ligera y elegante surgió de repente por detrás de la esquina del pasillo del instituto.

e) El profesor dijo que la bicicleta rápida, ligera y elegante saltó de repente por detrás de la esquina del pasillo asustando a su compañera.

f) El profesor dijo que la bicicleta rápida, ligera y elegante rozó de repente por detrás de la esquina del pasillo el botón de la alarma.

(14)

a) El guía dijo que el músico famoso por sus logros se inclinó hacia la izquierda junto al muro de retención totalmente desorientado.

b) El guía dijo que el músico famoso por sus logros circuló hacia la izquierda junto al muro de retención para dar la vuelta.

c) El guía dijo que el músico famoso por sus logros orientó hacia la izquierda junto al muro de retención su aparato de localización.

d) El guía dijo que el submarino famoso por sus logros se inclinó hacia la izquierda junto al muro de retención totalmente desorientado.

e) El guía dijo que el submarino famoso por sus logros circuló hacia la izquierda junto al muro de retención para dar la vuelta.

f) El guía dijo que el submarino famoso por sus logros orientó hacia la izquierda junto al muro de retención su aparato de localización.

(15)

a) La deportista dijo que el marinero retirado ya por sus años se hundió en la competición organizada por el club como un peso muerto.

b) La deportista dijo que el marinero retirado ya por sus años navegó en la competición organizada por el club rápido como el viento.

c) La deportista dijo que el marinero retirado ya por sus años vertió en la competición organizada por el club el agua dulce del depósito.

d) La deportista dijo que el velero retirado ya por sus años se hundió en la competición organizada por el club como un peso muerto.

e) La deportista dijo que el velero retirado ya por sus años navegó en la competición organizada por el club rápido como el viento.

f) La deportista dijo que el velero retirado ya por sus años vertió en la competición organizada por el club el agua dulce del depósito.

(16)

a) El vigilante dijo que la policía mejor preparada del equipo se tropezó en la propia puerta de urgencias del hospital con los bidones del suelo.

b) El vigilante dijo que la policía mejor preparada del equipo patinó en la propia puerta de urgencias del hospital en un derrape digno de película.

c) El vigilante dijo que la policía mejor preparada del equipo mojó en la propia puerta de urgencias del hospital a los sanitarios al pisar un charco.

d) El vigilante dijo que el camión mejor preparado del equipo se tropezó en la propia puerta de urgencias del hospital con los bidones del suelo.

e) El vigilante dijo que el camión mejor preparado del equipo patinó en la propia puerta de urgencias del hospital en un derrape digno de película.

f) El vigilante dijo que el camión mejor preparado del equipo mojó en la propia puerta de urgencias del hospital a los sanitarios al pisar un charco.

(17)

a) El hombre dijo que el delfín grisáceo y plateado se posó sobre la losa de mármol negro veteado arrastrado por el agua.

b) El hombre dijo que el delfín grisáceo y plateado brilló sobre la losa de mármol negro veteado con una intensidad deslumbrante.

c) El hombre dijo que el delfín grisáceo y plateado emitió sobre la losa de mármol negro veteado una luz resplandeciente.

d) El hombre dijo que el diamante grisáceo y plateado se posó sobre la losa de mármol negro veteado arrastrado por el agua.

e) El hombre dijo que el diamante grisáceo y plateado brilló sobre la losa de mármol negro veteado con una intensidad deslumbrante.

f) El hombre dijo que el diamante grisáceo y plateado emitió sobre la losa de mármol negro veteado una luz resplandeciente.

(18)

a) La gerente dijo que el bombero más voluminoso de la flota apareció de forma totalmente inesperada por la acera de la quinta avenida.

b) La gerente dijo que el bombero más voluminoso de la flota transitó de forma totalmente inesperada por la acera debido al incendio.

c) La gerente dijo que el bombero más voluminoso de la flota destrozó de forma totalmente inesperada por la acera el tubo de escape.

d) La gerente dijo que la moto más voluminosa de la flota apareció de forma totalmente inesperada por la acera de la quinta avenida.

e) La gerente dijo que la moto más voluminosa de la flota transitó de forma totalmente inesperada por la acera debido al incendio.

f) La gerente dijo que la moto más voluminosa de la flota destrozó de forma totalmente inesperada por la acera el tubo de escape.

(19)

a) La señora dijo que el futbolista ligero y muy solicitado se cayó cuesta abajo y a toda pastilla por la avenida durante la carrera.

b) La señora dijo que el futbolista ligero y muy solicitado corrió cuesta abajo y a toda pastilla por la avenida de Bilbao.

c) La señora dijo que el futbolista ligero y muy solicitado persiguió cuesta abajo y a toda pastilla por la avenida a su contrincante.

d) La señora dijo que el coche ligero y muy solicitado se cayó cuesta abajo y a toda pastilla por la avenida durante la carrera.

e) La señora dijo que el coche ligero y muy solicitado corrió cuesta abajo y a toda pastilla por la avenida de Bilbao.

f) La señora dijo que el coche ligero y muy solicitado persiguió cuesta abajo y a toda pastilla por la avenida a su contrincante.

(20)

a) El chico dijo que el conductor preferido de los pasajeros se desvaneció en el momento justo de la inauguración de la estación de tren.

b) El chico dijo que el conductor preferido de los pasajeros pitó en el momento justo de la inauguración con una bocina muy grave y fuerte.

c) El chico dijo que el conductor preferido de los pasajeros trajo en el momento justo de la inauguración a los viajeros que faltaban.

d) El chico dijo que el autobús preferido de los pasajeros se desvaneció en el momento justo de la inauguración de la estación de tren.

e) El chico dijo que el autobús preferido de los pasajeros pitó en el momento justo de la inauguración con una bocina muy grave y fuerte.

f) El chico dijo que el autobús preferido de los pasajeros trajo en el momento justo de la inauguración a los viajeros que faltaban.

(21)

a) La profesora dijo que el águila con manchitas amarillas desapareció dentro de la casa de la coleccionista sin ser vista.

b) La profesora dijo que el águila con manchitas amarillas voló dentro de la casa de la coleccionista revoloteando por el aire.

c) La profesora dijo que el águila con manchitas amarillas secó dentro de la casa de la coleccionista la humedad de la ramita.

d) La profesora dijo que la hoja con manchitas amarillas desapareció dentro de la casa de la coleccionista sin ser vista.

e) La profesora dijo que la hoja con manchitas amarillas voló dentro de la casa de la coleccionista revoloteando por el aire.

f) La profesora dijo que la hoja con manchitas amarillas secó dentro de la casa de la coleccionista la humedad de la ramita.

(22)

a) El médico dijo que el soldado polvoriento y manchado de sangre se desplomó como a cámara lenta ante la angustia de su amigo y compañero.

b) El médico dijo que el soldado polvoriento y manchado de sangre explotó como a cámara lenta ante la angustia de su amigo por una bomba.

c) El médico dijo que el soldado polvoriento y manchado de sangre mató como a cámara lenta ante la angustia de su amigo al otro médico.

d) El médico dijo que el cañón polvoriento y manchado de sangre se desplomó como a cámara lenta ante la angustia de su amigo y compañero.

e) El médico dijo que el cañón polvoriento y manchado de sangre explotó como a cámara lenta ante la angustia de su amigo por una bomba.

f) El médico dijo que el cañón polvoriento y manchado de sangre mató como a cámara lenta ante la angustia de su amigo al otro médico.

(23)

a) El organizador dijo que la fotógrafa con una cestita de mimbre surgió como si nada desde la parte de atrás del biombo en el salón de belleza.

b) El organizador dijo que la fotógrafa con una cestita de mimbre saltó como si nada desde la parte de atrás del biombo por encima del sillón.

c) El organizador dijo que la fotógrafa con una cestita de mimbre rozó como si nada desde la parte de atrás del biombo la columna de mármol.

d) El organizador dijo que la bicicleta con una cestita de mimbre surgió como si nada desde la parte de atrás del biombo en el salón de belleza.

e) El organizador dijo que la bicicleta con una cestita de mimbre saltó como si nada desde la parte de atrás del biombo por encima del sillón.

f) El organizador dijo que la bicicleta con una cestita de mimbre rozó como si nada desde la parte de atrás del biombo la columna de mármol.

(24)

a) La sargento dijo que el músico procedente de Francia se inclinó hacia la barandilla del paseo principal poco a poco.

b) La sargento dijo que el músico procedente de Francia circuló hacia la barandilla del paseo principal para saludar al presidente.

c) La sargento dijo que el músico procedente de Francia orientó hacia la barandilla del paseo principal un objeto alargado.

d) La sargento dijo que el submarino procedente de Francia se inclinó hacia la barandilla del paseo principal poco a poco.

e) La sargento dijo que el submarino procedente de Francia circuló hacia la barandilla del paseo principal para saludar al presidente.

f) La sargento dijo que el submarino procedente de Francia orientó hacia la barandilla del paseo principal un objeto alargado.

(25)

a) La joven dijo que el marinero más importante de la flota se hundió ante la tristeza de sus íntimos amigos en el naufragio.

b) La joven dijo que el marinero más importante de la flota navegó ante la tristeza de sus íntimos amigos muy mal en esa regata.

c) La joven dijo que el marinero más importante de la flota vertió ante la tristeza de sus íntimos amigos todo el ron del barco.

d) La joven dijo que el velero más importante de la flota se hundió ante la tristeza de sus íntimos amigos en el naufragio.

e) La joven dijo que el velero más importante de la flota navegó ante la tristeza de sus íntimos amigos muy mal en esa regata.

f) La joven dijo que el velero más importante de la flota vertió ante la tristeza de sus íntimos amigos todo el ron del barco.

(26)

a) El principiante dijo que la policía cargada de provisiones se tropezó justo en el momento de la llegada del jefe con una farola.

b) El principiante dijo que la policía cargada de provisiones patinó justo en el momento de la llegada del jefe en el charco de aceite.

c) El principiante dijo que la policía cargada de provisiones mojó justo en el momento de la llegada del jefe todo el suelo del almacén.

d) El principiante dijo que el camión cargado de provisiones se tropezó justo en el momento de la llegada del jefe con una farola.

e) El principiante dijo que el camión cargado de provisiones patinó justo en el momento de la llegada del jefe en el charco de aceite.

f) El principiante dijo que el camión cargado de provisiones mojó justo en el momento de la llegada del jefe todo el suelo del almacén.

(27)

a) El vigilante dijo que el delfín de la mujer entrada en años se posó encima de la elevación de color negro con delicadeza.

b) El vigilante dijo que el delfín de la mujer entrada en años brilló encima de la elevación de color negro bajo la luz del sol.

c) El vigilante dijo que el delfín de la mujer entrada en años emitió encima de la elevación de color negro una luz plateada preciosa.

d) El vigilante dijo que el diamante de la mujer entrada en años se posó encima de la elevación de color negro con delicadeza.

e) El vigilante dijo que el diamante de la mujer entrada en años brilló encima de la elevación de color negro bajo la luz del sol.

f) El vigilante dijo que el diamante de la mujer entrada en años emitió encima de la elevación de color negro una luz plateada preciosa.

(28)

a) El joven dijo que el bombero con unas alforjas rojas apareció ante la sorpresa de todos sus compañeros sin un rasguño.

b) El joven dijo que el bombero con unas alforjas rojas transitó ante la sorpresa de todos sus compañeros por la azotea del edificio.

c) El joven dijo que el bombero con unas alforjas rojas destrozó ante la sorpresa de todos sus compañeros la fachada del edificio.

d) El joven dijo que la moto con unas alforjas rojas apareció ante la sorpresa de todos sus compañeros sin un rasguño.

e) El joven dijo que la moto con unas alforjas rojas transitó ante la sorpresa de todos sus compañeros por la azotea del edificio.

f) El joven dijo que la moto con unas alforjas rojas destrozó ante la sorpresa de todos sus compañeros la fachada del edificio.

(29)

a) La periodista dijo que el futbolista favorito del presidente se cayó cuesta abajo por el terraplén embarrado por ir demasiado rápido.

b) La periodista dijo que el futbolista favorito del presidente corrió cuesta abajo por el terraplén embarrado rápido como una centella.

c) La periodista dijo que el futbolista favorito del presidente persiguió cuesta abajo por el terraplén embarrado a su rival.

d) La periodista dijo que el coche favorito del presidente se cayó cuesta abajo por el terraplén embarrado por ir demasiado rápido.

e) La periodista dijo que el coche favorito del presidente corrió cuesta abajo por el terraplén embarrado rápido como una centella.

f) La periodista dijo que el coche favorito del presidente persiguió cuesta abajo por el terraplén embarrado a su rival.

(30)

a) La revisora dijo que el conductor de la compañía extranjera se desvaneció después de una de las curvas más pronunciadas sin dejar rastro.

b) La revisora dijo que el conductor de la compañía extranjera pitó después de una de las curvas más pronunciadas por casi sufrir un accidente.

c) La revisora dijo que el conductor de la compañía extranjera trajo después de una de las curvas más pronunciadas muy malas noticias.

d) La revisora dijo que el autobús de la compañía extranjera se desvaneció después de una de las curvas más pronunciadas sin dejar rastro.

e) La revisora dijo que el autobús de la compañía extranjera pitó después de una de las curvas más pronunciadas por casi sufrir un accidente.

f) La revisora dijo que el autobús de la compañía extranjera trajo después de una de las curvas más pronunciadas muy malas noticias.

4. Filler sentences used in Experiment 2

(1 a-c)

i. La semana pasada pusieron en la tele un documental sobre aves rapaces de la Península Ibérica narrado por una científica.

ii. En el documental se comentaban los diferentes hábitos de caza y anidación de un ejemplar concreto.

(1 d-f)

i. La semana pasada pusieron en la tele un documental sobre plantas fascinantes de la Península Ibérica narrado por una científica.

ii. En el documental se comentaban los diferentes procesos biológicos de una especie concreta.

(2)

i. El otro día, subiendo por las escaleras, una chica oyó el diálogo de una película de guerra bastante antigua.

(3 a-c)

i. Cuando Cris y Jon decidieron casarse, fueron a una agencia bastante moderna y con buena pinta a contratar a una fotógrafa.

ii. Mientras se quitaba el vestido, la novia dijo que no habían quedado satisfechos con el trabajo de la profesional.

(3 d-f)

i. Cuando Cris y Jon decidieron hacer el camino de Santiago, fueron a una agencia bastante moderna y con buena pinta a comprar toda la equipación.

ii. Mientras se probaba unas botas, la chica dijo que vio en una pantalla enorme de alta resolución un vídeo promocional de bicis bastante extraño.

(4)

i. En la Complutense de Madrid un erudito del tema dio una charla sobre códigos gestuales utilizados durante la guerra para intercambiar información.

(5)

ii. A principios de año Miren empezó a leer Moby Dick porque le encantan los libros sobre ballenas y el mar.

iii. Mientras la profesora hablaba en clase, ella estuvo leyendo un pasaje súper interesante en el que hablaba un marinero de barba blanca.

(6)

Una periodista de pelo largo tuvo que cubrir en su primer día de trabajo una noticia sobre una persecución bastante absurda.

(7 a-c)

i. En el parque natural de Fuerteventura hicieron el año pasado muchas exhibiciones de animales acuáticos.

ii. Por eso María llevó a sus hijos a la isla, y después les contó a sus amistades emocionada lo que habían visto en el espectáculo.

(7 d-f)

i. En una joyería de Fuerteventura hicieron el año pasado muchas exhibiciones de piedras preciosas.

ii. Por eso María llevó a sus amigas a la isla, y después le contó a su marido emocionada lo que habían visto en la exposición.

(8)

i. Ayer por la tele en un programa de cine apareció un reportero con barba explicando la nueva y rompedora película de Spielberg.

(9)

ii. La otra noche mi vecino el fontanero dijo que estaban echando un reportaje de deportistas famosos en un programa especial en Teledeporte.

iii. La narradora del documental dijo que el deportista sobre el que hablaba participó en una persecución policial por pura casualidad.

(10)

i. Anteayer Pablo tuvo una conversación por teléfono con su madre contándole lo que había visto en el muelle de Zarautz ese día.

(11 a-c)

ii. Tanto en Netflix como en la radio podemos encontrar muchos programas y documentales sobre naturaleza.

iii. En uno de los favoritos de Sergio, el narrador es un biólogo que cuenta eventos diarios de un ave rapaz en la montaña donde vive.

(11 d-f)

i. Tanto en Netflix como en la radio podemos encontrar muchos programas y documentales sobre naturaleza.

ii. En uno de los favoritos de Sergio, el narrador es un biólogo que cuenta los métodos reproductivos de un árbol en peligro de extinción.

(12)

i. Una mujer del ejército contó en un informe militar los sucesos de una batalla de la Guerra Civil española.

(13 a-c)

ii. En un instituto de Vitoria los profesores hicieron un proyecto en el que fotografiaban a los alumnos de manera más espontánea.

iii. Trajeron a varios fotógrafos que se pusieron en los pasillos y en las aulas, disponibles para cualquier alumno.

(13 d-f)

i. En un instituto de Vitoria los profesores hicieron un proyecto en el que animaban a los alumnos a practicar deporte de manera más espontánea.

ii. Trajeron varias bicicletas y patinetes que se pusieron en los pasillos y en las aulas, disponibles para cualquier alumno.

(14)

i. En un tour por Copenhague, un guía turístico con sombrero les explicó a los visitantes un suceso curioso que había ocurrido durante la guerra.

(15)

ii. Todos los veranos el club náutico de Vigo organiza una regata por la ría entre las bateas, narrada por una profesional.

iii. La narradora dijo que un antiguo capitán de barco participó en el evento con su embarcación de madera de pino.

(16)

i. Dentro del hospital se reúnen siempre los de la empresa de seguridad para hablar de lo que han visto ese día en sus cámaras.

(17 a-c)

ii. Jose ganó un concurso la semana pasada para nadar en una piscina con unos mamíferos marinos entrenados para espectáculos.

iii. Le presentaron a un delfín, Flipper, y a una foca, Gustava, que se portaron muy bien durante toda la sesión.

(17 d-f)

i. Jose ganó un concurso la semana pasada para contemplar con sus propios ojos unas joyas importantísimas de Francia.

ii. Le dejaron tocar unas perlas auténticas y otras piedras preciosas, y dijo que se lo había pasado muy bien.

(18)

i. En una casa de Nueva York saltó de repente la alarma de incendios y los equipos de emergencia asistieron al instante.

(19)

ii. Todos los años se organiza en Burgos una carrera, y este año participó un deportista bastante conocido en España.

iii. Llegó en su limusina y justo cuando se estaba bajando presenció a un rival suyo al que le tenía mucha tirria, así que se decidió a ganar.

(20)

i. Un estudiante que va siempre a Bilbao dijo que el otro día hubo un contratiempo en la nueva estación.

(21)

ii. Al otro lado de la calle, nos dijo nuestra profe, vive una señora muy excéntrica que colecciona todo tipo de cosas.

iii. Cuando volvía a su casa, nos dijo que vio lo que estaba pasando dentro de la casa de la señora.

(22)

i. Un miembro de un equipo sanitario de la guerra contó cómo vivió un episodio bastante traumático en la batalla de Stalingrado.

(23)

ii. El equipo de marketing de Rosalía dijo que la joven cantante debería grabar un nuevo videoclip en uno de los salones de uñas que tanto frecuenta.

iii. El decorado del videoclip era bastante bizarro: había motosierras, bicicletas, patines, palomas y, por supuesto, uñas de gel.

(24)

i. Una sargento del ejército belga contó un suceso bastante inusual que observó en el puerto, donde sospecha haber visto a un espía.

(25)

ii. Paula, la chica con gafas que es miembro del club náutico de Lisboa, dijo en la cafetería del puerto que traía malas noticias.

iii. Al parecer algo le había pasado a su amigo Neira, el gallego, que estaba embarcado.

(26)

i. Uno de los nuevos dijo en la comisaría con la cafetera en la mano que una de sus compañeras había tenido un percance esa mañana.

(27)

ii. Ayer en las noticias dijeron que una mujer millonaria había sido detenida por tener en su posesión objetos y animales vivos indebidos.

iii. La mujer, una enamorada de las perlas y de los animales exóticos, fue delatada por uno de los miembros de seguridad de su casa.

(28)

i. En la academia de fuerzas y cuerpos de seguridad estuvieron haciendo unas prácticas un poco peligrosas el otro día.

(29)

ii. El presidente de Estados Unidos dijo que iría a ver en su helicóptero el partido de fútbol y la carrera, como había prometido.

iii. Hubo un par de momentos durante el evento deportivo de mucha tensión, que él después contó en Twitter.

(30)

i. Marisa, que trabaja para Alsa, contó el altercado que tuvieron ese día en la carretera hacia Miranda.

(31)

ii. Los padres de Mikel estaban muy preocupados cuando era pequeño con el tema de los amigos imaginarios.

iii. Su hijo decía que jugaba con su amigo imaginario a la pelota, a las muñecas y a los legos, entre otras cosas.

iv. El niño dijo que su amigo invisible llamó esa calurosa noche de verano a la puerta de casa.

(32)

i. En el tejado de su casa, María vio que había una gatita que bajó por el canalón de la fachada hasta llegar a la entrada.

ii. La niña dijo que la gata anaranjada y blanca maulló con muchísima fuerza y determinación hasta que le abrieron la puerta.

(33)

i. Una familia, deseosa de desconectar del ritmo frenético de la ciudad, se fue a una cabaña en el medio del bosque.

ii. Cada día la mujer contemplaba el amanecer, el atardecer, y las estrellas por la noche, ya que le gustaba mucho la naturaleza.

iii. La madre dijo que el primer rayo de sol de la mañana salió desde detrás de las montañas a lo lejos.

(34)

i. Mientras contemplaba el cortacésped con melancolía, un padre le confesó a su hijo lo que había sucedido.

ii. El padre dijo que el jardinero de pelo negro murió justo la noche anterior a la renovación de su contrato.

(35)

i. La abuela de Paula siempre ha sido la mejor repostera de la familia: hace unas magdalenas, donuts y palmeritas riquísimas.

ii. Una tarde Paula le pidió a su abuela que le enseñara a hacer esa masa tan rica, así que se pusieron a ello en la cocina.

iii. La abuela dijo que la masa de las palmeritas de chocolate subió enseguida hasta el borde del cuenco.

(36)

i. En el jardín con girasoles de Pepe hay un estanque lleno de animalitos entre los juncos verdes.

ii. El abuelo dijo que la rana verde y pequeñita del estanque nadó con una rapidez sorprendente para su tamaño entre las hojas.

5. Comprehension questions used in Experiment 2

(1)

a) ¿Qué desapareció en la cueva?

b) ¿Qué voló en la cueva?

c) ¿Qué secó el suelo?

d) ¿Qué desapareció en la cueva?

e) ¿Qué voló en la cueva?

f) ¿Qué secó el suelo?

(2)

a) ¿Quién se desplomó delante de la torreta?

b) ¿Quién explotó delante de la torreta?

c) ¿Quién mató a tres enemigos?

d) ¿Qué se desplomó delante de la torreta?

e) ¿Qué explotó delante de la torreta?

f) ¿Qué mató a tres enemigos?

(3)

a) ¿Quién surgió de repente?

b) ¿Quién saltó de repente?

c) ¿Quién rozó el altar?

d) ¿Qué surgió de repente?

e) ¿Qué saltó de repente?

f) ¿Qué rozó el altar?

(4)

a) ¿Quién se inclinó hacia la derecha?

b) ¿Quién circuló hacia la derecha?

c) ¿Quién orientó la cámara?

d) ¿Qué se inclinó hacia la derecha?

e) ¿Qué circuló hacia la derecha?

f) ¿Qué orientó la cámara?

(5)

a) ¿Quién se hundió muy lentamente?

b) ¿Quién navegó muy lentamente?

c) ¿Quién vertió el whiskey?

d) ¿Qué se hundió muy lentamente?

e) ¿Qué navegó muy lentamente?

f) ¿Qué vertió el whiskey?

(6)

a) ¿Quién se tropezó en el charco?

b) ¿Quién patinó en el charco?

c) ¿Quién mojó la cuerda?

d) ¿Qué se tropezó en el charco?

e) ¿Qué patinó en el charco?

f) ¿Qué mojó la cuerda?

(7)

a) ¿Qué se posó encima de la plataforma?

b) ¿Qué brilló encima de la plataforma?

c) ¿Qué emitió un brillo muy intenso?

d) ¿Qué se posó encima de la plataforma?

e) ¿Qué brilló encima de la plataforma?

f) ¿Qué emitió un brillo muy intenso?

(8)

a) ¿Quién apareció por el pasillo?

b) ¿Quién transitó por el pasillo?

c) ¿Quién destrozó la ventana?

d) ¿Qué apareció por el pasillo?

e) ¿Qué transitó por el pasillo?

f) ¿Qué destrozó la ventana?

(9)

a) ¿Quién se cayó por el campo?

b) ¿Quién corrió por el campo?

c) ¿Quién persiguió al ladrón?

d) ¿Qué se cayó por el campo?

e) ¿Qué corrió por el campo?

f) ¿Qué persiguió al ladrón?

(10)

a) ¿Quién se desvaneció en el muelle?

b) ¿Quién pitó en el muelle?

c) ¿Quién trajo el paquete?

d) ¿Qué se desvaneció en el muelle?

e) ¿Qué pitó en el muelle?

f) ¿Qué trajo el paquete?

(11)

a) ¿Qué desapareció bajo la sombra?

b) ¿Qué voló bajo la sombra?

c) ¿Qué secó la tierra?

d) ¿Qué desapareció bajo la sombra?

e) ¿Qué voló bajo la sombra?

f) ¿Qué secó la tierra?

(12)

a) ¿Quién se desplomó en la retirada?

b) ¿Quién explotó en la retirada?

c) ¿Quién mató a ocho hombres?

d) ¿Qué se desplomó en la retirada?

e) ¿Qué explotó en la retirada?

f) ¿Qué mató a ocho hombres?

(13)

a) ¿Quién surgió por detrás de la esquina?

b) ¿Quién saltó por detrás de la esquina?

c) ¿Quién rozó el botón de la alarma?

d) ¿Qué surgió por detrás de la esquina?

e) ¿Qué saltó por detrás de la esquina?

f) ¿Qué rozó el botón de la alarma?

(14)

a) ¿Quién se inclinó hacia la izquierda?

b) ¿Quién circuló hacia la izquierda?

c) ¿Quién orientó el aparato?

d) ¿Qué se inclinó hacia la izquierda?

e) ¿Qué circuló hacia la izquierda?

f) ¿Qué orientó el aparato?

(15)

a) ¿Quién se hundió en la competición?

b) ¿Quién navegó en la competición?

c) ¿Quién vertió el agua dulce?

d) ¿Qué se hundió en la competición?

e) ¿Qué navegó en la competición?

f) ¿Qué vertió el agua dulce?

(16)

a) ¿Quién se tropezó en la puerta de urgencias?

b) ¿Quién patinó en la puerta de urgencias?

c) ¿Quién mojó a los sanitarios?

d) ¿Qué se tropezó en la puerta de urgencias?

e) ¿Qué patinó en la puerta de urgencias?

f) ¿Qué mojó a los sanitarios?

(17)

a) ¿Qué se posó sobre la losa de mármol?

b) ¿Qué brilló sobre la losa de mármol?

c) ¿Qué emitió una luz resplandeciente?

d) ¿Qué se posó sobre la losa de mármol?

e) ¿Qué brilló sobre la losa de mármol?

f) ¿Qué emitió una luz resplandeciente?

(18)

a) ¿Quién apareció por la acera?

b) ¿Quién transitó por la acera?

c) ¿Quién destrozó el tubo de escape?

d) ¿Qué apareció por la acera?

e) ¿Qué transitó por la acera?

f) ¿Qué destrozó el tubo de escape?

(19)

a) ¿Quién se cayó cuesta abajo?

b) ¿Quién corrió cuesta abajo?

c) ¿Quién persiguió a su contrincante?

d) ¿Qué se cayó cuesta abajo?

e) ¿Qué corrió cuesta abajo?

f) ¿Qué persiguió a su contrincante?

(20)

a) ¿Quién se desvaneció en la inauguración?

b) ¿Quién pitó en la inauguración?

c) ¿Quién trajo a los viajeros?

d) ¿Qué se desvaneció en la inauguración?

e) ¿Qué pitó en la inauguración?

f) ¿Qué trajo a los viajeros?

(21)

a) ¿Qué desapareció dentro de la casa?

b) ¿Qué voló dentro de la casa?

c) ¿Qué secó la ramita?

d) ¿Qué desapareció dentro de la casa?

e) ¿Qué voló dentro de la casa?

f) ¿Qué secó la ramita?

(22)

a) ¿Quién se desplomó a cámara lenta?

b) ¿Quién explotó a cámara lenta?

c) ¿Quién mató al otro médico?

d) ¿Qué se desplomó a cámara lenta?

e) ¿Qué explotó a cámara lenta?

f) ¿Qué mató al otro médico?

(23)

a) ¿Quién surgió de detrás del biombo?

b) ¿Quién saltó de detrás del biombo?

c) ¿Quién rozó la columna de mármol?

d) ¿Qué surgió de detrás del biombo?

e) ¿Qué saltó de detrás del biombo?

f) ¿Qué rozó la columna de mármol?

(24)

a) ¿Quién se inclinó hacia la barandilla?

b) ¿Quién circuló hacia la barandilla?

c) ¿Quién orientó el objeto alargado?

d) ¿Qué se inclinó hacia la barandilla?

e) ¿Qué circuló hacia la barandilla?

f) ¿Qué orientó el objeto alargado?

(25)

a) ¿Quién se hundió en el naufragio?

b) ¿Quién navegó en la regata?

c) ¿Quién vertió el ron del barco?

d) ¿Qué se hundió en el naufragio?

e) ¿Qué navegó en la regata?

f) ¿Qué vertió el ron del barco?

(26)

a) ¿Quién se tropezó con una farola?

b) ¿Quién patinó en el charco?

c) ¿Quién mojó el suelo?

d) ¿Qué se tropezó con una farola?

e) ¿Qué patinó en el charco?

f) ¿Qué mojó el suelo?

(27)

a) ¿Qué se posó en la elevación?

b) ¿Qué brilló en la elevación?

c) ¿Qué emitió una luz plateada?

d) ¿Qué se posó en la elevación?

e) ¿Qué brilló en la elevación?

f) ¿Qué emitió una luz plateada?

(28)

a) ¿Quién apareció sin un rasguño?

b) ¿Quién transitó por la azotea?

c) ¿Quién destrozó la fachada?

d) ¿Qué apareció sin un rasguño?

e) ¿Qué transitó por la azotea?

f) ¿Qué destrozó la fachada?

(29)

a) ¿Quién se cayó cuesta abajo?

b) ¿Quién corrió cuesta abajo?

c) ¿Quién persiguió a su rival?

d) ¿Qué se cayó cuesta abajo?

e) ¿Qué corrió cuesta abajo?

f) ¿Qué persiguió a su rival?

(30)

a) ¿Quién se desvaneció después de la curva?

b) ¿Quién pitó después de la curva?

c) ¿Quién trajo muy malas noticias?

d) ¿Qué se desvaneció después de la curva?

e) ¿Qué pitó después de la curva?

f) ¿Qué trajo muy malas noticias?

Appendix D.
Supplementary materials to Chapter 4

1. Experimental sentences used in Experiment 3

(1)

a) María dijo que el marinero anciano de pelo cano, muchas arrugas en la cara y barba larga amó muchísimo durante los primeros veranos de su juventud a una mujer cubana.

b) María dijo que el marinero anciano de pelo cano, muchas arrugas en la cara y barba larga se divirtió muchísimo durante los primeros veranos de su juventud en las regatas de veleros.

(2)

a) Susana dijo que el electricista de aquel barrio, siempre con una visera azul y un mono de trabajo amó sin reservas ni dudas durante cada día de su vida a su esposa.

b) Susana dijo que el electricista de aquel barrio, siempre con una visera azul y un mono de trabajo se divirtió sin reservas ni dudas durante cada día de su vida con cada persona que conocía.

(3)

a) Pedro dijo que la fotógrafa originaria de un pequeño pueblo de la costa cerca de Philadelphia amó durante su breve estancia en una ciudad de Alemania a un artista bohemio.

b) Pedro dijo que la fotógrafa originaria de un pequeño pueblo de la costa cerca de Philadelphia se divirtió durante su breve estancia en una ciudad de Alemania como nunca.

(4)

a) Elena dijo que el músico de corbata negra, pantalón perfectamente plisado y semblante serio amó todos los días de ese verano idílico e inolvidable a un chico moreno y risueño.

b) Elena dijo que el músico de corbata negra, pantalón perfectamente plisado y semblante serio se divirtió todos los días de ese verano idílico e inolvidable en la playa con sus amigos.

(5)

a) David dijo que la futbolista de tatuajes en los brazos y melena larga y lisa en una coleta alta admiró mucho durante toda la temporada de competición internacional a su entrenadora.

b) David dijo que la futbolista de tatuajes en los brazos y melena larga y lisa en una coleta alta se alegró mucho durante toda la temporada de competición internacional de tener las compañeras que tenía.

(6)

a) Marta dijo que el conductor de mediana edad con el pelo rubio y una mandíbula muy cuadrada admiró aquella tarde en el seminario sobre las nuevas medidas de seguridad a la profesora.

b) Marta dijo que el conductor de mediana edad con el pelo rubio y una mandíbula muy cuadrada se alegró aquella tarde en el seminario sobre las nuevas medidas de seguridad de haber traído un bocadillo.

(7)

a) Cristina dijo que el piloto estadounidense con una camisa blanca e impoluta de algodón admiró durante su breve estancia en un hotel de las Maldivas el carácter de los lugareños.

b) Cristina dijo que el piloto estadounidense con una camisa blanca e impoluta de algodón se alegró durante su breve estancia en un hotel de las Maldivas cuando pudo por fin hacer buceo.

(8)

a) Juan dijo que la frutera procedente de una pequeña aldea entre Galicia y Asturias admiró en las primeras semanas de adaptación a la nueva tienda el aguante de sus compañeros.

b) Juan dijo que la frutera procedente de una pequeña aldea entre Galicia y Asturias se alegró en las primeras semanas de adaptación a la nueva tienda de tener unos compañeros tan buenos.

(9)

a) Sergio dijo que la pintora con una bata larga blanca y pelo teñido de color azul intenso quiso muchísimo durante aquella primavera del año ochenta y cuatro a una escultora francesa.

b) Sergio dijo que la pintora con una bata larga blanca y pelo teñido de color azul intenso se animó muchísimo durante aquella primavera del año ochenta y cuatro gracias al reconocimiento que obtuvo.

(10)

a) Daniel dijo que la enfermera recién salida de las últimas prácticas obligatorias de la carrera quiso un montón en aquella época de su vida universitaria a un novio que tenía.

b) Daniel dijo que la enfermera recién salida de las últimas prácticas obligatorias de la carrera se animó un montón en aquella época de su vida universitaria en su fiesta de cumpleaños.

(11)

a) Sara dijo que el marinero aficionado a la música clásica y especialmente a las obras de Zarzuela quiso muchísimo durante los últimos años de su jubilación a una cantante famosa.

b) Sara dijo que el marinero aficionado a la música clásica y especialmente a las obras de Zarzuela se animó muchísimo durante los últimos años de su jubilación en aquel concierto.

(12)

a) Alba dijo que el electricista procedente de un barrio de las afueras de Bilbao quiso durante su breve estancia en una ciudad de Corea del Norte a una profesora japonesa.

b) Alba dijo que el electricista procedente de un barrio de las afueras de Bilbao se animó durante su breve estancia en una ciudad de Corea del Norte en su aniversario de bodas.

(13)

a) Mario dijo que la fotógrafa de mediana estatura, ojos azul verdoso y preciosa sonrisa adoró durante los primeros años de su estancia en el colegio de primaria a aquella profesora de inglés.

b) Mario dijo que la fotógrafa de mediana estatura, ojos azul verdoso y preciosa sonrisa se ilusionó durante los primeros años de su estancia en el colegio de primaria con los nuevos amigos que hizo.

(14)

a) Teresa dijo que el músico de pelo rizado y oscuro, buen porte y sonrisa agradable adoró todos los días de aquella primavera de primero de la ESO pasar las mañanas con Eva.

b) Teresa dijo que el músico de pelo rizado y oscuro, buen porte y sonrisa agradable se ilusionó todos los días de aquella primavera de primero de la ESO al ver pasar a la chica rubia que le gustaba.

(15)

a) Pablo dijo que la futbolista natural de un pequeño pueblo al sudeste de Valladolid adoró durante toda su adolescencia y los primeros años de su veintena a su entrenadora.

b) Pablo dijo que la futbolista natural de un pequeño pueblo al sudeste de Valladolid se ilusionó durante toda su adolescencia y los primeros años de su veintena con la posibilidad de ir a las Olimpiadas.

(16)

a) Alejandra dijo que el conductor aficionado a los programas de competición y supervivencia adoró un montón en aquella época de su vida en una comuna hippie la libertad que tenía.

b) Alejandra dijo que el conductor aficionado a los programas de competición y supervivencia se ilusionó un montón en aquella época de su vida en una comuna hippie con su progreso en la pintura.

(17)

a) Noelia dijo que el piloto bastante joven de pelo castaño, ojos verdes y un poco de barba apreció un montón en los momentos más duros de su formación profesional el apoyo de sus compañeros.

b) Noelia dijo que el piloto bastante joven de pelo castaño, ojos verdes y un poco de barba se emocionó un montón en los momentos más duros de su formación profesional con el apoyo incondicional de su madre.

(18)

a) Miguel dijo que la frutera procedente de una familia muy querida en ese barrio de León apreció bastante en aquella época tan triste y difícil después de la pandemia la ayuda de su jefa.

b) Miguel dijo que la frutera procedente de una familia muy querida en ese barrio de León se emocionó bastante en aquella época tan triste y difícil después de la pandemia con la solidaridad de la gente.

(19)

a) Jose dijo que la pintora mexicana con unos tatuajes en el cuello y pendientes grandes de oro apreció muchísimo durante los primeros años de su formación profesional la paciencia de su mentora.

b) Jose dijo que la pintora mexicana con unos tatuajes en el cuello y pendientes grandes de oro se emocionó muchísimo durante los primeros años de su formación profesional con las palabras de su mentora.

(20)

a) Manuel dijo que la enfermera bastante aficionada a los documentales de animales y naturaleza apreció enormemente al final de aquella tarde calurosa de agosto la fiesta sorpresa que le hicieron.

b) Manuel dijo que la enfermera bastante aficionada a los documentales de animales y naturaleza se emocionó enormemente al final de aquella tarde calurosa de agosto con su fiesta de cumpleaños sorpresa.

(21)

a) María dijo que el marinero vestido con unos vaqueros vintage y una gorra manchada de pintura odió muchísimo durante los últimos años de su vejez a un hombre bilbaino.

b) María dijo que el marinero vestido con unos vaqueros vintage y una gorra manchada de pintura se aburrió muchísimo durante los últimos años de su vejez los días de bingo.

(22)

a) Susana dijo que el electricista nacido en el barrio más pobre y destartalado de toda Salamanca odió durante todas las carreras de fórmula uno de ese año a ese piloto.

b) Susana dijo que el electricista nacido en el barrio más pobre y destartalado de toda Salamanca se aburrió durante todas las carreras de fórmula uno de ese año por la falta de emoción.

(23)

a) Pedro dijo que la fotógrafa con una corbata negra y fina de mujer y una camisa ajustada de seda odió durante su larga estancia en un pueblecito de Polonia a un camarero muy maleducado.

b) Pedro dijo que la fotógrafa con una corbata negra y fina de mujer y una camisa ajustada de seda se aburrió durante su larga estancia en un pueblecito de Polonia sin sus amigas.

(24)

a) Elena dijo que el músico procedente de una familia bastante numerosa de siete hermanos odió todos los días de su estancia con la familia de intercambio al hijo más pequeño.

b) Elena dijo que el músico procedente de una familia bastante numerosa de siete hermanos se aburrió todos los días de su estancia con la familia de intercambio por no saber hablar bien la lengua.

(25)

a) David dijo que la futbolista originaria de un pequeño pueblo cerca de Santiago de Compostela envidió mucho durante toda la temporada de viajes y giras internacionales a su entrenador.

b) David dijo que la futbolista originaria de un pequeño pueblo cerca de Santiago de Compostela se apenó mucho durante toda la temporada de viajes y giras internacionales de tener las amigas que tenía.

(26)

a) Marta dijo que el conductor vestido con una camisa de cuadros azules y amarillos envidió aquella tarde en el seminario sobre las nuevas medidas de seguridad a la profesora.

b) Marta dijo que el conductor vestido con una camisa de cuadros azules y amarillos se apenó aquella tarde en el seminario sobre las nuevas medidas de seguridad de haber traído un bocadillo.

(27)

a) Cristina dijo que el piloto más inteligente de toda su promoción de estudios en la academia envidió durante su prolongada estancia en un hotel de Marbella la riqueza de la ciudad.

b) Cristina dijo que el piloto más inteligente de toda su promoción de estudios en la academia se apenó durante su prolongada estancia en un hotel de Marbella cuando tuvo que marcharse.

(28)

a) Juan dijo que la frutera más chismosa y cotilla de entre las dependientas de la tienda envidió durante las primeras semanas de aprendizaje en la tienda nueva el favoritismo del dueño a María.

b) Juan dijo que la frutera más chismosa y cotilla de entre las dependientas de la tienda se apenó durante las primeras semanas de aprendizaje en la tienda nueva de no tener buenos compañeros.

(29)

a) Sergio dijo que la pintora con mejor formación clásica de todos los estudiantes de la academia temió cada día en las clases de alemán de las tardes de los miércoles que la tratasen mal.

b) Sergio dijo que la pintora con mejor formación clásica de todos los estudiantes de la academia se preocupó cada día en las clases de alemán de las tardes de los miércoles de que no mejoraba.

(30)

a) Daniel dijo que la enfermera enganchada al programa del mediodía de La Ruleta de la Suerte temió un montón en aquella época de su vida laboral después de la universidad la subida del precio del alquiler.

b) Daniel dijo que la enfermera enganchada al programa del mediodía de La Ruleta de la Suerte se preocupó un montón en aquella época de su vida laboral después de la universidad por los precios del alquiler.

(31)

a) Sara dijo que el marinero de vivos ojos azules, tatuajes en los antebrazos y piel morena temió muchísimo durante los primeros años de su juventud morir ahogado en el mar.

b) Sara dijo que el marinero de vivos ojos azules, tatuajes en los antebrazos y piel morena se preocupó muchísimo durante los primeros años de su juventud por la salud de su madre.

(32)

a) Alba dijo que el electricista más callado y tímido de aquella empresa de reparaciones del hogar temió durante su larga estancia en una ciudad al norte de Estados Unidos que lo echaran del trabajo.

b) Alba dijo que el electricista más callado y tímido de aquella empresa de reparaciones del hogar se preocupó durante su larga estancia en una ciudad al norte de Estados Unidos por su inestabilidad laboral.

(33)

a) Mario dijo que la fotógrafa muy querida por todos los niños del colegio de primaria del barrio detestó todos los miércoles y jueves en las clases de tecnología el trato por parte del profesor.

b) Mario dijo que la fotógrafa muy querida por todos los niños del colegio de primaria del barrio se agobió todos los miércoles y jueves en las clases de tecnología con la actitud del profesor.

(34)

a) Teresa dijo que el músico con un clavel rojo intenso metido en el bolsillo de la chaqueta americana detestó después del cambio a otra clase de tercero de la ESO la soberbia de la tutora.

b) Teresa dijo que el músico con un clavel rojo intenso metido en el bolsillo de la chaqueta americana se agobió después del cambio a otra clase de tercero de la ESO con la soberbia de la tutora.

(35)

a) Pablo dijo que la futbolista con una melena rubia impresionante y abundantes pecas en la nariz detestó al final de la fiesta de su vigésimo primero cumpleaños la mala actitud de su familia.

b) Pablo dijo que la futbolista con una melena rubia impresionante y abundantes pecas en la nariz se agobió al final de la fiesta de su vigésimo primero cumpleaños con la actitud de su familia.

(36)

a) Alejandra dijo que el conductor uruguayo de baja estatura, piel morena y enorme sonrisa detestó muchísimo durante la época de su vida pasada en los Andes el frío de las montañas.

b) Alejandra dijo que el conductor uruguayo de baja estatura, piel morena y enorme sonrisa se agobió muchísimo durante la época de su vida pasada en los Andes con su empeoramiento de salud.

(37)

a) Noelia dijo que el piloto proveniente de Etiopía pero residente en Barcelona despreció por completo en los momentos más difíciles de su formación profesional la ayuda de su mentor.

b) Noelia dijo que el piloto proveniente de Etiopía pero residente en Barcelona se indignó por completo en los momentos más difíciles de su formación profesional con la falta de ayuda de su mentor.

(38)

a) Miguel dijo que la frutera con un vestido largo de flores azules por debajo del delantal verde despreció totalmente en aquella época tan delicada de los inicios de la crisis la caridad de su jefa.

b) Miguel dijo que la frutera con un vestido largo de flores azules por debajo del delantal verde se indignó totalmente en aquella época tan delicada de los inicios de la crisis con la caridad de su jefa.

(39)

a) Jose dijo que la pintora con un moño en la nuca hecho con un par de palillos de madera despreció en la primera clase con la profesora nueva de Estados Unidos la ayuda de su compañero.

b) Jose dijo que la pintora con un moño en la nuca hecho con un par de palillos de madera se indignó en la primera clase con la profesora nueva de Estados Unidos con los modales de la mujer.

(40)

a) Manuel dijo que la enfermera con un tatuaje de golondrinas y flores rojas en el antebrazo despreció al final de aquella guardia de casi 24 horas de duración los esfuerzos de su marido por alegrarla.

b) Manuel dijo que la enfermera con un tatuaje de golondrinas y flores rojas en el antebrazo se indignó al final de aquella guardia de casi 24 horas de duración con los malos modales del celador.

2. Filler sentences used in Experiment 3

(1)

i. Dice el jardinero que el árbol navideño se tala con hacha de filos de corte delgados.

ii. Dice el jardinero que el árbol navideño se tala con cuchillo de filos de corte delgados.

iii. Dice el jardinero que el árbol navideño se tala con llave de filos de corte delgados.

(2)

i. Dice el auxiliar que la aguja hipodérmica suministra lentamente la vacuna a cada paciente.

ii. Dice el auxiliar que la aguja hipodérmica suministra lentamente la píldora a cada paciente.

iii. Dice el auxiliar que la aguja hipodérmica suministra lentamente la piña a cada paciente.

(3)

i. Dice la abuela que la colada blanca está en la lavadora desde hace tres días.

ii. Dice la abuela que la colada blanca está en el horno desde hace tres días.

iii. Dice la abuela que la colada blanca está en la noria desde hace tres días.

(4)

i. Dice la técnico que el lago vitoriano estaba repleto de cisnes con plumaje blanco.

ii. Dice la técnico que el lago vitoriano estaba repleto de gallinas con plumaje blanco.

iii. Dice la técnico que el lago vitoriano estaba repleto de alfombras con plumaje blanco.

(5)

i. Dice el chico que el pez cartilaginoso fue capturado con caña de carrete giratorio.

ii. Dice el chico que el pez cartilaginoso fue capturado con escopeta de carrete giratorio.

iii. Dice el chico que el pez cartilaginoso fue capturado con imán de carrete giratorio.

(6)

i. Dice el hombre que la abeja obrera produce propóleo y miel cada primavera.

ii. Dice el hombre que la abeja obrera produce propóleo y leche cada primavera.

iii. Dice el hombre que la abeja obrera produce propóleo y diamantes cada primavera.

(7)

i. Dice el barrendero que el barco pesquero arribó rodeado de gaviotas hambrientas e inquietas.

ii. Dice el barrendero que el barco pesquero arribó rodeado de pavos hambrientas e inquietas.

iii. Dice el barrendero que el barco pesquero arribó rodeado de monjas hambrientas e inquietas.

(8)

i. Dice el monitor que la nieve artificial es para los trineos de plástico ligero.

ii. Dice el monitor que la nieve artificial es para los patinetes de plástico ligero.

iii. Dice el monitor que la nieve artificial es para los pollos de plástico ligero.

(9)

i. Dice la anciana que el campanario antiguo alberga una preciosa cigüeña desde hace años.

ii. Dice la anciana que el campanario antiguo alberga una preciosa avestruz desde hace años.

iii. Dice la anciana que el campanario antiguo alberga una preciosa portería desde hace años.

(10)

i. Dice la abuela que las setas Boletus se recogen en cestas de mimbre natural.

ii. Dice la abuela que las setas Boletus se recogen en bolsos de mimbre natural.

iii. Dice la abuela que las setas Boletus se recogen en ascensores de mimbre natural.

(11)

i. Dice el excursionista que la paella valenciana se come con cuchara plana de madera.

ii. Dice el excursionista que la paella valenciana se come con navaja plana de madera.

iii. Dice el excursionista que la paella valenciana se come con guitarra plana de madera.

(12)

i. Dice el cuento que la reina malvada llevaba siempre una corona llena de piedras preciosas.

ii. Dice el cuento que la reina malvada llevaba siempre una visera llena de piedras preciosas.

iii. Dice el cuento que la reina malvada llevaba siempre un donut lleno de piedras preciosas.

(13)

i. Dice el instructor que el pimentón dulce condimenta el pulpo a la perfección.

ii. Dice el instructor que el pimentón dulce condimenta el delfín a la perfección.

iii. Dice el instructor que el pimentón dulce condimenta el bolsillo a la perfección.

(14)

i. Dice el niño que la colchoneta hinchable flotaba en la piscina de aguas transparentes.

ii. Dice el niño que la colchoneta hinchable flotaba en el pozo de aguas transparentes.

iii. Dice el niño que la colchoneta hinchable flotaba en la urna de aguas transparentes.

(15)

i. Dice mamá que el queso majorero se hace con leche de cabra de Fuerteventura.

ii. Dice mamá que el queso majorero se hace con leche de perro de Fuerteventura.

iii. Dice mamá que el queso majorero se hace con leche de nudo de Fuerteventura.

(16)

i. Dice Julio que el casco negro estaba junto a la moto roja y brillante.

ii. Dice Julio que el casco negro estaba junto a la caravana roja y brillante.

iii. Dice Julio que el casco negro estaba junto a la bandeja roja y brillante.

(17)

i. Dice el responsable que el cava catalán se sirvió en copas grandes de vino.

ii. Dice el responsable que el cava catalán se sirvió en tazas grandes de vino.

iii. Dice el responsable que el cava catalán se sirvió en sacos grandes de vino.

(18)

i. Dice el experto que el indígena filipino pescaba siempre en canoa estrecha de madera.

ii. Dice el experto que el indígena filipino pescaba siempre en yate estrecho de madera.

iii. Dice el experto que el indígena filipino pescaba siempre en triángulo estrecho de madera.

(19)

i. Dice la enfermera que el empaste metálico estaba en la boca del desorientado paciente.

ii. Dice la enfermera que el empaste metálico estaba en la nariz del desorientado paciente.

iii. Dice la enfermera que el empaste metálico estaba en la chaqueta del desorientado paciente.

(20)

i. Dice el maestro que el estiércol fresco atrae a las moscas con mucha rapidez.

ii. Dice el maestro que el estiércol fresco atrae a las libélulas con mucha rapidez.

iii. Dice el maestro que el estiércol fresco atrae a las camisetas con mucha rapidez.

(21)

i. Dice el técnico que el retrato original mostraba trazos de pincel de grandes dimensiones.

ii. Dice el técnico que el retrato original mostraba trazos de rodillo de grandes dimensiones.

iii. Dice el técnico que el retrato original mostraba trazos de bellota de grandes dimensiones.

(22)

i. Dice el tío que la hierba aromática se corta con la hoz de mango corto.

ii. Dice el tío que la hierba aromática se corta con la tijera de mango corto.

iii. Dice el tío que la hierba aromática se corta con la esponja de mango corto.

(23)

i. Dice el periodista que el senderista desaparecido vestía aquel día unas botas azules muy llamativas.

ii. Dice el periodista que el senderista desaparecido vestía aquel día unos tacones azules muy llamativas.

iii. Dice el periodista que el senderista desaparecido vestía aquel día unas pilas azules muy llamativas.

(24)

i. Dice la directora que el colegio concertado ofrece servicio de autobús cada curso escolar.

ii. Dice la directora que el colegio concertado ofrece servicio de limusina cada curso escolar.

iii. Dice la directora que el colegio concertado ofrece servicio de cámara cada curso escolar.

(25)

i. Dice Manuel que el bombero en mejor forma física de toda la brigada comió el día de la inauguración de la nueva estación, mucho más moderna que la anterior, un bocadillo de lomo.

ii. Dice Manuel que el bombero en mejor forma física de toda la brigada comió el día de la inauguración de la nueva estación, mucho más moderna que la anterior, un bocadillo de lomo.

(26)

i. Dice Jesús que el fontanero que llevaba una visera blanca patrocinando su empresa bebió después de arreglar la instalación de cañerías de toda la casa una copita de champán.

ii. Dice Jesús que el fontanero que llevaba una visera blanca patrocinando su empresa bebió después de arreglar la instalación de cañerías de toda la casa una copita de champán.

(27)

i. Dice Maite que la limpiadora rubia y alta y que siempre llevaba los labios pintados escribió rápidamente en un momento libre entre dos turnos que tenía la lista de la compra.

ii. Dice Maite que la limpiadora rubia y alta y que siempre llevaba los labios pintados escribió rápidamente en un momento libre entre dos turnos que tenía la lista de la compra.

(28)

i. Dice Nerea que el leñador noruego que siempre llevaba una camisa de cuadros roja leyó por las tardes de aquel mes de noviembre después de salir del trabajo un montón de novelas de misterio.

ii. Dice Nerea que el leñador noruego que siempre llevaba una camisa de cuadros roja leyó por las tardes de aquel mes de noviembre después de salir del trabajo un montón de novelas de misterio.

(29)

i. Dice Aitor que la cartera que tenía un montón de hobbies muy diversos pintó durante sus vacaciones de verano en Costa Rica y el Salvador unas preciosas láminas de acuarela.

ii. Dice Aitor que la cartera que tenía un montón de hobbies muy diversos pintó durante sus vacaciones de verano en Costa Rica y el Salvador unas preciosas láminas de acuarela.

(30)

i. Dice Luis que el bebé de siete meses con unos ojos azules enormes comió entusiasmadamente ante la sorpresa de su madre y su abuela toda la papilla.

ii. Dice Luis que el bebé de siete meses con unos ojos azules enormes comió entusiasmadamente ante la sorpresa de su madre y su abuela toda la papilla.

3. Comprehension questions used in Experiment 3

(2)

b) ¿Quién amaba a su esposa?

(3)

b) ¿Quién se divirtió durante su estancia en Alemania?

(5)

a) ¿Quién admiró a su entrenadora?

(6)

b) ¿Quién se alegró de tener un bocadillo?

(8)

a) ¿Quién admiró el aguante de sus compañeros?

(9)

b) ¿Quién se animó aquella tarde de 1984?

(11)

a) ¿Quién quiso a una cantante famosa?

(12)

b) ¿Quién se animó en su aniversario de bodas?

(14)

a) ¿Quién adoraba pasar las mañanas con Eva?

(15)

b) ¿Quién se ilusionó con las Olimpiadas?

(17)

a) ¿Quién apreció el apoyo de sus compañeros?

(18)

b) ¿Quién se emocionó con la solidaridad de la gente?

(20)

a) ¿Quién apreció la fiesta sorpresa?

(21)

b) ¿Quién se aburría en el bingo?

(23)

a) ¿Quién odiaba a un camarero maleducado?

(24)

b) ¿Quién se aburrió en su estancia?

(26)

a) ¿Quién envidió a la profesora?

(27)

b) ¿Quién se apenó al marcharse de Marbella?

(29)

a) ¿Quién temía que la tratasen mal?

(30)

b) ¿Quién se preocupó por los precios del alquiler?

(32)

a) ¿Quién temía que lo despidiesen?

(33)

b) ¿Quién se agobió con la actitud del profesor?

(35)

a) ¿Quién detestó la actitud de su familia?

(36)

b) ¿Quién se agobió por su mala salud?

(38)

a) ¿Quién despreció la caridad de su jefa?

(39)

b) ¿Quién se indignó con los modales de la profesora?

(1)

iii. ¿Quién sabe cómo talar el árbol?

(2)

i. ¿Qué suministra la vacuna?

(3)

ii. ¿Dónde está la colada blanca?

(4)

ii. ¿Qué abundaba en el lago?

(5)

iii. ¿Qué animal fue capturado?

(6)

i. ¿Qué produce miel y propóleo?

(7)

iii. ¿Qué arribó en el puerto?

(8)

ii. ¿De qué son los patinetes?

(9)

i. ¿Qué alberga el campanario?

(10)

i. ¿Qué se recoge en cestas de mimbre?

(11)

ii. ¿Qué se come con navaja?

(12)

iii. ¿Cómo era la reina?

(13)

ii. ¿Cómo es el pimentón?

(14)

iii. ¿Cómo era la colchoneta?

(15)

i. ¿De dónde es el queso majorero?

(16)

ii. ¿Qué estaba junta a la caravana?

(17)

iii. ¿De dónde era el cava?

(18)

iii. ¿De dónde era el indígena?

(19)

i. ¿Dónde estaba el empaste?

(20)

ii. ¿Cómo es el estiércol?

(21)

ii. ¿Cómo era el retrato?

(22)

iii. ¿Cómo era la hierba?

(23)

i. ¿Qué vestía el senderista?

(24)

ii. ¿Cómo era el colegio?

(25)

i. ¿Qué comió el bombero?

ii. ¿Qué comió el bombero?

(26)

i. ¿Qué bebió el fontanero?

ii. ¿Qué bebió el fontanero?

(27)

i. ¿Qué escribió la limpiadora?

ii. ¿Qué escribió la limpiadora?

(28)

i. ¿Qué leyó el leñador?

ii. ¿Qué leyó el leñador?

(29)

i. ¿Qué pintó la cartera?

ii. ¿Qué pintó la cartera?

(30)

i. ¿Qué comió el bebé?

ii. ¿Qué comió el bebé?

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